Title
The invisible blade

Author
Simon, Christian Michael

Publication Date
1996

Peer reviewed|Thesis/dissertation

The Invisible Blade

Technology, Culture, and Mixed Metaphor in a North American Hospital

by

CHRISTIAN MICHAEL SIMON

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

MEDICAL ANTHROPOLOGY

in the

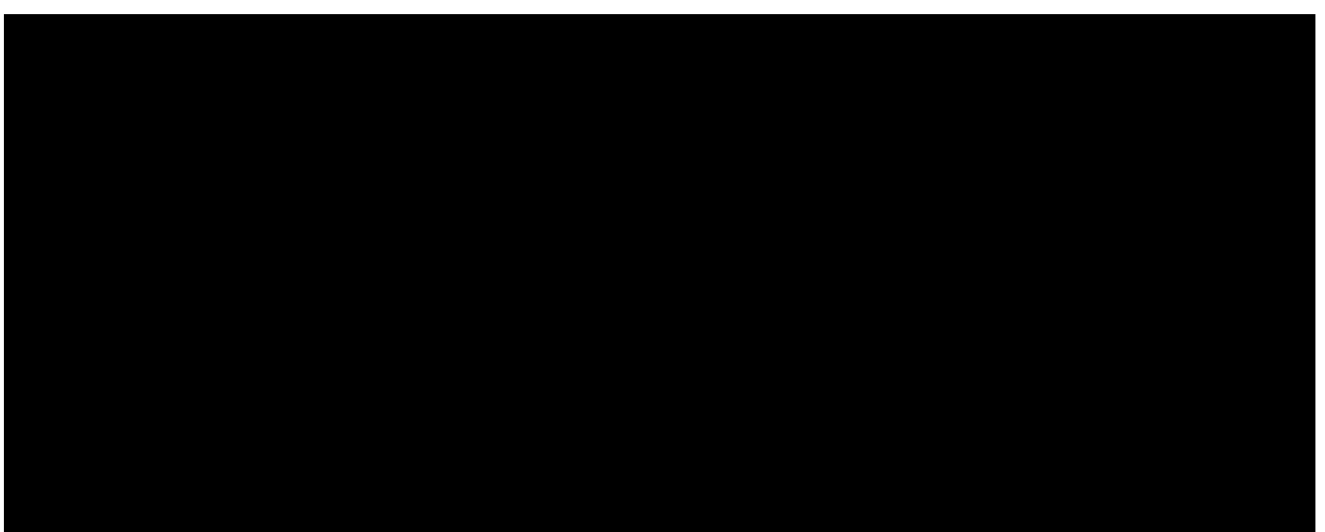
GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA

San Francisco AND

BERKELEY



Date University Librarian

Degree Conferred: . . . . . .

ACKNOWLEDGMENTS

Many people helped me conceive, research, and produce this dissertation; I thank them all from the bottom of my heart. I would like to thank especially those patients, health professionals, administrators, and others whom I interviewed, observed, and spent time with; under immense pressures, you were remarkably receptive, warm hearted, and helpful. I would also like to extend thanks to both faculty and student members of the Medical Anthropology Program at the University of California, San Francisco and Berkeley, many of whom have supported me and provided seminal advice throughout my doctoral training and research. Nancy Scheper-Hughes and Adele Clarke made useful suggestions and comments, and, perhaps more importantly, helped provide the kind of coursework training that encourages the development of good ideas. For her meticulous reading and prompt, thoughtful critique of all my draft installments, Linda Mitteness deserves special mention. Gay Becker, Norman Fineman, and Abigail Kohn were also very supportive; thank you for always being open to questions, and for making the business of paying the rent an enjoyable and educational one. Many ideas in the dissertation also bore fruit through discussions with my close friends Randy Inouye and Frank Rothschild; my thanks to both of you. Thanks also to Brenda Gee for easing the administrative side of things with professional flair and friendliness. Kindest thanks also go to Phoebe Platt, whose unflagging encouragement and enthusiasm I could not have done without. Finally, for the financial support they extended to me leading up to and including my dissertation research, I am deeply grateful to the Regents of the University of California, to Elekta Incorporated, and to the Centre for Science Development. Their generous financial assistance towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at are mine, and are not necessarily to be attributed to these benefactors.

THE INVISIBLE BLADE

Technology, Culture, and Mixed Metaphor in a North American Hospital

Christian Michael Simon

ABSTRACT

How are new medical technologies shaped and made meaningful? What can focus on these processes teach us about the culture of biomedicine? This dissertation extends current work on these questions by examining a machine now increasingly used in the United States and elsewhere to treat people with deep-seated brain disorders. With data collected during 15 months of fieldwork in a hospital in California, it shows how ideas, meanings, and symbols typical of operating rooms and open-body surgeries are cultivated around this machine even though it has, practically speaking, little in common with these domains.

The dissertation begins by pointing out the metaphoric associations that tie the machine to surgery and surgical practices. These include associations that its users draw between the machine and classic surgeries and surgical practices in their forms of speech, ideas and actions, the location, sequence, and proximities of their work, and in consent documents. The dissertation analyzes these associations, their roots in past and present relations, and how they influence patients and their experiences with the technology.

Its central finding is that while the associations that surround the machine may go unnoticed among its users or seem superfluous to their clinical enterprise, they seriously mystify patients and the social nature of their healing experiences. The dissertation recommends that consideration should be given

by the machine's users and their institutions to the adverse means by which their services are discursively constructed, and how with the input of patients these means might be reversed or avoided.

On a broader scale the dissertation helps further scholarly understanding about biomedicine and technological innovation. It shows that the practical and symbolic valence of new medical technologies may be rooted in older, established tools and the ways in which physicians have conceived and used them. The dissertation thus urges anthropologists and others to examine in detail the role of the past in the culture of biomedicine, and how technological advance may serve to reexpress older ideas and ideologies.

TABLE OF CONTENTS

FIGURES AND ILLUSTRATIONS

Chapter One

Introduction: People, Places, Powers

> The terrors of suffering, sickness and death, of losing ourselves and losing the world are the most elemental and intense we know; and so too are our dreams of recovery, of being wonderfully restored to ourselves and the world. [Oliver Sacks, *Awakenings*]

> We move mostly inside the possible, do what we can, build for ourselves a world in which we can live. But there are breaks, break-ins in this order, states of the outer limit that are, however, unfulfilled, that one cannot get beyond though everything urges beyond them. [Hans-Jost Frey, *Interruptions*]

New kinds of technologies gain in human hands the power to change things: our habits and habitats, our daily rituals, how we structure our ideas, thoughts, and practices, how we see ourselves, others, and the wider world, even how we live and die. New kinds of *medical* technologies are no exception. These too gain in human hands, usually the health professional's, the power to change things: our bodies and bodily predicaments, the onset and duration of our pain and suffering, and, the most profound power of all, whether -- and how -- we live or die. The essence of this power is technical in part, rooted in the chemical valence of a drug, the mechanical functioning of a heart valve, the technical know-how that directs a scalpel this way and not that. It is also a social and cultural essence, however, because medical technologies are used always in the province of lived feelings, memories, and emotions, learned intuitions and knowledges, and individual and collective relations, that is, in the "rough earth" that comes with "being in the world," as Sartre might well have told us (Sartre 1939/1992:389).

It is power exercised in this province -- this "rough earth" -- by custodians of new kinds of medical technologies that I explore in this dissertation. More specifically, I examine an example of how users of new medical technologies define and apply their novel acquisitions by aligning or associating them with established ideas, conventions, and practices of the past. Such association, I argue, influences how patients symbolize their therapies and recoveries, what they come to expect and live for, and how they derive, in the context of serious illnesses, their prospects of healing and health. My immediate aim is to support this argument with ethnographic data and analysis. Ultimately, I aim to illustrate that a balanced account of "progress" and innovation in medicine and society also requires close and sustained inspection of how naming and association processes unfold on the cusp of technological change, and how through misuse or ignorance of these processes medical professionals may inflict psychological and emotional harm on those whom they are ostensibly attempting to help.

This dissertation is thus broadly speaking about processes of naming, aligning, and associating, and their origins and outcomes. Below, I present some ethnographic material to introduce these processes and the people, places, and issues in relation to which I will examine them in the chapters that follow.

Background

Mrs. Julie Campbell, 58-years-old and divorced, awoke one blustery March morning in 1995 in her home in central California with what she assumed was a common cold. She had a headache and felt "a little" feverish. "Not one to run to the doctor with a sniffle," Mrs. Campbell medicated herself with herbal teas, soap operas, and sleep, a remedial combination for colds "that

I swear by." Her symptoms abated; on the third morning after their onset she rejoined her fitness class, which she endured with no more than usual "pain and strain." In the evening she ate a hearty dinner, and went to bed "feeling pooped but good." Fall asleep, however, Mrs. Campbell could not. She tossed and turned, feeling her previous symptoms resume, escalate, then take on strange and frightening proportions. Lights rippled "like a kaleidoscope" across her bedspread, pain and dizziness enveloped her, and from somewhere unknown came voices and sounds so "weird and loud" that she clapped her hands over her ears, but in vain. In the early hours of the next morning, with her head hammering and her mouth "dry as cotton," Mrs. Campbell reached, frightened and displaced, for the telephone.

The main entrance to Hillcrest Hospital resembles the entrance to a fashionable hotel.[1] It has a driveway that circles an island of meticulously trimmed grass, embossed glass doors and well-shined floors, a lounge with plush seats and green plants, an overpriced gift shop, an efficient reception desk. People carrying luggage bustle in and out as though the hospital were a Hilton or a Hyatt. This resemblance fades rapidly if you venture past the reception area and deeper into the building. Soon you confront not porters and suites but hospital personnel and wards, neither especially given to the demeanor or ambience that becomes a hotel. The tempo mounts. Doctors, nurses, interns, students, technicians, and delivery workers dart down corridors and into elevators, from one patient, procedure, or place to the next, seemingly with little or no time to spare. Gurneys surge along, some matted and empty, others occupied. Here and there medical personnel in blood-spattered dress

[1] Hillcrest Hospital is an urban, university-based state hospital on the west coast of the United States that I have renamed to protect the privacy of those who seek and provide medical care on its premises. People's names have also been changed throughout the dissertation for the same reason.

spin through doors like cowboys emerging from a barroom brawl. Floor after floor, corridor after corridor, there reigns an atmosphere rich in haste, austerity, and intrusiveness.

But continue on and you might descend into an area of Hillcrest Hospital that promotes a different atmosphere, one that reestablishes with refinements the building's hospitable facade. This area lies below street level, in part of a basement retrofitted with burnished wood and Klee prints, generously designed corridors and bathrooms, waiting rooms equipped with both water dispensers and coffee makers. Here too there are people moving about -- but in a less harried fashion, dressed in pristine white coats or designer suits and ties. Concentrated in the west wing of this basement area, in a room bearing the sign, "The Gamma Knife Suite," are a set of fixtures even more discreet: walls decorated in pastel rose and blue, a print of palm trees and parapets, a sleek, varnished cabinet, and, in the upper half of the suite, a machine with a silver plaque on its side that announces in elaborate calligraphy: "The Gamma Knife."

Forty-five, slender, and mild-mannered, Dr. Steven Platt is an ex-New Yorker and a neurosurgeon at Hillcrest Hospital. I found him in his office before sunrise on June 4, 1995. He sat flipping through a ream of black and white images, surrounded by neurosurgical books and journals, an extra chair, an IBM computer, a boombox playing Vivaldi, several pictures waiting vainly for wall space, a phone that was already ringing -- all in an office, Dr. Platt likes to lament, "smaller than the bathroom in my home." He waved me to the extra chair as he picked up the ringing phone. "This is [Steve]. Yeah, I'm looking at them right now...Yeah, big piece-a-pie. Right, correct. We'll get [Dawson] to work around the optic apparatus. OK. See ya later." Hanging up, he turned to me with one of the images: "Take a look at this, one of the cases we're doing today. A

Mrs. [Julie Campbell]."

The image showed that Mrs. Campbell has deep seated in her brain an arteriovenous malformation or AVM, member of a class of vascular disorders renown in biomedical circles for remaining (until they become symptomatic) hard to detect (or "clinically silent"), for parading misleadingly behind common flu-like symptoms such as headaches, and for striking at their hosts with unpredictable, life-threatening force. "Congenital anomalies" Dr. Platt and his biomedical contempories call them, meaning that Mrs. Campbell and others diagnosed with AVMs -- at an annual expected rate of one patient per population of 100, 000 people -- are considered predisposed from birth to their development (see Cunha e Sa 1996:471; Kihlström 1986: 11). The key players in this congenital process are arteries (that carry oxygenated blood to different parts of the body), and veins (that return deoxygenated or "used" blood to the heart). Under normal circumstances the first direct or "shunt" blood to the second through connecting capillaries. An AVM, however, misroutes the blood so that it flows directly from an artery to a vein without first diffusing through connecting or "interposing" capillaries. The offended vein swells and presses on the brain, trapping blood. As the pressure mounts the walls of the vein are strained. In some people -- between 60 and 70 percent of patients with a history of AVMs (see Cunha e Sa 1996:472) -- the engorged vein then ruptures, blood pours into neural tissue in the brain, and cells begin to asphyxiate.

Dr. Platt and his neurosurgical colleagues call this outcome "intracranial hemorrhaging," the painful and bewildering impact of which Mrs. Campbell had experienced that night in March. Though Mrs. Campbell had survived this impact with "minimal neurological damage," Dr. Platt was concerned. Her AVM could hemorrhage again and lead to her death as a result, as reportedly it does

in over 20 percent of untreated AVM patients (see Cunha e Sa 1996:472). Mrs. Campbell's age also increased this possibility; AVMs typically become symptomatic and recur rapidly "in the fourth to fifth decades of life" (Cunha e Sa 1996:471). Thus, in words carefully chosen not to instill in his patient a false sense of hope nor to dissuade her, horrified, from his office, Dr. Platt suggested to Mrs. Campbell that "we attempt to minimize the risk of a rebleed."

Five years ago Dr. Platt (or one of his neurosurgical colleagues) would almost certainly have made this attempt in an operating theater, alongside anesthesiologists, nurses, and other surgical personnel. Using a neurosurgical drill, rongeurs, and other tools of his trade, he would have removed a portion of Mrs. Campbell's skull, carefully delved into her brain, and clamped closed or occluded her hapless vein, relying in the process on skills, concepts, and techniques passed down through his education and experience by such legendary American brain surgeons as Harvey Cushing, William Halsted, Walter Dandy, and John Green. Today, Dr. Platt has open to him a novel and quite different option, the Gamma Knife, the technological centerpiece for the performance of "Gamma Knife surgery," or "radiosurgery." Imported from Sweden and embedded since 1991 in the basement of Hillcrest Hospital, the Gamma Knife that Dr. Platt uses is currently one of 31 such machines used by other physicians at various medical centers in the United States. All were introduced to the U.S. after 1986, the year in which the country's first Gamma Knife was installed at the University of Pittsburgh Medical Center.

In the wake of the technology's recent introduction, Dr. Platt and his surgical colleagues have themselves been introduced to conditions of work and interaction markedly different from those historically familiar to them. Absent from all Gamma Knife work, for one, are their classic surgical tools and rituals,

including scalpels, forceps, incision making, and suturing, which have for decades contributed to the matador-like aura and thrill of neurosurgical repair (see Fishman 1988; Shelton 1989). Gone, for another, is the kind of absolute patient- compliance that surgeons have traditionally gained in operating rooms through the use of general anesthesia (see for example, Goffman 1961; Hirschauer 1991; Katz 1981; Thorwald 1956; Wilson 1954). Gamma Knife patients typically remain awake and sensate before and during their "surgeries," able to scrutinize the neurosurgeon's moves and potentially make known their likes and dislikes. Nor do neurosurgeons working with the Gamma Knife enjoy in their efforts the classically unquestioned boundaries of authority and control that are generally observed to the benefit of surgeons in operating rooms (see Bosk 1979; Cassell 1986, 1987; Fischer and Peterson 1993; Freidson 1970). Gamma Knife work is performed by an interdisciplinary team whose other members -- physicists and radio-oncologists -- consider themselves on equal or even superior professional footing to their neurosurgical colleagues, and who are quick to remind them that here, in the realms of the Gamma Knife at any rate, they are the historical newcomers, less skilled and less experienced.

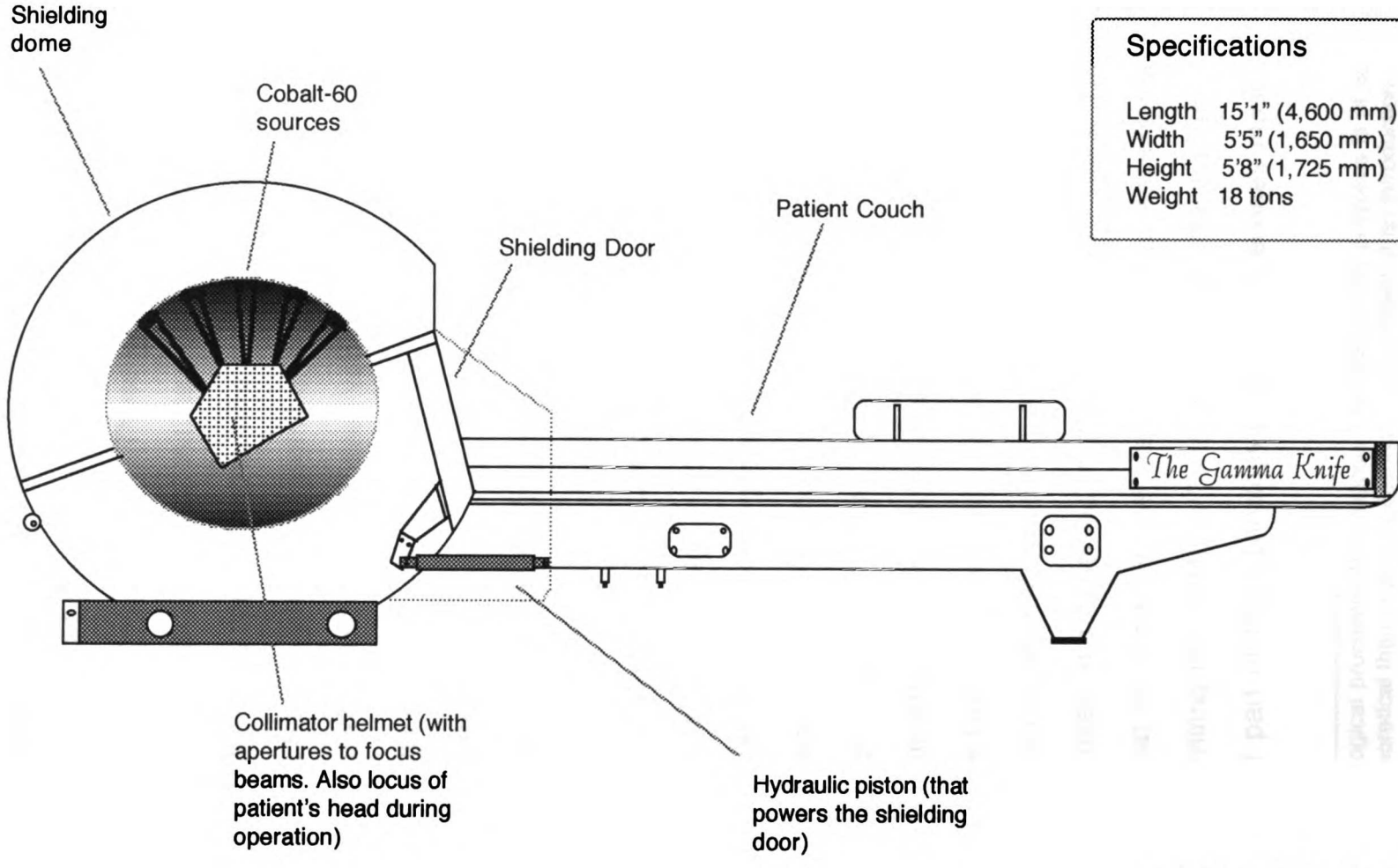
Yet, neurosurgeons like Dr. Platt also give indication that they have been far from idle or complacent in responding to these and other changes. They have readily infused their role in Gamma Knife work with new intellectual challenges, adjusted their ways and habits of perceiving and interacting, resisted encroachments on their authority, prestige, and control. Key to the manner in which they have done so is by versing themselves in the knowledge-world of the Gamma Knife -- by grasping and adopting the many theories, laws, models, algorithms, and principles with which the role and behavior of the Gamma Knife is scientifically understood. Let us turn briefly to this knowledge-

world, for without some grasp of it we too would remain, like an unversed neurosurgeon, on its margins.

The Gamma Knife is by historical right a product of modern physics and physicists. Designed and constructed in the 1950s and 1960s, in the context of a bioscientific world enamored with the radioactive atom and the funding dispensed with largess to exploring its potentials, the Gamma Knife embodies principles central to the behavior and impact of radioactivity. Understanding these principles is an essential step for all Gamma Knife users, for their work and its outcomes are governed by the actions of 201 radioactive cobalt cells housed in the technology's large cast-iron dome (see diagram over leaf). These cells emit gamma rays: radioactive beams with nuclei that are in a process of disintegration. Known as "decay," this process releases photons or bundles of energy that travel at the speed of light through solid matter such as bone, fluid, and tissue -- without necessarily affecting or "interacting" with them. Once the photons cover a distance of 30 centimeters and over, however, they begin to disperse and interact with matter around them, according to the tenets of a theory known as Compton scattering, which maintains that

> [s]ome of the photon's energy will be dissipated in detaching the electron from its path and in giving it kinetic energy. The rest of the energy will continue as a new photon with an energy equal to the energy of the incident photon less the energy required to detach the electron and the kinetic energy delivered to that electron. [Ganz 1993:8]

The Gamma Knife



Specifications

Length	15'1" (4,600 mm)
Width	5'5" (1,650 mm)
Height	5'8" (1,725 mm)
Weight	18 tons

Source: Field notes 1995

This interaction involves, in the context of a disorder such as an AVM, the transfer of energy from the radioactive photons to electrons so that the latter become "agents of dose deposition," causing tens of thousands of ionizations in the area of the disorder, or "target." These ionizations (whereby neutral atoms gain positive or negative charges) initiate a process called "cell death," which prevents cells -- cells deemed undesirable in this instance -- from proliferating. This process has the effect of occluding or shutting down through necrosis the "nidus," the point at which the malformed vein and artery in an AVM meet. Once shut-down, the risk of a rebleed, in that part of the patient's body at least, is considered alleviated.[2]

Dr. Platt has patently grasped and accepted these and other more complex theories and premises. He can speak at length about such actions and reactions as radioactive decay, Compton scattering, dose deposition, and cell death -- aspects of knowledge in 20th-century physics that he actively applies and participates with in evaluating and selecting patients for the Gamma Knife, in planning and executing Gamma Knife procedures, and in checking and assessing their impact and results. Dr. Platt does not, however, communicate this knowledge without referring to other kinds of practices. First of all, he brings to bear on the Gamma Knife words, terms, and explanations infused with clear-cut references to operating theaters and the tools, techniques, and outcomes that he has used and observed in them for over 15 years. These include references that he makes in the presence of his colleagues as well as his patients to "knifing the AVM," to "cutting away" and "taking out," and to "The Knife" -- that part of the technology's name that echoes most strongly his

---

[2] The microbiological processes that exposure to radioactivity provokes is of course far more complex and theoretical than I can fully describe in the context of an introduction. Chapter Three points to these processes in more detail. Otherwise, see Ganz 1993 for a full and up-to-date technical account.

training and on-going participation in operating theaters. Second of all, Dr. Platt resorts alongside these surgical references to a set of words and phrases that adds a greater measure of potency and realism yet to his recently learned trade. Farmed in from the realm of modern weapons and ballistics, this set of words and phrases includes consistent reference in all stages of his Gamma Knife work to "shots" and "targets," to "accuracy" and "angles of penetration," to "blowing out" and "obliterating." Gamma Knife treatment, in other words, is something that Dr. Platt talks, thinks, and writes about using words and images drawn from operating theaters and war rooms or battlefields: domains highly potent and invasive, and witness to highly tangible and dramatic results.

Paramount to much that follows in this dissertation is the incongruity that results from the maintenance of surgical or incisive discourse among physicians like Dr. Platt in the context of a form of treatment that takes up to three years to reach its desired clinical effect. This needs some explanation. "Latency" is a term that Gamma Knife physicians use to describe the period that follows the delivery of gamma radiation to their patients. As notes Lindquist, a professor of neurosurgery, in his recent article, "The Gamma Knife in the Neurosurgical Armamentarium":

> Radiosurgery...differs from other surgical techniques in one important aspect. This is in the fact that ionizing radiation even if delivered in a high dose in a single session has a *considerable latency to its desired effect as well as to complications.* [Linquist 1996:185. Italics added]

This period of latency may continue for three years, for such may be the length of time that is typically required for an AVM to be "obliterated," the gold standard in the biomedical measurement of therapeutic success in radiosurgery: "It is the the belief of all major centers involved in Gamma Knife surgery that nothing less than **total obliteration** will reduce the rebleed rate [in the treatment of AVMs]" (Ganz 1993:101. Bold emphasis in original). Progress after treatment is in this light calculated with percentages, gained from reading "postoperative" brain images. Clinical consensus reveals:

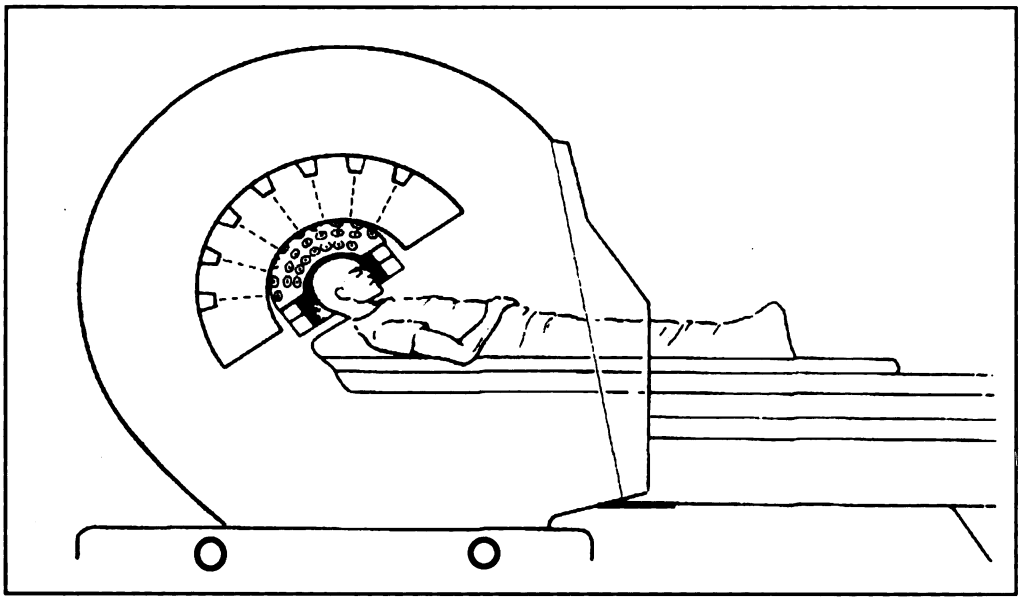
> The aim of radiosurgery in AVM is obliteration. The effect continues even after the second year following treatment.... After the first year 30-50% of all AVMs have disappeared angiographically [an imaging technique], after the second year 70-85% and after the third year approximately 90% are obliterated. [Cañizal 1996:180]

The above are statistics -- clinical expectations -- that Dr. Platt and his Gamma Knife colleagues readily communicate to prospective patients, typically during consultations well before patients undergo Gamma Knife radiosurgery. Mrs. Campbell, for example, was told by Dr. Platt six weeks before she opted for Gamma Knife treatment that "it could take up to three years for the AVM to totally disappear -- that's what it *could* take."

What Dr. Platt did *not* tell Mrs. Campbell, however, was that she would most probably find herself involved during those three years in a seemingly unending healing marathon, battling not only the gradual onset of such side-effects as loss of hearing, headaches, and even partial paralysis but also a mounting sense of bathos and malaise, borne from an erosion of the incisive

metaphors and connotations of expedience and resolution that will have been impressed upon her throughout her Gamma Knife treatment. In short, Dr. Platt did not tell Mrs. Campbell that what he had told her about the latency of Gamma Knife treatment would be outweighed soon by words and actions resonant with his training, experience, and conduct in operating rooms, which blend together alongside other processes of association a scenario altogether different from that in which she will in reality find herself.

Mrs. Campbell entered the Gamma Knife suite at Hillcrest Hospital on the afternoon of June 4, 1995. Assisted by Dr. Platt and a nurse, she edged off her gurney and onto the Gamma Knife's "patient couch" (also referred to as the "operating table"). She lay on her back, around her the pastel-colored walls, the picture of parapets and palm trees. Dr. Platt asked her, "Are you comfortable?"; she replied: "Oh yes, this feels good." Shortly, Dr. Platt wheeled over a device that looks like an oversized sieve, a collimator helmet; this he lowered over Mrs. Campbell's head. Her voice grew muffled: "What's this thing for?" "It's to help guide the rays to your AVM -- so we can target it accurately," Dr. Platt replied. Some time passed before Dr. Platt spoke again. "You're ready for the first shot now, it won't take long. You Ok? Ok. See you in a while." She heard footsteps recede, and the sound of a door closing. Then it was silent. Five minutes? Ten? Mrs. Campbell had no way of telling, before the couch underneath her started moving, and she began to slide into the machine. The diagram on the next page approximates her position on the Gamma Knife, once personnel have left the room and flipped the switch that operates the machine.



Position of a patient on the Gamma Knife. Note the collimator helmet around the head. [Adapted from Lunsford 1993:239]

Several hours later, after her procedure, Mrs. Campbell would describe to me her experience on the Gamma Knife as follows:

> ...and that was really it -- the sound of the bottom [patient couch] moving. Oh and it got a bit darker but otherwise nothing really happened. I mean, not that I expected it to, but something...you can't even be sure the thing's really working, you know? So I kind of asked Dr. [Platt] that after the first shot [when he came back into the suite] and he laughed a little and said yes, other patients tend to say the same thing, while the machine is really running and it's busy doing its work. So during the next shot, and the one after that -- I think I had three -- I just stopped thinking about it. [Did you think about anything?] Um...I tried to visualize them, the rays, you know? First I asked myself: What shape are they, are they long, round, or what? Then I tried to imagine them being like arrows or missiles and the AVM being the target. I tried to see them shooting through the holes in that sieve thing over my head. [Did you do this because someone recommended it?] Not really, I mean I remember that Dr. [Platt] talked about "the target" and "shots" and so on. But it was more because nothing seemed to be going on.

Mrs. Campbell was discharged from Hillcrest Hospital the next morning, June 5, 1995, with a pat on the shoulder from Dr. Platt and a reminder that she was scheduled for her first "postoperative" scan -- "to see where we stand" -- in six months time. She returned to her home in central California, and began to wait. "The first month was the worst," she would later conclude. "I treated my head like an overripe watermelon, laid around on pillows, did nothing and felt nothing. I didn't know what, if anything, was going on." Nor did Mrs. Campbell feel that she could present after her treatment anything tangible or "real" to help elicit support and sympathy from her family and friends. Scars or sutures, those "icons of travail" that usually provide scrutable proof of medical intervention and serve latently to generate social sympathy (see Kleinman 1988:68), had eluded her:

> "I kept getting this feeling that everyone, my sister and daughter included, were looking at me and saying with their eyes, 'so you had surgery, where's the scar, show us the scar' as if I was supposed to *prove* to them that I had this -- this surgery. But there weren't any. I kept having to tell them it wasn't *that* kind of surgery.

Recalling also in the still of night the eruption of her AVM in March, Mrs. Campbell found it difficult to sleep. Opting against sleeping pills lest "they might interfere with my recovery," she grew fatigued, depressed, "nasty even," from lack of sleep. The weeks passed, the headaches that beset her she began to think of as "in my mind," no-one from the hospital called. "I started to doubt if I had even been there."

Her first "postoperative" scan proved promising. Opting to travel once again to Hillcrest Hospital instead of having the scan done locally, Mrs. Campbell welcomed the occasion:

> I desperately wanted to know what was going on, and to hear it from the horse's mouth. I hadn't had a rebleed, but from what they told me about it [her AVM] that didn't mean very much. I felt I still had this bomb in my head, and that it could go off at any time.

At once eager and nervous she underwent the scan; the resulting images, deciphered for her by Dr. Platt, provided the proof she sought: her AVM was in remission -- not yet by much, but enough to see Mrs. Campbell return home elated, her previous embodied observations that little or nothing had come of her treatment now banished by medical reassurance writ large in photographic black and white.

Mrs. Campbell's story does not end here. Nor does it end quite as happily, for not long after her first postoperative scan she started developing a tremor in her right hand not apparent before. The elation she had experienced subsided, old fears crept in, and she struggled anew in an attempt to reconcile the erratic messages that issued from her person with the cool prognoses provided by her surgeon. Her second postoperative scan, performed 11 months after her Gamma Knife treatment, again encouraged her to see her embodied doubts about her state of health as groundless and insubstantial: 45 percent of her AVM showed up as "obliterated;" the likelihood of a rebleed was deemed even more slim. Dr. Platt was pleased. Forty-five percent conformed to his best expectations, which were modeled on a clinical consensus that reckons with a

maximum of 50 percent obliteration in the first postoperative year. He said as much to Mrs. Campbell, but added quickly that "more time would tell." In the convoluted regions of the brain, as Dr. Platt and his colleagues believe, therapeutic activities are not complete or over when there are percentages outstanding. More time and scans were needed to (hopefully) show that Mrs. Campbell's AVM had been totally obliterated. Thus, almost a year after her Gamma Knife treatment, Mrs. Campbell's "case" was not yet clinically resolved. Balanced on a thin boundary between despair and hope, sensation and interpretation, fiction and fact, she would continue to falter, emotionally and physically.

Stepping Back: The Dissertation in Perspective

The Gamma Knife is one among several kinds of medical technologies developed in the last 20-odd years that are now transforming the definition, practice, experience, and outcomes of one of Western medicine's oldest and most commanding domains -- surgery. Called "noninvasive" (or "virtual" by some), these innovations, which also include ultrasonic dissectors, lasers, the "cyberknife," chemical and gene-based "bullets," and robotic systems, are fast replacing scalpels, forceps, and other tools in the medical arsenal that surgeons have used on their patients for centuries. Emerging in their wake is a kind of surgery that once belonged uniquely to the world of science fiction: free of narcosis, bloodshed, and scars, capable of being performed in a matter of minutes, and patently sensitive to personal and cultural preferences such as comfort, convenience, and minimal hospitalization. These and other attributes and features, however, may be experienced among the earthbound with a

degree of circumspection, disquiet, and misgiving not usually evident among those who inhabit the world of science fiction. Patients may develop around a technology such as the Gamma Knife concerns and fears that stem not just from the gravity of their afflictions, but also from their encounters with the new technology, its users, and the kind of messages and meanings that emanate from them. These concerns and fears may later escalate so profoundly that patients come to experience uncertainty, alarm, and emotional decline at a time when they most desire clarity, peace of mind, and a sense of progress and recovery.

The sample for this dissertation includes 41 patients whose Gamma Knife experiences I observed and followed while conducting ethnographic research on the Gamma Knife at Hillcrest Hospital in 1993 and 1995-1996; this sample, which includes Mrs. Campbell, is united in its experience of the escalating concerns and fears that I have referred to above. In this dissertation I explore the source of this shared experience, which I see as rooted in processes whereby new medical technologies are aligned with older ideas and conventions, and in experiences that render these alignments incongruous, untenable, and even absurd. I examine, in other words, how people have forged a link in medical and popular culture, naming processes, everyday speech, and actual practice, for example, between a medical invention developed in the late 20th century and a medical practice all but centuries old, creating or constructing for it a symbolic kinship ultimately misshapen and anachronistic.

I show that this link is notably fostered by Gamma Knife users like Dr. Platt, who encounter their own sorts of problems as they begin and continue to use a technology such as the Gamma Knife. Working with an innovation that

involves no incisions and minimal hand-related skills, and facing a knowledge world over which other specialists claim command, Dr. Platt and his colleagues, a hitherto elite corps of neurosurgeons, act as bricoleurs, bringing to the Gamma Knife old or established ideas and conventions in a bid to symbolically align this new, late-modern technology with terms that traditionally ground their professional stature and reputation. This alignment also serves among neurosurgeons as a means to contest the claim made by medical physicists that the Gamma Knife is "really a physicist's technology;" the micro politics that unfold on the cusp of technological change are thus also key to this dissertation.

Patients are influenced by this alignment. Though few expect Gamma Knife surgery to precisely conform to classic surgical operations, most anticipate in the wake of its associations a procedure that provides them at the very least with icons of travail, or a scrutable or discernible foundation for locating and socially registering their experience and progress. Instead, they find themselves and their maladies in a static and empty situation. Neither the terms and images that patients adopt to visualize their procedures with surgical-like realism, nor the surgeon's use of "postoperative" scans to furnish positive proof may in the long run provide patients with a reliable means to register progress, repair, or recovery. Indeed, these and other means sometimes even prove iatrogenic in their alignment with classic surgery, inspiring in patients expectations or hopes that become less and less tenable as time goes by. This leads me to question the impact of metaphoric associations and alignments on biomedical patients, and to recommend that "metaphor-making" and other association processes also be included as subjects of ethical assessment before new medical technologies are adopted and used.

Positioning the Dissertation

Where does this dissertation fit into the broader anthropological and social science literature? First, it joins an anthropological tradition long concerned with examining material culture -- goods and artifacts that are about more than the sum of their parts, woven as they are into the fabric of cultural thought and action. This tradition has a pedigree that extends from the 19th century into the present, and that has endured major paradigmatic shifts in anthropology (see Ortner 1984). Researchers and their topics of interest include in this context Malinowski's (1922/1961) ethnography on the cultural import of canoe-making and the circulation of valuables in the Trobriands; Mauss' (1925/1954) study of gifts and their roles in culture; the study of relations between tool manufacture and social change (Sharp 1952; Oakley 1949); focus on "consummable" technologies such as food and drink and their political and economic roles in modern history (Mintz 1985) and in maintaining cultural rules and taboos (Douglas 1991, 1966); the accumulation and ritual destruction of material surplus in the making of cultural rank and title, or in ecological redistribution (Codere 1950; Vayda 1969); research into the cultural and symbolic production and flow of goods and materials (Appadurai 1986; Thomas 1991); the discursive role of cloth in supporting dominant cultural ideas and habits (Weiner and Schneider 1988); the influence of cameras, cinema screens, and other modern materials and organic objects on memory and perception (Seremetakis 1994). Though their theoretical foci may differ, these and other anthropological studies share with this dissertation the view that material artifacts are also social and cultural artifacts, and that they thus deserve the *same* measure of attention as other, ostensibly less tangible inventions.

Second, the dissertation brings to bear on a highly modern Western medical setting the same curiosity and awareness of the social and the cultural that has accompanied medical anthropological inquiry further afield for much of this century (see Casper and Koenig in press; Gaines and Hahn 1982; Lindenbaum and Lock 1993; Lock 1988; Rhodes 1990). In short, the dissertation strives to approach a biomedical domain unbridled by claims that its members, tools, forms of reasoning, and practices are intrinsically different from those of any other indigenous knowledge system (see Latour and Woolgar 1979/1986; Lock 1988; Sperber 1985; Tambiah 1990). So guided, the dissertation also joins research undertaken by scholars in numerous disciplines that seeks in essence to strip bioscientific enterprises of their "ideologized vestments," which so liberally cloak or hide beneath layers of seemingly neutral, objective, and rational fabric their social, cultural, economic, and political character (see Nader 1996:12. Also see for recent reviews and examples of this literature, Aronowitz 1988; Bijker and Law 1992; Casper and Koenig in press; Clarke and Fujimura 1992; Escobar 1994; Franklin 1995; Ginsberg and Rapp 1995; Gray et al. 1995; Haraway 1991, 1989; Hess in press, 1995; Hess and Layne 1992; Pfaffenberger 1992; Pickering 1995; Rabinow 1996; Traweek 1993, 1988). This research embraces a wide range of perspectives and topics; nevertheless, it is bound together by keen interest in grasping the relations, powers, processes, and constructions that underlie the intersection of science, medicine, and technology in contemporary societies.

Third and more specifically, the dissertation joins studies that focus on the ways in which key metaphors shape biomedical ideas and practices. Metaphors are vehicles that carry meaning over from one domain to another, including domains that are clearly rooted in the greater social and cultural

context in which biomedical ideas and practices prevail.[3] This is evident, for example, in the context of such illnesses as AIDS and cancer (among many others), which are deeply rooted in metaphors that align or transform them into *enemies*, their treatment into *battles*, and those who do the treating into *officers* (see Sontag 1989; Stein 1995; Winslow 1994). The battlefield and war room serve thus in biomedicine as domains from which to draw connections and render meaningful some of its illness categories, diagnoses, and therapies.

At another level, scholars show that medical care and organization are modeled on metaphors drawn from war rooms, business, industry, economics, commerce, and the marketplace, such as *reductions in force, patient flow, downsizing, briefing, cost containment, alliance, strategy, regimen,* and many others that are routinely and factually used in everday biomedical speech (see Pellegrino 1994, Stein 1995). Pharmaceuticals in turn are said to gain valence or "charm" based on their metaphoric associations, as do injections when they are referred to as "shots" (see van der Geest and Whyte 1989). Elsewhere in biomedicine, in genetics and immunology, for example, gender differences are "metaphorically written" into biomedical conceptions of immune systems (Martin 1990; see also Haraway 1991). These and other scholars show that metaphors are not only prevalent in biomedicine, but that they serve to render its definitions, texts, tools, and practices concrete, factual, and real. Metaphors thus serve in biomedicine as well as other social realms as "strategies for dealing with situations" (Fernandez 1986), as "tools for working with experience" (Kirmayer 1992, 1988; Moerman 1991), and as symbolic

[3] "Metaphor" is derived from the Greek, *meta*, meaning "above or over," and *phorein*, meaning "to carry or bear from one place to another" (see Kopp 1995:92). There is of course a vast literature [beyond the anthropological] that explores the significance in language, society, and culture of this carrying or mobilizing power of metaphor, including studies in philosophy, history, literary theory, linguistic theory, psychology, psychiatry, and psychotherapy. The dissertation is not directly concerned with this literature.

mechanisms that help people "move" from the inchoate to the concrete, and from the ethereal to the palpable (van der Geest and Whyte 1989:353-354).

There is another kind of metaphor, however, that does not prima facie consolidate, clarify, concretize, or make matters as palpable as those that anthropologists and others so widely examine. This is the mixed metaphor, a "succession of metaphors that produce an incongruous and ludicrous effect" (Morris 1969:841). Among the most understudied semantic constructions in anthropology, mixed metaphors -- and their close cousin, the oxymoron -- can be viewed as vehicles that do not manage to carry over meaning quite as successfully as regular kinds of metaphors. They fail, to put this another way, to establish that "unitary conceptual framework" achieved through the interplay of symbols by regular kinds of metaphors (see Geertz 1973:210-211).[4]

"Gamma Knife" (from the Swedish, *Strahlkniven* -- see Chapter Two) and the catch-all term invented to define its application, "noninvasive surgery," are also examples of mixed metaphors. They too leave us somewhat puzzled as to their meaning and import. Are we to think in the wake of these terms that the technology is a knife, meaning that it possesses knife-like qualities, *and* that it is not a knife, meaning that it does not cut, invade, or sever? If so, the technology will surely occupy in our minds a position ambiguous, even contradictory, in scope and implication. Numerous terms and designations that are applied to the Gamma Knife in the media -- from hospital brochures and

[4] The structure of mixed metaphor involves images that clash; consider the following example: "John is a snake in a lion's den." Combined in one sentence are two metaphors, "snake" and "lion's den," both of which would convey in separate sentences (i.e. "John is a snake" or, "John is in a lion's den") clear and unambiguous meanings (i.e. that John is dangerous *or* that he is in danger). Together in one sentence, however, they leave us puzzled: is John dangerous *or* is he in danger, or, is John dangerous *and* in danger, or, put another way, is John the antagonist *or* the protagonist, or is he the antagonist *and* the protagonist? We cannot tell for sure -- mixed metaphors render meaning ambiguous, unclear, inchoate.

promotional videos to advertising campaigns and statements made by physicians to the press -- add to this ambiguity and contradiction. In these, the Gamma Knife is frequently referred to as "the invisible blade," and the "knife with no blade." Consider, for example, these newspaper headlines: "Invisible blade on medicine's cutting edge," "New surgery uses knife with no blade," "Healing the brain with an invisible blade," "brain surgery without cutting," "Marvin Myers undergoes surgery without a knife," "Brain surgery with an invisible knife." When we -- and prospective patients -- read these and many other labeling statements, we are invited to puzzle over (and marvel at) the nature of the Gamma Knife, which is rendered with mixed metaphors curiously ambiguous, unclear, and inchoate.

In everyday biomedical practice, when physicians at Hillcrest Hospital use the Gamma Knife, there is no evidence that they perceive it as a technology that is couched in metaphors that puzzle, or that render its functions unclear and inchoate. Nor do these physicians even appear to consider the Gamma Knife a "noninvasive" technology; on the contrary, they speak of it in highly invasive terms, defining and communicating talk about rays, atoms, and particles -- the allegedly "noninvasive" ingredients of the Gamma Knife -- as invisible agents that *resemble or behave like scalpels* in their potent capacity to cut, excise, and remove. We are faced thus with a curious situation, in which meanings appear unclear and at odds with each other in one context -- a public arena -- and clear and complementary in another -- a biomedical arena.

How have the "Gamma Knife" and "noninvasive surgery" come to take on clear and complementary meanings in everyday biomedical practice? What underlies the puzzled, impatient look that so often greeted me when I asked physicians whether, perhaps, the "Gamma Knife" is a metaphor (among others)

that "confuses what the technology does with operating-room surgery"? Why, in short, can we not speak of the Gamma Knife as a technology that is surrounded in medical practice, as it is in public discourse, by mixed, unclear, and ambiguous metaphors? One can begin to accurately answer these and other questions, as I hope to show in the rest of this dissertation, by realizing that "Gamma Knife," "noninvasive surgery," and the use of terms such as "cut," "knife," and "take out" hold in everyday medical speech and practice something other than a metaphoric status. That is, they are approached and used not as metaphors, symbolic references, analogies, or any other semantic fabrication, but as objective, real, and socially independent accounts of objective, real, and socially independent processes. "Gamma Knife," "noninvasive surgery," and their terminological offshoots are perceived thus as official extensions of the self-avowedly "objective" and "rational" character of biomedical thinking and action, as, indeed, are most biomedical metaphors (see Good 1995; Stein 1995:132). To put this another way: forms of language in biomedicine are seen and used not as *artifactual* (i.e.. produced or constructed) but as *factual* (i.e. naturally independent) in origin and meaning (see Gordon 1988; Latour and Woolgar 1979/1986). To approach them thus as metaphors (and by implication as socially constructed) in an interview or an informal conversation with a medical professional amounts quite simply to bad fieldwork, an etic misunderstanding of how such words and terms are locally construed, used, and understood as plausible and meaningful.

My perspective in this dissertation is therefore strongly influenced by the observation that what we as social scientists single out in biomedicine as its metaphoric constructions or culturally and socially constituted language forms and nomenclatures are not typically approached as such among those who

adopt and use them. *We* see symbolically laden words and terms as social artifacts, *our biomedical informants* see them as symbolically unladen, objective, and factual. In one respect -- in order to remain true to our classic anthropological charge to see as others see, to avoid being ethnocentric -- we too must initially approach biomedical metaphors as if they were factual and objective. This does not mean, however, that we must forsake the perspective that biomedical metaphors are constructed, socially embedded, and rooted in prevailing cultural norms and assumptions. In analyzing and interpreting our data, in other words, we may appropriately choose to disagree with our biomedical informants about the nature and consequences of their language forms. Edmund Pellegrino, to cite an example, has done exactly that, pointing out that the quality of heath care may be seriously jeopardized where physicians take certain metaphors as objective and factual:

> The greatest peril I see in all the talk about health care reform is that physicians and even patients might begin to believe that physicians really are "case managers," "fundholders," gatekeepers," or "clinical economists" and should relate to each other in that way. if they do, physicians will surely lose the final moorings of their professional integrity. Physicians might then feel exempt from their traditional ethical imperatives and place the blame on the system for their own moral defection. Needless to say, to protect themselves against such physicians, patients will have to adopt the precautions of the marketplace. Instead of trusting in the physician's ethical commitments, they will have to be guided by the principle of *caveat emptor.... Used too often, and unthinkably, we mistake the metaphor for the reality.* [Pellegrino 1994:505. Italics added]

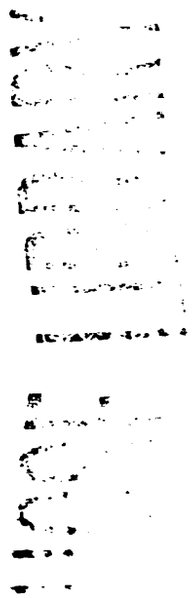
I reach a similar conclusion in this dissertation, while attempting at the same time to understand that the physicians I have studied also derive a sense of place, meaning, and identity from their reified use of metaphors. Metaphors for these physicians, when used objectively, help them explain to themselves (and others) who they are and what they are doing. Thus I attempt to be both sympathetic and critical toward my biomedical informants, engaging as I do so that fluid relationship between inside and outside perspectives that has become a major strength of anthropological investigation.

Agency and Aesthetics

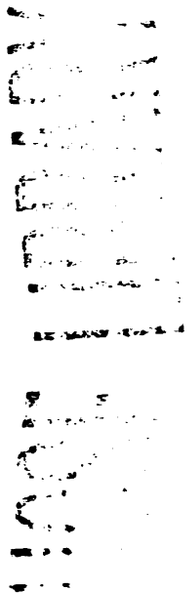
Jürgen Habermas has commented in *Toward a Rational Society* that medical encounters are "depoliticized." By this he meant that because they are focused on a model of disease causation that limits medical conversation and action to the neutral terrain of the physical body, medical encounters shut out questions about subjective being, human relations and control, and about the limits of reason (Habermas 1971). The metaphors that I focus on in this dissertation -- Gamma Knife, noninvasive, cut, blast, take out, knife, obliterate, shot, and so forth -- are also depoliticized, in the sense that they help shut out from Gamma Knife encounters questions about subjective being, human relations, and control, and about the limits of biomedical reason. They serve in Gamma Knife practice not as metaphors per se, but as extensions of claims that thought and action in Gamma Knife practice are objective, factual, and rational. To put this another way: the metaphors that I deal with should be taken in their everyday context as further examples of the socially and culturally constructed nature of biomedicine, *and* as constructions that in the biomedical imagination

further separate or render biomedical practice independent from society and culture.

If biomedical encounters -- including Gamma Knife encounters -- and the metaphors that prevail in them are depoliticized, someone or something must be doing the depoliticizing. Some agent or agents must be responsible, in other words, for selecting metaphors and shaping them so that they do not contradict or oppose claims to biomedical reason, objectivity, and truth. As a model of agency to plumb the processes by which metaphors are depoliticized, this dissertation uses James Ferguson's notion of "unplotted strategies" in *The Anti-Politics Machine* -- an ethnographic account of a rural development project and its depoliticizing outcomes in Lesotho, Southern Africa (Ferguson 1994). Writing against scholarly traditions that largely evaluate the merits of development projects on the basis of *who* exercises power over their aims, resources, and outcomes and *to whom* intended rewards and outcomes flow, Ferguson concerns himself with both *who* and *what* as agents reshape the meanings and outcomes of development projects such as the Thaba-Tseka Project in Lesotho. His main premises in this respect are taken from the works of Michel Foucault. With these, Ferguson seeks to understand the Thaba-Tseka Project with a "decentered conception of power," and to test the hypothesis that the Thaba-Tseka Project functions in a fashion similar to the fashion in which institutions such as prisons function -- in Foucault's view, as an institutional form that does not "miss its target" by failing to meet its expressed goal, reforming criminals, but rather, that achieves in *not* doing so a goal or outcome of far greater implication, the creation of a class, or "specific type," of delinquency and illegality that helps inversely to produce notions of legality, normality, and moral good (in Ferguson 1994:17-21).



Ferguson therefore seeks to show that projects such as the Thaba-Tseka Project may in failing to meet their expressed goals succeed in meeting other, unarticulated, goals of considerable political, social, and economic significance. He sets out to this end with the idea that people may act out power in ways that are "unintelligible" to them. Such power-related actions lend themselves most effectively to the enactment of "unplotted strategies" -- or an unacknowledged means by which people behave in discursive service to society and state. In the context of the Thaba-Tseka Project, which in all formal project-related accounts was deemed a "failure," Ferguson argues that the project was bureaucratically and logistically conceived and implemented so that it actually succeeded in bringing about "important structural changes," which were "unplotted" in that they were not openly intended or expressedly planned (Ferguson 1994:275). Accordingly,

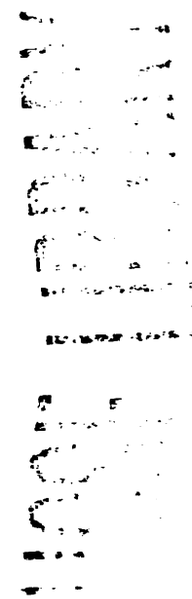


> In a situation in which "failure" is the norm, there is no reason to think that Thaba-Tseka was an especially badly run or poorly thought out project.... But it may be that what is most important about a 'development' project is not so much what it fails to do but what it does do; it may be that its real importance in the end lies in the 'side effects'... that are at one and the same time instruments of what 'turns out' to be an exercise of power. [Ferguson 1994:254-5]

Ferguson discusses several such "side effects," including a project-related tax collection center that continued to collect taxes from nearby villagers after other project facilities had been abandoned, and the frequent use of a road by the Lesotho government and military that had been conceived and built to transport agricultural equipment and products to and from the project.

The Thaba-Tseka Project provided in its expressed goal to change for the better an impoverished district a "depoliticized" medium for later bringing about in a seemingly natural or logical way very real political, administrative, and economic changes in that district. Thus we arrive at Ferguson's conclusion:

> When we deal with planned interventions by powerful parties...., it is tempting to see in the discourse and intentions of such parties the logic that defines the train of events. Intentions, even of powerful actors or interests, are only the visible part of a much larger mechanism through which structures are produced, reproduced, and transformed. [Ferguson 1994:276]



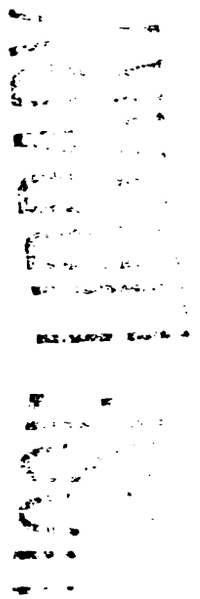
And, in his final paragraph:

> Systems of discourse and systems of thought are.... bound up in a complex causal relationship with the stream of planned and unplanned events that constitutes the social world. The challenge is to treat these systems of thought and discourse like any other kind of structured social practice, neither dismissing them as ephemeral nor seeking in their products the master plans for those elaborate, half-invisible mechanisms of structural production and reproduction in which they are engaged as component parts. [Ferguson 1994:277]

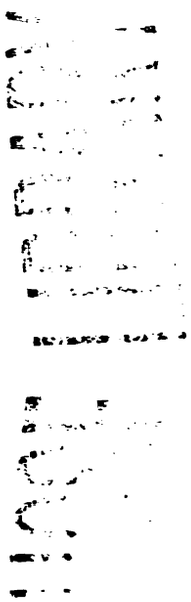
Lesotho and Thaba Tseka are geographically a long way away from the United States and Hillcrest Hospital. Nevertheless, health care professionals in the latter -- including those who work with the Gamma Knife -- can be seen as similarly involved in processes whose nature and outcomes they do not openly

or consciously think or know about. They too may contribute by their words and actions to unplotted strategies, including the depoliticization of metaphors so that these appear as seamless, natural components of biomedical thought and conduct. Their intentions, in other words, may be seen also as "only the visible part of... much larger mechanism[s] through which structures are produced, reproduced, and transformed."

The part of this larger mechanism that I focus on involves a creative yet unplotted strategy whereby physicians establish for a technology and its use a specific "aesthetic" (see Good 1994:166-74) that importantly plays into patients' experiences with the technology and its use. I am concerned in this regard with two issues: 1. how this aesthetic is constructed, and, 2. the ways it influences patients during and after their encounters with the Gamma Knife. I aim to show that the first of these issues entails a "carrying over" or transferal of discourse from surgical tradition and practice to the Gamma Knife and Gamma Knife practices. Several actors and processes contribute to this transferal, including neurosurgeons and their role in appyling surgical names and terms to the Gamma Knife and its use, the institutional placement of the Gamma Knife into the control of neurosurgery and neurosurgeons, the use of terms such as "operation" and "surgery" in the consent documents that Gamma Knife patients are given to read and sign, the spatial and conceptual proximity in Hillcrest Hospital of Gamma Knife practices to operating rooms, surgeries, and surgical rituals of practice and conditions of compliance. Chapter Two introduces these issues by considering the historical events and developments that have helped forge a surgical aesthetic around the Gamma Knife. Chapter Three closely examines the role played by present-day power relations among Gamma Knife physicians in further constructing and maintaining this aesthetic.



The second issue, of how patients are influenced by the transferal to the Gamma Knife of surgical discourse, is discussed in Chapters Four and Five. These respectively illustrate the structure and outcomes of associations that are forged between classic operating-room surgery and the Gamma Knife. Setting out with Byron J. Good's (1994:128) observation that "one of the central efforts in healing is to symbolize the source of suffering," Chapter Four explores how Gamma Knife patients symbolize the *end of suffering* as a second and related effort in healing. Into this symbolizing process enter several considerations, including how patients are physically and spatially handled before, during, and after their Gamma Knife treatments, and how this handling contributes to the construction of their treatments as a rite of passage resonant with surgical images and connotations of repair, renewal, and restoration. This construction is then examined in Chapter Five in view of the strains that are placed upon it in the "postoperative context," and how it breaks down -- or deconstructs -- with an accordingly disturbing and turbulent impact on patients.

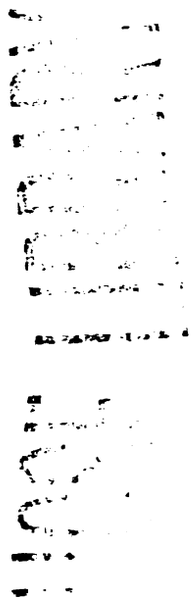


Underlying all the chapters in this dissertation is the idea that new kinds of medical technologies are "enrolled" (see Clarke and Casper in press; Latour 1987) into biomedicine so that their use conforms with and reexpresses "old" or established biomedical ideas, practices, and relations of power. Thus, in a sense, there may be nothing particularly "new" about them. Such a view is short-sighted, however, unless one recognizes that new kinds of technologies may also change the structure and organization of biomedicine's established ideas, practices, and relations. The conclusion to this dissertation summarizes some of these changes, and suggests that the hospital itself is an institution that is shifting position through the ongoing enrollment of technologies such as the Gamma Knife. As delivering "surgery" becomes increasingly swift and

consumption oriented, it argues, we may be faced in the not-so-distant future with a situation in which even the most serious human illnesses receive in hospitals intense yet only fleeting attention, and in which those stricken with such illnesses are rapidly discharged and cast adrift into a sea of uncertainties and undertows.

About the Research

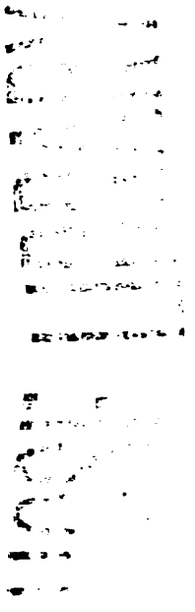
Ethnographic research for this dissertation was carried out mainly at Hillcrest Hospital between January and June 1993, and between May 1995 and June 1996. I observed and interviewed during these two periods hospital administrators, medical professionals, and patients involved in Gamma Knife radiosurgery at Hillcrest Hospital. These included officials responsible for acquiring Hillcrest's Gamma Knife, neurosurgeons, physicists, and radio-oncologists who directly carry out Gamma Knife radiosurgery, the nurses, technologists, and other medical personnel who assist them, and a total of 41 patients who underwent Gamma Knife treatment for their AVMs. I also attended local talks, lectures, and professional conferences relevant to Gamma Knife radiosurgery. To gain the perspective of other parties with a vested interest in the Gamma Knife, I also spoke with people at Elekta Incorporated, the company that manufactures, sells, and distributes the Gamma Knife, and interviewed Gamma Knife users from other medical centers in the United States. I also obtained from Gamma Knife physicians a considerable amount of secondary data in the form of unpuplished conference papers, medical reports, statistics, schedules, and written reflections -- perhaps among the most accessible forms of data in highly literate professional communities whose members have little



time to entertain curious outsiders.

Below, I discuss my research in greater detail, focusing on three areas or sets of factors that strongly shaped my fieldwork. The first deals with changes in the research setting and in my approach to it, the second involves issues of access and interaction, and the third includes matters of funding, focus, and accountability.

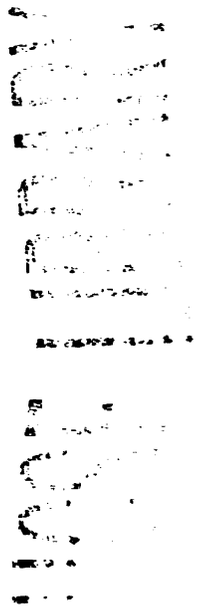
Changes in the Research Setting



The data in this dissertation were collected during ethnographic fieldwork conducted in 1993 and 1995-1996 (see above), two periods in the first four years of the Gamma Knife's existence at Hillcrest Hospital. The first fieldwork period, during which I interviewed physicians, observed procedures, and attended decision-making conferences, provided me with insight into those early stages of routinization that typically accompany the adoption of new kinds of biomedical technologies (see Barley 1988; Koenig 1988). New at Hillcrest Hospital, the Gamma Knife stood idle most of the time, having available to it only one or two patients a week, who were then treated by enthusiastic but still-inexperienced users, given to anthropomorphic insults whenever the machine or some feature of it appeared to fail or perform obstinately (see Barley 1988). By 1995 the Gamma Knife at Hillcrest Hospital was well on its way to complete routinization. More patients were available for treatment -- the Gamma Knife was typically in use twice a day, three days a week -- and a waiting list of potential patients now existed. Gamma Knife users had gained experience to call upon when making decisions or performing procedures, and problems with equipment had been ironed out, or were, such as the occasional computer

"crash," taken in stride.

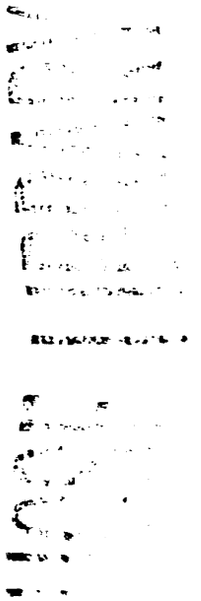
A number of key changes also took place in the organization and structure of the "Gamma Knife Team" whose members operate the Gamma Knife at Hillcrest Hospital. First, two specialists (one biophysicist and one radio-oncologist) were added to the team, thus expanding its composition to 12 members (three neurosurgeons, four biophysicists, three radio-oncologists, a nurse, and a technologist). Second, in 1995 a previous neurosurgical team member was elected to co-head the team. Third, interns and visiting specialists, hitherto lowkey and few in number, now frequently attended and participated in Gamma Knife decision-making and planning events. Fourth, the number of Gamma Knife centers in the United States increased from 12 in January 1993 to 30 in June 1996, including the establishment at a nearby university-based hospital of Hillcrest Hospital's closest rival Gamma Knife center.



These developments changed the dynamics of Gamma Knife practices in several ways. The addition of two specialists modestly increased the Gamma Knife facility's human resources, and placed physicists (in view of the team's composition) into the majority. The new co-director, a younger neurosurgeon, approached his role in the Gamma Knife team differently to his predecessor, a less mild-mannered, more brusque, individual. Rising attendance by interns and visiting specialists contributed elements of education, social visibility, and external scrutiny to planning and decision-making events, while the ongoing establishment of rival Gamma Knife centers placed added pressure on Hillcrest team members to recruit more avidly from a patient population increasingly prized elsewhere in California and the wider United States. The data that I collected reflect these changes, particularly in the review and selection of Gamma Knife patients, a process which I discuss in Chapter Three.

Issues of Access and Interaction

Meeting and asking people questions in a modern urban hospital in which time and space are premium was not easy. Encounters with my subjects, both patients and physicians, were typically brief encounters in areas of the hospital occupied with busy people, machines, gurneys, computers, books, furniture, and medical odds-and-ends. Swift footwork and opportune timing were accordingly needed to meet physicians and patients and to ask them questions. As a result, I carried out much of my fieldwork on the move: getting out the way, rushing from one location to another, asking a question here and hoping for a comment there. Yet, if tight schedules and crowded conditions made some aspects of doing fieldwork in Hillcrest Hospital difficult, they also made others easier. In the hustle-and-bustle of the hospital I was often overlooked or ignored, for example, while there unfolded around me actions, conversations, and arguments that keen awareness of my presence might otherwise have tempered. Rushing around in the footsteps of people in Hillcrest Hospital also brought me into intimate contact with the stress and controlled confusion that reign in such medical institutions. This kind of contact helped me understand that behavior in Hillcrest Hospital was governed also by basic human impulses and reactions to frustration and stress, and not just by complex metaphoric processes and hidden associations.



My interactions with patients were complicated for reasons related to the tempo at which their treatments unfold. First, Gamma Knife radiosurgery at Hillcrest Hospital (and at all other medical centers around the United States) is swiftly delivered and completed; patients are typically admitted in the morning

and discharged in the evening or the following day. Second, only a handful of patients treated during the time I conducted my fieldwork lived within 200 miles of Hillcrest Hospital; of these, three consented to informal interviews, which I conducted at their homes. Others returned after their Gamma Knife treatments to their homes in other states; two had even traveled, in the space of a few days, to and from Central and South America. My interviews with patients were therefore mostly conducted on-site, before and after their Gamma Knife procedures, and when they returned to Hillcrest Hospital for scans or additional procedures. The Internet provided me with a useful way to follow up interviews with patients from whom I had previously gained consent, and to collect through it stories from them that were at times more revealing and explicit than those gained from face-to-face interviews.[5]

Other technologies besides the Internet mediated my fieldwork interactions. I could only observe the Gamma Knife in action, for example, by standing in an adjacent room and peering into two small monitors that depicted from different angles the machine and the patient on it. A central research setting of mine was thus at a key time effectively off-limits, sealed closed during actual procedures to avoid exposing to radiation everyone but patients. Unable to directly observe or speak to patients while they were on the Gamma Knife I needed to rely on their later reconstructions of their procedures, a limitation that may lead in cases of extreme delay to the underreporting of numerous facets of medically related experience (see Heap 1985). To help prevent this, I typically approached patients and gained (with two exceptions) their consent to talk to them about their actual procedures as soon as they had returned from them to

[5] See Schwimmer 1996 for a detailed discussion on the ethnographic uses of the Internet. Also see Pareras and Martin-Rodriguez 1996 for a discussion on how the Internet helps medical specialists, including Gamma Knife users, to circulate clinical information and solicit expertise on "difficult" clinical cases.

the nursing unit, where patients remained for the evening and night before being discharged the following morning.

Funding, Focus, and Accountability

Research for this dissertation was carried out with funding provided by the Regents of California, the Centre for Science Development, and Elekta Inc., the Swedish company that manufactures and sells the Gamma Knife (among other neurosurgical technologies). I obtained this latter funding (USD 14,496) under the following circumstances. In 1993, I wrote to Elekta's headquarters in Atlanta, Georgia, and introduced to the vice president of their Radiation Systems Division the nature and goals of my project, stating that I wished to study "the activities and viewpoints of persons engaged in Gamma Knife Surgery" using "standard anthropological methods." My aim at this point was to establish rapport with the company, which I felt could prove to be an important source of documentation and information about the Gamma Knife and its manufacture, distribution, and use. I soon received a reply (from the vice president), which, along with some historical and epidemiological information on the Gamma Knife that I had requested, included a cover letter that stated, "Elekta may be amenable to providing funding for part of your research. As your work progresses and becomes more defined, please contact me to discuss such funding." I wrote back and thanked Elekta for the historical and epidemiological information, and for their willingness to perhaps fund part of my *pro*ject. I said I would contact them once I had a clear proposal of what I wished to research.

In December 1994 I wrote to the company again, having completed most of my courses leading up to the dissertation research, and having drafted a research proposal. I attached to this proposal and a budget of reseach-related expenses a copy of my last letter from Elekta, and mailed it to their U.S. office in Atlanta. By mid-January, 1995, I had received no reply; I decided to call the company. After speaking with the vice-president, it appeared that my letter had been lost in the mail; I sent along a second copy. This the vice-president forwarded to the executive vice president and clinical director of Elekta in Stockholm, Sweden, from whom I received a reply in March. The director thanked me for my proposal, adding "I find it a very interesting and neat study and I know that [the vice-president in Atlanta], as well as myself and others, will be interested in learning from it." Subject to my agreeing to produce a progress report and that funding be dispensed in two installments, the letter also agreed to fund my research with the amount of USD 14,496, the amount that I had requested in my budget. I agreed to these terms in writing, and again thanked Elekta for its support. I started my research with the help of this funding in May 1995.

Funding, even from non-profit sources, is rarely provided to researchers on an impartial basis, without strings or an agenda of some sort attached (see Price 1992). Still, anthropologists and other social scientists may be understandably wary of accepting funding from industrial or corporate sources to pave the way for their research. Given its interests in the commercial well being of a particular product or service, a company may seek control over a researcher's activities, focus, and general investigative independence. Or, more subtly, feeling that he or she owes the company something, the researcher may consciously or subconsciously shy away in his or her investigations from

exposing and analyzing issues that conceivably clash with or discredit their benefactor's interests and public and commercial reputation.

As I hope this dissertation shows, these and other adverse potentialities did not influence my research or writing in any significant way. My relationship with Elekta was an ideal one in many respects. The company, I firmly believe, helped fund my research because it was genuinely interested and intrigued in a project that proposed an open-ended and holistic approach to understand the the local conception and use of one of its products. I also believe -- in the wake of the fact that at no stage did it attempt to stipulate or mould the conditions or focus of my research -- that the company was keen to maintain a relationship in which I would feel free to complete my research without concern for what it might like or dislike about my findings. This does not mean that the company had no intentions of profiting in some way from my research. As a firm in the process of selling a relatively new product in a highly competitive marketplace, Elekta most probably hoped to learn something from my research that would benefit its commercial prospects. My research findings may well help them in this respect, but only, as I hope to show, if the concerns and experiences of patients are closely considered. Thus, I see the funding and support I received from Elekta as a clear signal that there is room in contemporary society for an ethnographic researcher and a leading biotechnological company to work together in advancing the interests of all concerned (see Rabinow 1996).

Chapter Two

History and the Gamma Knife

The Gamma Knife at Hillcrest Hospital has at the base of its steel dome four wheels, each about 20 centimeters in diameter. These were included in the design of the machine so that it could be pushed, pulled, or maneuvered into place more readily than its bulkish 18 tons would otherwise permit. Though now essentially useless with the technology enclosed in a concrete room in the basement of Hillcrest Hospital, from which it would have to be hauled with a crane through the existing ceiling should its removal ever become necessary, these four wheels remain behind as small symbols of the enormous amount of historical pushing, pulling, and maneuvering that has brought the Gamma Knife into existence.

The present chapter examines several key events and developments in the genesis and mobilization of the Gamma Knife. It focuses, to use a classic anthropological term, on the *kinship status* of the Gamma Knife, in view of which the technology has inherited certain meanings, traits, and alignments that predicate its present-day identity and use as a surgical-like instrument -- as a "Knife." The chapter argues that these inherited features stem largely from a historical convergence on the Gamma Knife of two bioscientific traditions, surgery and physics, which symbolically blend into the social and medical conception of the technology the use of scalpels and the use of radiation, both of which denote penetration, invasion, and radical change. To grasp the scope of this convergence, the chapter is divided into three sections that successively examine the following areas: the rise of modern neurosurgery, the adoption and

use of radiation in modern medicine, and the role played by the Gamma Knife's inventor, Lars Leksell, in bridging surgery and the field of medical radiation. The conclusion suggests that these multiple histories and the alignments they have shaped are collectively embedded in the present-day conceptions, relations, and interactions that surround the Gamma Knife.

The Surgeon, the Scalpel, and the Brain

Tinkering surgically with the human brain dates back to prehistoric times, judging from the large number of trephined skulls that archeologists have unearthed and dated, often in proximity to flint and obsidian tools that still carry human-bone residue (see Ganz 1993:3; Williams and Warwick 1980:810). Human sacrificial remains and mummies also show signs of trephining, suggesting that brain-related surgeries played a strong religious role in some cultures. Records that have survived the rise and fall of Greek and Roman civilizations provide further evidence of an impulse to perform surgery on the human head (see Ganz 1993:3; Williams and Warwick 1980:810). Hippocrates, for example, offered practical advice on how to cool a trephined skull, Herophilus and Erasistratus, teachers at the Alexandria School, dissected and distinguished conceptually between the cerebrum and cerebellum, and Galen's neuranatomical writings, based largely on humoral theories, provided a working foundation for future generations of surgeons and physicians who attempted to repair injured or dysfunctional human brains. Notably, these early surgical theories and practices appear to have been limited to operations directed not at the brain itself, but at removing a portion of the skull to relieve cranial pressure, or to allow the influx or escape of humors or spirits in addressing problems

ranging from melancholy to epilepsy. Emphasis on surgically entering and repairing the brain itself is much more recent (see below). Thus, it is perhaps more accurate to speak of "skull surgery" (rather than "brain surgery") when discussing the prehistory of neurosurgical practice.

Following the "Dark Ages," during which they were "all but extinguished" (see Williams and Warwick 1980:811; Pouchelle 1990), these old neurosurgical legacies were revitalized and refined among anatomists, physicians, thinkers, and artists of the Renaissance in the late fifteenth and early sixteenth centuries. The brain, its significance, and how best to repair it again became a subject of interest and fascination, amid an interchange of ideas and knowledge that took place between physiologists such as Andrea Vesalius, artistic depictions of the inner brain such as the wax casts of Leonardo da Vinci, and the hands-on work of barber-surgeons such as Ambroise Pare.

Like other areas of thought and practice, skull surgery was caught up during this time in an emerging mechanical world view. The brain, like the heart, was increasingly approached (with influence from naturalists such as Vesalius, William Harvey, Bacon, and Descartes) as a mechanical structure, which featured distinct anatomical regions, nerve bundles, and an objective morphology in place of the spirits and arcane forces that were once thought to flow through it. Technological developments during the seventeenth and eighteenth centuries helped impose on the brain this mechanistic paradigm; simple microscopes began to appear, alongside magnetic devices and stimulation, cooling, and staining techniques that allowed anatomists and others to inspect the brain and isolate as electromechanical in function its various parts and regions (see Williams and Warwick 1980:911; Star 1989).

The late eighteenth and nineteenth centuries heralded rapid and complex developments in brain research and skull surgery. Besides being influenced in theory and practice by the emergence of phrenology and the increasingly high "scientific stake in demonstrating a physical basis of mind," (Star 1989:9; see also Harrington 1987), brain-related research and surgery were responding to ongoing social, institutional, and technical changes. The establishment of clinics and hospitals in both Europe and the United States, for example, began to provide a legitimate institutional context for surgery, including skull surgery, helping thus to gradually sever its grisly associations with barber shops, kitchens, and cemeteries (see Duffy 1993:188-202). Spurring its establishment were such innovations in operative precautions and cleanliness as the antiseptic techniques and measures developed by Joseph Lister, Oliver Holmes, and Mortiz Schuppert, the rise of intravenous infusion, and the adaptation to skull surgery of such electrically-powered instruments as. the Borchardt cranial drill (see Duffy 1993:188-202; Pait et al. 1991).

These developments, combined with the emerging view that the brain was governed by electromechanical principles -- a complex organ perhaps, yet a mere organ nevertheless -- heralded a turning point in neurosurgical practice from the mid-1800s on. Increasingly, the brain itself was the site of surgical intervention, rather than just the skull. Brain surgery, in other words, began to replace skull surgery. Spurred by the work of Victor Horsley and later, that of Harvey Cushing, this shift toward brain surgeries was rapidly adopted among other skull surgeons. Between 1886 and 1896, for example, more than 500 surgeons in Europe and the United States reportedly breached the frontier of the skull and performed operations directly on the brain (Wilkins, cited in Fishman 1988:205). Still based, however, on crude instruments and poor

localization and antiseptic techniques, this shift also led rapidly to mortality rates that far exceeded those that accompanied the previous limitation of surgery to the opening of the skull. Such leaders in the field as Victor Horsley were consequently involved in generating a legacy of grim statistics, which in some instances prompted their institutions to strip them of their rights to admit patients, and to perform brain surgeries (see Fishman 1988:204-206). Thus, by the start of the 20th century, a complex combination of developments that had made the ailing brain directly accessible to biomedicine was also shrouding in bleakness and pessimism those who chose to access it, inspiring among brain surgeons such adages as "everyone dies that I touch" (Cushing in Fishman 1988:208).

Matters would improve, however, as brain surgeons and brain surgery stood to benefit from several developments between 1900 and the Second World War. The advent in the early years of the century of anesthesiology as a medical specialty was one such development; its growing membership began to facilitate the work of surgeons, including brain surgeons, with improved anesthetic drugs and muscle relaxants (i.e. barbiturates, curare), and superior types of devices for administering them (see Duffy 1993:260). Blood transfusion methods and coagulants were also improved and made more widely available (Crichton 1970:110-4), the rise of sulfa drugs sharply reduced the danger of infection during surgical procedures (Duffy 1993:260), the adoption and refinement in the United States of Roentgen's X-ray technology also provided brain surgeons with a powerful diagnostic tool (see below), and the production by the Carl Zeiss Company of new, high-powered surgical microscopes, or teleloupes, enhanced the brain surgeon's visual capabilities during operations (see Neil-Dwyer 1996:159). In 1919 the American College of Surgeons also declared that it would henceforth consider neurological surgery a formal

surgical specialty -- the first of many organizational innovations that helped establish for brain surgeons a stable, orthodox niche in 20th-century biomedicine (see for a history of neurosurgery's organizational development, Hauber and Philips 1995).

By the 1940s, brain surgery (as opposed to skull surgery) had advanced in the wake of these and other developments well beyond its miserable beginnings in the 1800s. Combining technical innovations, experience, and fastidious surgical skills, Harvey Cushing, for example, had by 1930 conducted 149 brain operations with a mortality rate of only 7.3 percent; merely ten to fifteen years earlier, the same kinds of operations had claimed over 30 percent (see Fishman 1988:209). Cushing's students and contemporaries too were able to tally up surgical successes far more frequently than their counterparts around the turn of the century.

The next frontier in 20th-century brain surgery became the arteriovenous malformation (AVM) and its close pathological cousin, the aneurysm, vascular disorders that few brain surgeons had so far operated on. Indeed, while the removal of brain tumors had become by the 1940s almost routine, AVMs and aneurysms in the brain were still shrouded in mystery and taboo. "The diagnosis [of an aneurysm] is, as a rule, impossible," wrote William Osler, a preeminent American physician, in his *Principles and Practices of Medicine* in 1920 (cited in Fishman 1988:167). This view was shared by prominent brain surgeons, who believed that to attack an AVM or aneurysm surgically was almost unthinkable:

> Elsewhere in the body where tourniquets could be applied or pressure be temporarily exerted against resistant tissues, bleeding [from an AVM or aneurysm] can be controlled but this is not true of

> the brain. There is little to be said from our own experience in any way encouraging in regard to the surgical attack on one of these formidable lesions. The mere exposure may be attended with great risks. [Cushing and Bailey 1928, cited in Fishman 1988:168]

The prospect of dealing with AVMs and aneurysms, it seemed, was "to face, once again, colossal morbidity and mortality rates," and so reinvite the sour, dystopic note on which brain surgery had set out (Fishman 1988:169). Not all brain surgeons, however, refrained from surgically addressing AVMs and aneurysms. Walter Dandy, a student of Cushing's, reported having attempted in the 1920s to excise AVMs in eight of his patients; all died during or shortly after surgery. Similar failures were recorded in both Europe and the United States by other brain surgeons (see Fishman 1988:168-9). The first successful attempt on an AVM was made in Sweden by Herbert Olivecrona in 1932, proof enough to some neurosurgeons that a patient could survive and recover from an operation on a vascular disorder in the brain. By 1965, medical literature contained reports on 187 surgical excisions of AVMs and aneurysms, nearly 11 percent of the patients operated on had died (Fishman 1988:169). Despite such failures, a new branch of neurosurgery was emerging from these attempts, vascular neurosurgery, whose practitioners, often dubbed the "brain squad," rapidly rose in the neurosurgical hierarchy to an elite and envied position (Fishman 1988:167). Technical advances in the 1970s and 1980s, especially in diagnostic imaging techniques such as computed scanning and magnetic resonance imaging, made their surgical attacks on AVMs and aneurysms more precise, and helped substantially lower mortality and morbidity rates, to less than five percent in some instances (Fishman 1988:187). These rates do not, however, reflect the enormous amount of damage that vascular neurosurgeons

often inflicted on the brain while attempting to excise an AVM or aneurysm -- damage that surgeons may have considered par for the course, but that often diminished the quality of life for their patients in the wake of "side-effects" such as blindness, deafness, seizures, and loss of muscular function.

This section has considered some key characteristics and developments in the genesis and rise of modern neurosurgery. It has focused particularly on the shift from skull surgery to brain surgery, which involved a perilous redirection of surgical skills, tools, and aims from surface structures to the internal regions of the brain. Disorders in these regions, such as AVMs and aneurysms, then gradually became the focus of sub-specialized attention, as neurosurgery developed into an organized, orthodox medical field. Below, I show how there has unfolded alongside these and other developments another history, that of the radioactive atom, and how gradually it converged (in a web of commercial and political interests) with the emerging practice of brain surgery. One key reason for doing so is to illustrate that the Gamma Knife has entered in a social and medical landscape long embroiled in the United States in the commerce and politics of radiation. I also highlight the emergence in the United States of a cultural discourse that still speaks of the profound promises and perils of radiation, which the Gamma Knife and its use has not eluded. The section begins with a short, turn-of-the-century story about the portent of this discourse, and continues on to trace its rise in relation to biomedicine in the United States.

Physicists and Physicians, Entrepreneurs and Politicians

One hundred years ago, on January 6, 1896, there appeared in the

United States of America for the first time, in the New York Sun, an article about Wilhelm Roentgen's discovery of X-rays in Vienna. The article read, in part:

> It is announced that Professor Routgen [sic] of the Wurzburg University has discovered a light which, for the purposes of photography, will penetrate wood, flesh, and most other organic substances. The professor has succeeded in photographing metal weights which were in a closed wooden case; also a man's hand, which shows only the bones, the flesh being invisible. [Quoted in Caufield 1989:4]

Four weeks later an American with an infamously sharp eye for sensation, William Randolph Hearst, composed the following telegraph, a request to obtain from Roentgen's infant technology an image of the human brain: "WILL YOU AS AN ESPECIAL FAVOUR...UNDERTAKE TO MAKE A CATHODOGRAPH OF HUMAN BRAIN KINDLY TELEGRAPH AT OUR EXPENSE" (Caufield 1989:5). Hearst's request was directed at Thomas Alva Edison, already widely known for his work on and success with electric light and power, moving pictures, and the phonograph. Edison accepted the task, and began work on the cathodograph in a state-of-the-art laboratory in West Jersey, staked out night and day by reporters. After having assured the press that the cathodograph was imminent, Edison reported at the end of three weeks that X-rays did not, after all, lend themselves to its construction; the project was ostensibly abandoned on technical grounds.

In the same year, 1896, Edison initiated two other X-ray related projects. Both involved Clarence Dally, a glassblower and laboratory technician who had worked closely and frequently on the ill-conceived cathodograph. With the first

project Edison had in mind something completely novel: an X-ray-powered light bulb. While using X-rays and calcium tungstate to develop the bulb for Edison, Dally began to develop curious reactions. Hair on his head started falling out, and the skin on his fingers and hands grew inflamed, and ulcerated. Edison concluded that these were not being caused by the tungstate, a better known element, but in all likelihood by Dally's exposure to X-rays. Later Edison reported:

> I found that the X-ray had affected poisonously my assistant, Mr. Dally, so that his hair came out and his flesh commenced to ulcerate. I then concluded that it would not do, and that it would not be a very popular kind of light, so I dropped it [the project]. [Caufield 1989:9]

Edison's second project, aimed at improving an existing X-ray technology, Roentgen's fluoroscope, was more successful. With the hands-on help once again of the ailing Clarence Dally, Edison produced a fluoroscope that achieved images six times brighter than Roentgen's. This Edison exhibited at the Electric Light Association Exposition in New York in May 1896, where thousands of people "queued to put their hands, legs, or heads into the path of the rays and watch themselves on a fluorescent screen" (Caufield 1989:6). Following the Exposition Edison patented two other fluoroscopes, one designed for diagnostic use in medical circles, and the other -- known as the Thomas A. Edison X-ray Kit -- designed for home or popular use. Both sold prolifically before and after Dally's death in 1904 at the age of 39, the first death in modern

history known to be caused by radiation poisoning.[1]

Among the many people who soon followed in Edison's and Dally's footsteps, spotlighting both the promise and peril of the introduction into the 20th century of the radioactive atom, were health care professionals and their patients. By 1905 already adopted en masse by medical institutions around the United States, X-rays signaled to health care professionals and patients alike the creation of a new and remarkable "window into the interior of the body" (see United States Government 1996:3), and the beginning of the end for a host of medical problems. Surgeons were from the outset among the champions and chief beneficiaries of this new radiation-based form of diagnosis. Optically limited previously in their knowledge and procedures to opaque surfaces and exteriors, surgeons began to adopt and use X-ray technologies with great enthusiasm, creating as the main offshoots of their surgical units the first radiology departments in the United States (see Duffy 1993:198-9). Alongside innovations in anesthesia, sterilization, and blood transfusion, the diagnostic use of X-rays by surgeons from 1905 onwards gradually helped lower an inhouse mortality rate among their patients that in many instances exceeded 70 percent (Duffy 1993:200).

The perils of exposure to X-rays and other radiation materials also soon became apparent. An increasing number of physicians and patients began developing through prolonged exposure to X-rays the same lesions, burns, and ulcerations as Clarence Dally. By 1908 the American Roentgen Ray Society had reported 50 cases of X-ray poisoning, a statistic followed soon by a spate of

[1] Dally had developed serious lesions, burns, and ulcerations, for which had undergone by 1904 a string of amputations: first his left hand, then four fingers and part of the palm on his right hand, followed by his right arm, and finally his left arm below the elbow. For a more detailed account of Dally and his death, see Brecher and Brecher 1969; Glasser 1993; Kathren 1982. For a more detailed account of Edison's involvement with the cathodograph, X-ray bulb, fluoroscope, and other X-ray related projects, see Josephson 1961.

grim first-hand testimonies from medical and other sources (see Caufield 1989:13). In the wake of these statistics and stories, some people and their forums -- the publishers of the American X-Ray Journal, for example --voiced their concern with cautionary reports and the removal from their publications of a key symbol of the day, a figure of 'Science' holding an X-ray tube aloft to irradiate the world. In response to such signs of concern, others urged for the continuation of work begun by "martyrs to science through the roentgen rays," and labeled as "casualties to natural causes" those who were following in Dally's footsteps. Thus, with the perils of X-rays emerging, there also began to emerge, in the United States and Europe, a discourse of gain and loss and of defense and criticism, split as the radioactive atom itself is split, into positive and negative, for and against.

This discourse would split further with the introduction to science and medicine of another radioactive player, radium. One may point to several people and events important to its discovery and incorporation into medical thought and practice. In France in 1900, Paul Villard identified from a sample of radium and other radioactive elements the emission of gamma rays, now considered the most powerful form of radiation known to humankind. Also in France, in 1901, Henri Becquerel, then Professor of Physics at the Ecole Polytechnique in Paris, reported that radium, which had left burns on his body that resembled X-ray burns, might also "possess...therapeutic power" -- followed two years later by an even more portentous observation, made by Alexander Graham Bell: "There is no reason why a tiny fragment of radium...should not be inserted into the very heart of a cancer, thus acting directly upon the diseased material" (in Caufield 1989: 24-25). Marie Curie, in turn, began extracting radium from pitchblende in 1904, under conditions of exposure that would lead

to her death from aplastic anemia in 1934. In Canada and later England, Ernest Rutherford began experiments with radium (and uranium) that would lead to the realization in 1919, through bombardment of nitrogen atoms in his laboratory, of "the old alchemist's dream: the transmutation of matter" (Keller 1983). In the wake of these and other efforts, radium swiftly became the radioactive element of choice among researchers in Europe and North America.

By 1931, 287 hospitals and 414 individual physicians in the United States possessed and worked with supplies of radium (Caufield 1989: 27). Alongside X-ray equipment, these radium supplies (and other radiation sources) were used to experiment with and treat a range of afflictions, particularly cancers. These experiments and treatments, which sometimes involved high doses of radiation, are now known to have led in turn to the inducement of cancer many years after they were carried out (see United States Government 1996). Elsewhere in the U.S, radium was injected and orally administered to thousands of patients for such afflictions as rheumatism, high blood-pressure, menstrual irregularities, and depression, frequently with the sanction of the American Medical Association (see Caufield 1989). Radium (like X-rays) had also spawned a popular fringe market in the U.S. and Europe, where it was advertised and peddled in patent medicines, hearing aids, toothpastes, chocolate bars, and other products as a prevention or cure for such afflictions as arthritis, sinusitis, migraine, eczema, asthma, and diabetes (Caufield 1989:28). Many consumers of these products, where genuinely they contained radium, fell sick and eventually died, joined in turn by people whose labor supported both these mainstream and fringe medical markets: mine and factory workers, engineers, transport and storage personnel, salespeople, physicians, and lay practitioners. As they grew in number, these fatalities came

under increasing public and medical scrutiny; radium joined X-rays in generating cries of alarm and caution.

However, opposition, particularly corporate-based opposition, to criticism and moral attack against radium and other radiation-based products, therapies, and enterprises had also grown formidably. The sway of big business in challenging the legitimacy of existing knowledge and the scrutiny of radiation-related hazards, in other words, also entered the radiation-technologies arena. This is perhaps best exemplified in the case of the Radium Luminous Materials Company (later renamed the U.S. Radium Corporation), established by Dr. Sabin von Sochocky and several partners in 1915, two blocks from Thomas Edison's famous laboratory. Setting out to turn zinc sulphide and radium-226 into luminescent wristwatch dials, the company additionally turned dozens of its employees into radiation victims through exposure on the factory floor to radium paint. Though legally forced by 1930 to implement protective measures and to compensate victims and their families, Sochocky and his partners -- with hired scientific backing from Columbia University and various other 'reputable' institutions -- successfully defended for almost two decades their claim that their afflicted workers were suffering from illnesses unrelated to radiation poisoning, an overture in many respects to the financial muscle that now flexed on the radiation landscape (see Caufield 1988 for a more detailed account of the U.S Radium Corporation and its tenacious stand against litigation; also see Pringle and Spigelman 1981).

In sum, the passage of radiation and radiation technologies into society and medicine in the period 1896-1936 was lined from the very start by the transcontinental travel of scientists, knowledge, and information, by high hopes and false confidence, by personal aggrandizement and corporate interest, and

by tragedy. Beginning with Edison and Dally, the harnessing of radiation proved a blessing to some and a curse to others, advancing interests so selectively that already by 1910 -- over 40 years before Hiroshima and Nagasaki -- controversy and diverging interests marked the development of radiation-based tools and industries. The same period also witnessed the introduction of radiation in medical diagnostics, and the first attempts to extend its application to medical therapeutics. These developments were structurally ossified with the establishment of the first radiology departments, and the emergence of nuclear medicine, which is said to have begun with a lunchtime seminar at Harvard in November 1936, at which MIT president, Karl Compton, talked on "What Physics Can Do for Biology and Medicine" (see United States Government 1996:4-5).

These trends and characteristics would continue to prevail over radiation and radiation technologies from 1936 onwards -- but on a scale much changed, owing to the entrance into and dominance over the radiation industry of another, hitherto low-key player, namely government. As the Second World War drew closer, and as radiation researchers began to tap the atom's most ominous potential yet, governments in the United States and in Europe took notice, and stepped in. Several key technical developments, in the context of a brooding prewar climate and a quest for techno-military oneupmanship, spurred their interest. These include the description by the German physicist Ida Noddack of atomic fission in 1934, the production by Frederic and Irene Joliot in the same year of artificial radioactivity, the emergence in 1937 of Leo Szilard's theories on critical mass and chain reaction (and their placement in patent form in British hands), the news in 1938 that two German physicists, Otto Hahn and Fritz Strassman, had learnt how to split atoms and render them volatile in their

laboratory in Berlin.

By 1943 the focus of radiation research had shifted decisively to military ends, feverishly funded and pursued in the U.S and Europe by government and its various agencies. Political leaders in Britain, France, Sweden, and other European countries ordered the mass recruitment of physicists and radiation scientists to the "war-effort," the establishment of bomb-making groups, the financing with largess of radiation laboratories, the supply of more labor to mining houses in order to spur the extraction and production of radioactive materials such as radium, uranium, and plutonium -- orders galvanized in 1940 by the report that Hitler had confiscated large supplies of Danish radium in his own quest for a super-weapon.

In the United States in the meantime, with Roosevelt's approval, the Manhattan Project was born. Embracing by the end of the war more than 39 radiation-related plants and research facilities, 40, 000 workers, and a budget of over two billion dollars, the project was on a staggering scale geared almost exclusively to bomb-building. Not incidentally the project also involved physicists and physicians, many of whom would later echo the words of Stafford Warren, a radiologist at the University of Rochester, to imply that they had, given the nature of their recruitment, little choice but to contribute to the project, and so also to its fateful outcome:

> They [government intermediaries] wanted to know what I was doing in radiation. So I discussed the cancer work and some of the other things. Then we got upstairs and they looked in the closet and they closed the transom and they looked out the window.... Then they closed and locked the door and said, "Sit down." [quoted in United States Government 1996:6]

Like Stafford, who was made medical director of the Manhattan Project and a colonel in the U.S. Army, civilian specialists in physics and medicine were after such meetings frequently given privileged organizational roles and military titles, thus entrenching and sanctioning in the name of professional recognition and national security their collaboration in the Manhattan Project. Much of their work centered on learning about radiation hazards in order to safeguard the secrecy of the project, for organizers feared that if no measures were devised to preempt workers from seeking outside medical help or legal aid due to radiation injuries that in all likelihood many would sustain on the project, its progress and know-how would become widely known. The Project thus created an extensive medico-experimental agenda: large numbers of animal studies designed to obtain data on the physiological effects of radiation were conducted in Chicago, Berkeley, and elsewhere; the University of Rochester was contracted to receive and process data on physical exams and other tests from Project sites; Stafford Warren (with the help of Robert Oppenheimer) launched a program that involved secretly injecting patients with plutonium, uranium, and possibly other radioactive elements (see United States Government 1996:7-8). At various university-based hospitals, including Hillcrest Hospital, surgeons and radiologists began at the federal government's behest to collect data for the Project by administering radioisotopes and external forms of radiation to patients, often without their consent (United States Government 1996:7-8).

While the practical value to the Manhattan Project of this research was

questionable,[2] it established a collaborative, federally sanctioned platform for spurring medical interest, knowledge, and application of radiation-related technologies, a platform that was to be maintained and bolstered after the war. The U.S. government continued to fund radiation-related research, extending sums ranging into the millions to universities and research centers that had contributed to the Manhattan Project during the war.[3] Beginning in 1951, and for two decades thereafter, medically-derived data from irradiated patients was collected and passed on to the Defense Department, as the Cold War set into motion a new scramble for techno-informational superiority that included radiation research and production.

Beyond generating information with which the U.S. government hoped to advanced its position in the nuclear arms race, radiation-related efforts at biomedical institutions also served as a symbolic linchpin in the "Atoms for Peace" program, a sweeping ideological attempt to free the radioactive atom and those who had helped harness it from their recently-gained association with calamity and destruction (see Hewlett and Moll 1989). Amid promises that it would soon revolutionize the provision of civil and commercial needs from domestic lighting to canals and harbors, the radioactive atom was envisioned as a medical blessing, a source of life rather than death. Talking about the future of radiation research, Dwight Eisenhower pledged as much at the United Nations in 1953: "The United States will devote its entire heart and mind to find a way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life" (in The Atomic Age 1996; see also McKay

---

[2] Although they resulted in the implementation of several safety measures on the Project, data from this research were most probably less effective in preventing workers from leaving and jeopardizing the security of the Project than the practice of "rotating out" Project employees from hazardous roles to those that did not involve radiation exposure (see United States Government 1996:6).

[3] For a list of figures and recipient institutions, see United States Government 1996:37.

1984).

The era of transforming radioactive swords into ploughshares had begun. On one side, this transformation was galvanized by the nuclear power plant, first opened in the U.S. for the production of electricity in 1955 in Arco, Idaho, under a government promotional banner, "Arco Sees New Light." In 1957 Shippingport, Pennsylvania, became the next recipient of a nuclear power plant, followed by three more towns in 1963. By the early 1970s, 100 nuclear power plants had been ordered for the commercial and domestic supply of electricity in the U.S. (in The Atomic Age 1996). Alongside this push to happily routinize its uses in local hearts and homes, the radioactive atom moved center stage in many medical research and treatment facilities around the United States. By 1955 an extensive and well-funded radiation research bureaucracy had emerged, as part of an even greater transformation in federal support for biomedical research in industry and universities (United States Government 1996:10-11; see also Starr 1982: 335-47). The biomedical program of the Atomic Energy Commission (AEC), which absorbed many researchers and resources from the Manhattan Project, occupied the apex of this bureaucracy. Through its Division of Biology and Medicine, the AEC fostered and helped fund new and improved radiation technologies (such as the super voltage X-ray machine, cyclotrons, and linear accelerators), the production of radioactive cobalt (a cheaper substitute for radium), and research and application of radioisotopes,[4] alongside promotional campaigns and press releases that extolled the "medical revolution" that would emanate from these efforts (see United States Government 1996:8-11).

Cancer concurrently became the single most important focus in radiation-

[4] These isotopes (identical atoms with different numbers of neutrons) were produced and made available to doctors and researchers from the first nuclear reactors, at lower cost and greater quantities than before (see Caufield 1989:143).

based biomedicine (see Caufield 1989:140; Livingstone-Wheeler and Addeo 1984). By 1952 the AEC had licensed 1200 medical institutions in the U.S. to use radioisotopes for treating cancer, primarily of the thyroid (Caufield 1989:143). Other cancers, including leukaemias and brain cancers, were also being widely researched and treated -- seldom with the full knowledge or consent of human research subjects or patients (see, for example, the discussion of the Boston Uranium Project in United States Government 1996:158-60). Though by no means always successful, radiation technologies nevertheless provided a foundation for clinical advance against cancer that few other technologies had so far promised, generally forcing into remission cancerous cells far more readily than other existing interventions. With wholesome government support in tow, physicians and financiers alike thus hailed radiation-based technologies as the logical choice for pursuing the treatment of cancer, not on the fringes of medicine and society, but "in every town and village in the United States" (see Livingston-Wheeler and Addeo 1984:94).[5]

Pitted against cancer, the radioactive atom seemed to be adopting a role closer than ever before to the one Eisenhower had publicly envisaged for it at the end of the Second World War, in which radiation preserved life, rather than issued forth death. Metaphors or war and battle helped establish this role. Cancer increasingly became biomedicine's arch *enemy*, a disease that needed to be voraciously *battled,* with *weapons* suited to its precise *destruction* -- a militaristic theme that has marked biomedical efforts against cancer (and other disorders) to this day (see Martin 1990; Stein 1995; Winslow 1994). Contributing to this discourse, in which radiation technologies were being

[5] Adamant opposition to the use of radiation technologies for treating cancer also gradually emerged, especially among researchers and physicians who entertained theories of causality different to those dominant in biomedicine then and now (see Hess in press)

shaped into powerful yet benevolent medical tools, were attempts to use radiation to cure and ameliorate disorders considered mental or neurological in origin. Epilepsy, schizophrenia, and Parkinson's Disease were among these -- disorders for which physicians began offering radiation treatment as an alternative considerably less invasive and violent than the lobotomy procedures that had become for treating the "mentally disturbed" almost standard since the 1930s. Here too, directly in the realms of the dysfunctional human brain, radiation technology would gradually accumulate to its credit further discursive capital while its main clinical competitor, the highly-invasive lobotomy, would be increasingly discredited as barbaric and inhuman, and disappear eventually from biomedical practice.

This section has detailed several key developments in the convergence of biomedicine and the field of modern radiation. It has shown that radiation-based activities and enterprises expanded during and after the war from cottage-industry roots into an industrial-military complex, and that biomedical applications of radiation served in the onset of the Cold War as a counter-symbol to the dark and destructive identity that the radioactive atom and its custodians earned in the wake of Hiroshima and Nagasaki. Two trends in this context directly foreshadowed the development of the Gamma Knife in Europe: 1. the increasing availability in the postwar years of radiation materials, including Cobalt 60, the active ingredient of the Gamma Knife, mined in Canada and the United States, and sold to medical research centers in Europe; and, 2. the decline in popularity of lobotomies and the search for new psychosurgical therapies for functional disorders, which, as the next section shows, played a central motivating role in the development of the Gamma Knife.

Convergence: Scalpels, Isotopes, and the Brain

Among the countless people who may play a role in conceiving, developing, and defining a technology are also those who may play in these processes more of a role than others. This section considers the man -- some say genius, pioneer -- who played a major role in the advent of the Gamma Knife, Swedish neurosurgeon Lars Gustaf Leksell. It considers several factors that underlie Leksell's creative involvement with the Gamma Knife, including his early experiences with brain surgery, his interest in mechanics, his application of radioisotopes in brain surgery, his development of the Gamma Knife as a response to the declining popularity of lobotomies, and the role he played in shifting the application of the Gamma Knife from functional (or "mental") disorders to vascular disorders such as AVMs. Focus on these factors will further place the technology into a broader context; it will also help reveal how the historical processes so far discussed have converged on an inventor to shape the mix of symbols and meanings that surrounds the Gamma Knife at present.

Lars Gustaf Leksell was born in Stockholm, Sweden, in 1907, under the sign of Sagittarius, from which he later adopted the motto, "to ride, to shoot with the bow, and to tell the truth" (Leksell, L. 1992:278). His father was a local businessman and his mother was a porcelain decorator. His first memorable experience with medicine followed a motorcycle accident at the age of 19; he was hospitalized for knee surgery, and recalled being "very impressed by these men in white [surgeons]" who performed the operation (Leksell, D.1992:257). Leksell went on to study at the Karolinska Institute, perhaps Sweden's most prestigious institution of medical learning and practice. "[His] preclinical studies

were boring, and he almost considered leaving medicine," writes Dan Leksell, his son (Leksell, D. 1992:257). Yet Leksell would stay, fostering a mentorship with Herbert Olivecrona, the Swedish neurosurgeon who performed the first successful operation on an AVM (see above). By 1927, at the age of 20, Leksell had become an assistant to Olivecrona. "My duty was to follow the boss like a shadow and to anesthetize [his] patients," Leksell recalls in his memoirs (Leksell, L. 1992:268).

During this stint as Olivercrona's assistant, and thereafter, as he began part of his neurosurgical training in the operating room, Leksell developed what appears to have been a rather ambivalent attitude towards neurosurgical practice. On one hand he seemed favorably impressed with the field, recalling early on the "fast, brilliant," and "efficient" operating techniques that he witnessed (268), the "artistic craft" (276) involved, the "grace" and "balance" (276) of the rongeur and the scalpel (Leksell, L. 1992). On the other hand he seemed appalled, struck time and again by the violent, often fateful attempts by his mentors to intervene manually in "that most remarkable machine -- the human brain" (285). He describes the following experience, for example, with obvious distaste:

> The patient had typical cerebellar gait disturbance. At surgery, the cerebellum was laid bare.... There was no tumor visible, and the patient became agitated, shouted, and tried to get away from the operating table. "Stay quiet, stay quiet!!" The cerebellum swelled and pushed out of the wound. Then there was silence. Olivercrona took off his bloody rubber boots and left. "It was mostly his [the patient's] own fault," he said. [Leksell, L. 1992:271-2]

"Such experiences," Leksell writes, "have accelerated the development of neuroradiology" -- the application of X-rays and other radiation sources to brain disorders (Leksell, L. 1992:271-2). They also appear to have accelerated Leksell out of the operating theater once he had completed his medical degree and internship, and into research for a Ph.D. that would for the first time bring him into close contact with radiologists and physicists, and their way of seeing and doing things. He aimed in his Ph.D. research to classify hitherto unknown motor nerve fibers in cats, which he hoped to isolate using X-rays in the form of a cathode-ray oscilloscope. Leksell recalls:

> The days started with the decerebration of cats. The brain was shoveled out, and the classical preparation, with extended legs and many reflexes left, but without pain, was obtained.... Several times, I felt the excitement to see on the screen the blue cathode-ray revealing something dramatically new, something unknown till then, and this sensation compensated for many long working hours and deceptions. [Leksell, L. 1992:273-4]

With this research complete and both his M.D. and Ph.D. in hand, Leksell began in the 1930s to pursue advances in the treatment of deep-seated brain disorders, an area of neurosurgical practice in which mortality rates still soared to 70 percent. The most promising avenue lay for Leksell in the field of stereotaxy.[6] Pioneered in 1889 by the Russian anatomist D.N. Zernov and developed further by the British surgeon Victor Horsley (see above) and his

[6] The word "stereotaxy" derives from two Greek roots: "stereos," meaning three-dimensional or spatial, and "taxis," meaning arranged, or ordered. The root "taxis" was in 1973 changed to "tactic" by the World Society for Stereotactic and Functional Neurosurgery, which maintained that "tactic," derived from the Latin for "touch," better reflected the tactile, surgical, aspects of stereotactic applications, an etymological move still deemed inappropriate by some neurosurgeons (for example, Ganz 1993).

colleague, R.H. Clarke, stereotactic techniques are based on the use of mathematics and geometry to isolate (or pinpoint) disorders in the brain. The aim of these techniques is to "relate the location of intracerebral structures to a three dimensional Cartesian axis system" (Ganz 1993:8), or, as Leksell put it, quoting an American neurosurgeon with whom he collaborated, "to come out of the 'marsh' of brain experiment and therapy into the orderly, positive and straight medium of brass and steel" (see Leksell, L. 1992:285). Seeking to improve existing stereotactic systems, which for Leksell lacked both function and aesthetic appeal, he devised the Leksell Stereotactic System, which is still used in many kinds of surgical procedures today.

Leksell's stereotactic system was potentially important for two reasons. First, it could provide, when used together with X-rays, a means superior to the use only of x-rays to pinpoint deep-seated brain disorders. Second, since a metal arm or probe could be attached to the system and used to engage the brain along precise coordinates, the system could effectively do away with much of the guesswork and risk that typically accompanied the scalpel-wielding hand. The system offered, in short, an improved, mechanically based solution to the surface limitations of the human eye and the unsteadiness of the human hand, no matter how skilled or deft. And perhaps because it did so, challenging the long-cultivated need for the most revered of surgical skills, hand-to-eye coordination, the system was largely ignored, much to Leksell's chagrin and disappointment. "I had anticipated a rapid development in this area," he would write later, "but I did not reckon with the neurosurgeons' conservatism and resistance to any technique deviating from the routine" (Leksell, L. 1992:278). Topping his sense of let-down, Leksell discovered that others also did not share his aesthetic appreciation of the system, which he saw as "exact and beautiful,"

even when mounted on a human skull (286). He relates, for example, how the owner of a sculpture gallery, to whom he showed the device in the hope that it might be exhibited, reeled with shock at the sight of the frame and the skull on which Leksell had mounted it: "'Take it away, take it away,' he ordered" (Leksell, L.1992:285).

Leksell would continue to work with the system, joining a handful of neurosurgeons elsewhere -- Henry Wycis in Philadelphia (whom Leksell visited), Wendell Krieg in Chicago -- to form a maverick cohort whose members were determined to refine and introduce to the wider neurosurgical community this product of the mechanical age. They began to meet with some success during and after the Second World War, as knowledge, production, and use of artificial radiation spread throughout bioscientific communities in Europe and the United States (see above). In the wake of this wider development, Leksell started using his stereotactic system to introduce radioisotopes -- concentrated quantities of radioactive elements -- directly into brain tumors. Working with a physicist, Kurt Liden, his first such attempt met with little initial approval:

> The radiotherapist advised absolutely against the treatment; he considered it to be too dangerous because isotope had never before been used in a brain tumor. But I continued without official permission. The result was overwhelming. The cyst decreased, the sight improved, and H.A. [the patient] was nearly completely cured. We all were very satisfied. This operation convinced me that such mechanically directed operations signified important progress in the deep surgery of the brain. [Leksell, L. 1992:279]

Leksell would go on to perform -- with official approval -- many more such operations, blending in the process mechanics and physics, or the medium of

brass and steel and "a cosmos in continuous movement, more like a lovely thought than solid matter" (291). Working alongside physicists and radiologists, he sought at the same time to develop a radiation source that complemented his stereotactic guidance system, but that did away with the need to manually implant radioisotopes. Leksell invented a term for this mission, "radiosurgery," and defined as its aim the destruction with radiation of a brain disorder without the need to open the skull -- a procedure, he envisaged, that would introduce into neurosurgery a revolutionary idea, the "closed-skull operation" (Leksell 1949, 1971).

Leksell first realized this idea in 1967 with a prototype machine, known simply as the Gamma Unit, which he conceived and constructed in Geneva with the help of biophysicist Borje Larsson. The machine was used for the first time that same year to treat a patient with a brain a tumor, before the machine had left the factory (see Ganz 1993:60). Later, after having the unit installed in Sofiahemmet Hospital, Stockholm, Leksell used it to treat patients who were diagnosed with so-called 'functional" disorders, particularly Parkinson's Disease. Neurosurgeon Jeremy Ganz explains this early emphasis:

> It is easy to forget today, when the major indications for Gamma Knife surgery are tumors and malformations, that the limits of imaging techniques...in the nineteen fifties and sixties meant that tumor delineation was approximate. Thus, the first clinical instruments [i.e. the Gamma Unit] were designed...with a view to making cerebral lesions, for treating functional disorders. [Ganz 1993:55].

There existed also a second reason for applying the Gamma Unit to functional disorders, namely to "fill the gap" that was emerging due to the decline in

popularity of lobotomies, a decline which Leksell considered unwarranted and absurd. He writes:

> Misdirected propaganda against the old-fashioned lobotomy, sometimes performed without correct indications, stopped the activity in the whole field. For me this was a practical, empirical problem: if the patient's suffering could be alleviated best by surgery, no fanatical ideologists, free from anxiety and pain, should prevent the patient from getting help. [Leksell, L. 1992:281]

Having himself in the past "done a few lobotomies," and having on several occasions shared his enthusiasm for the procedure and his findings with Egas Moniz, pioneer of the lobotomy and winner of the Nobel Prize in medicine for its introduction, Leksell was an avid supporter of psychosurgery, who viewed with considerable disdain the decline of its mainstay procedure, the prefrontal lobotomy (p.279). Though he stops short of saying so, Leksell's impulse to create the Gamma Knife was thus in part also a response to an increasingly dystopic social vision of psychosurgery, a field that he would nevertheless continue to foster with the "bloodless knife."

Two developments in the early 1970s encouraged Leksell to produce a second and somewhat modified machine, which he named *Strahlkniven*, a Swedish term that he would later translate into the English, "Gamma Knife". The first development involved the advent of the drug dopamine, in response to which the number of Parkinson patients previously referred to Leksell for treatment decreased (see Ganz 1993:61). The second involved dramatic improvements in imaging, particularly the introduction of computed tomography into routine clinical use after 1972. Both these developments helped shift the

role that Leksell envisaged for the Gamma Knife from functional disorders such as Parkinson's Disease to brain tumors and vascular disorders.

Thus the prototype, Gamma Unit, which produced with its radiation a disc-shaped lesion ostensibly suited to treating functional clinical indications, needed to be replaced by a machine that would produce (smaller, circular) lesions appropriate to tumors and vascular disorders. So Leksell developed, once more with Larsson's help, the 179 ^{60}Co Gamma Knife: better suited, according to Leksell, for treating tumors and vascular problems not only because of the shape of the lesions that it produced, but also because it was more accurate and powerful than its predecessor.

Leksell would devote the 1970s to using and improving this model, mostly with support and interest from local physicists and radiologists. He studiously published his clinical findings, and unabashedly promoted the Gamma Knife -- and the concept of radiosurgery -- with accruing evidence that treatment with the machine reduced the risk of deep-seated, AVM-related hemorrhaging more effectively than any other kind of neurosurgical tool to date. Yet, the neurosurgical world seemed not to notice. By the early 1980s, Leksell was by-and-large still a solitary figure in radiosurgery, who would after treating a patient on the Gamma Knife typically stroll out into Stockholm's Karla Park and pay tribute under its birch trees to the statue of Linnaeus, who "had his eyes open and grasped the interplay of nature" Leksell, L. 1992:266).

It was not until 1984 that a Gamma Knife was first exported from Sweden. From then on, however, neurosurgeons the world over seemed suddenly to clamor for the technology and to embrace with open arms its underlying concept, the closed-skull operation. The first machine was shipped to a neurosurgical center in Buenos Aires, headed by a German neurosurgeon. The

second went to England, and the third to Japan. The University of Pittsburgh Medical Center installed the United State's first Gamma Knife in 1987. Switzerland, China, Mexico, France, Norway, Italy, Austria, Spain, Taiwan, South Korea, and Hong Kong followed suit. By 1995, over 80 Gamma Knife machines would be in use worldwide, 30 of those in the United States. Articles and reports on radiosurgery and the Gamma Knife began to appear in almost every international neurosurgical journal. Neurosurgeons in the United States wrote that their field was opening to Leksell's invention "like Pandora's box" (Lunsford et al. 1993:2); and started to debate with both their national and international colleagues its merits and shortcomings. On the clinical front, the Gamma Knife, now a trademark technology, had been used by 1994 to treat a cumulative total of 27,373 patients, a dramatic increase over the 1320 patients treated between 1968 and 1986 (Leksell Society Report 1994). And by 1993, Elekta Inc., the company started by Leksell to manufacture, sell, and distribute the Gamma Knife (and other neurosurgical tools), posted in its annual report an increase of total sales from 83.4 million SEK to 254.6 million SEK, an increase of over 200% (Elekta Annual Report 91/92).

It is doubtful that one factor alone prompted the rather sudden surge of interest and use on an international scale of the Gamma Knife. Responsible in all likelihood was a timely convergence of the following factors:

Developments in brain imaging: Leksell would expand the application and appeal of the Gamma Knife to include tumors and other brain-related disorders in the light of ongoing improvements in imaging techniques, particularly the advent of computed tomography and magnetic resonance imaging. These improved techniques also rendered detectable a great number of brain-related disorders that previously -- in what some present-day

neurosurgeons call "the blind old days" (Garfield 1996:190) -- stayed undetected due to the limitations of past diagnostic techniques. These detections may account in part for what some have termed the "mysterious rise" of brain tumors and disorders in the last 15-odd years (see Brody 1995), and thus also to an increase in demand for technologies, such as the Gamma Knife, with which to address this rise.

Computerization: The rise and application since the mid-1970s of computers in biomedicine may also account in part for the increase in popularity among neurosurgeons of the Gamma Knife. Computer hardware and software have made more accurate and speeded up the process of locating brain disorders and the creation of treatment protocols. Indeed, the planning and delivery of Gamma Knife treatment in most present-day medical facilities would probably grind to halt without computerized support, so dependent are these processes on products of the Computer Age (see Chapter Three).

Leksell's data and Elekta: Though slow to accrue, the clinical data that Leksell produced with the Gamma Knife over the last 20-odd years most probably gained a numerical respectability so that the technology itself came to be seen by others as adequately tried-and-tested, or more-than-experimental. This perception would be avidly fostered in the late 1980s by Elekta Inc., which has to this day consistently included in its marketing campaigns the idea that the Gamma Knife has a long and proven track record, although this record was for many years almost wholly the product of one man, pitching his invention at largely disinterested medical communities.

Global and national competition: Gamma Knife users often remark quite openly that the current popularity of the Gamma Knife stems also from a larger "international arms race" for sophisticated biomedical technologies among

hospitals and medical centers in different nations. Certainly purchase in the United States of 30 Gamma Knife units between 1986 and 1995 coincides uncannily with the introduction into Japan of nine such units over the same period, which has led some American neurosurgeons to comment derisively that "the Japanese archipelago is sinking under the weight of all its Gamma Knives" (Field notes 1995). Prestige-based competition on a national scale is also evident, and has reached its peak in the United States, for example, in the respective purchase and installation of a Gamma Knife at two medical centers in Florida that are a mere ten miles apart -- a phenomenon driven, say critical observers, by the "bragging rights" desired by medical institutions in the United States (see Anders 1994:A6). These competitive, culturally rooted processes have in all likelihood also contributed to the recent international and national upsurge in Gamma Knife purchases.

Leksell's role in defining the Gamma Knife: Finally, the rise in popularity of the Gamma Knife in recent years may stem also from the definitions that Leksell cultivated for the technology. Perhaps having learnt the hard way from his trials with stereotaxy that innovation could insult convention, especially when it seemed to minimize through mechanization established human skills and statuses, Leksell defined the first Gamma Knife as a "complement" to classic neurosurgical techniques, justified its development by saying that "the history of neurosurgery is the history of [its] instruments" (285), and aligned it with -- rather than against -- surgical tradition by calling it The Gamma *Knife*, and its field of application, radio*surgery*. He took care, in other words, not to offend the sensibilities of his neurosurgical peers, seeking to "enroll" his technology and cultivate its appeal while it was still in its infancy (see Latour 1987; Clarke and Casper in press).

In sum, Lars Leksell's role in the genesis and development of the Gamma Knife was a synthesizing one. Facilitated by wider trends (the decline of lobotomies, improvements in brain-localization methods and imaging), Leksell synthesized know-how and materials from physics and neurosurgery, which his dual medical career brought him into contact with. The outcome was an artifact, the Gamma Knife, and a field, radiosurgery, both of which made it possible to conceive of brain surgery as a practice in which the surgeon would address disorders not with eye and scalpel, but with mind and machine. Prima facie this would be a practice that had nothing in common with neurosurgery as it had been practiced for decades, even centuries. No sharp instruments would be involved, no burr holes and skull saws, no need for narcosis and sterilization, no operating room -- just a "flick of a switch," as Leksell himself has pointed out (Leksell, L. 1992:265). Yet both the Gamma Knife and radiosurgery -- in name and association -- would remain associated with connotations of incision, penetration, and radical change. It is in this sense also that Leksell synthesized, shaping into his creation terms and metaphors that history and his own ingenuity had made available to him.

Conclusion

This chapter has broadly aimed to place the Gamma Knife into historical context. Less broadly, it has aimed to identify some of the main people, places, and processes that have contributed to the advent of the technology and its use in the United States and elsewhere. With both these aims in mind, the chapter has focused on developments in neurosurgery and radiation-related research and technologies, and how the inventor of the Gamma Knife, Lars Leksell,

facilitated the convergence of these developments to bring the technology into existence. This has involved more than a convergence of technical and material items and practices. Words, terms, and metaphors have also converged, and have blended into the making of the Gamma Knife a hybrid identity, fashioned from a longstanding surgical and neurosurgical discourse, on one hand, and from a more recently established discourse about atoms, rays, and particles, on the other. These discourses have proved complementary in many ways, even though the former seems based in highly tangible and visible -- mechanical -- practices while they latter seems based on highly abstract and invisible -- atomic -- processes. Both have attracted in their respective trajectories dystopic and violent associations, of which the bloody scalpel and the atomic bomb are iconographic. Both discourses clearly also share mutual claims to the powers of scientific observation, procedure, and intervention. Thus, it is a blending or convergence of complementary discursive traditions as well as materials, technical know-how, and individual and collective agency that have contributed to the making of the Gamma Knife.

Finally, it remains to be said that while a social scientist may accurately perceive a technology such as the Gamma Knife as the work of numerous and diverse actors, knowledges, and historical periods and forces, this perspective is not necessarily shared by its users, who may instead think of the same technology as the work over a limited period of a single individual: the pioneer, the visionary, the genius. This is certainly the case among Gamma Knife users, who tend in their writings and conversations to attribute the Gamma Knife and its field to one person, Lars Leksell. Does this unilateral attribution play a role in the day-to-day application of the Gamma Knife? Yes it does, in two respects: 1. by having imparted to the Gamma Knife an origin and a biography distinct from

those of all other medical technologies, and, 2. by having maintained through its concentration on Lars Leksell, a neurosurgeon, the Gamma Knife's link to the world of neurosurgery and neurosurgeons. The first distinction has helped fashion for all Gamma Knife users at Hillcrest Hospital a sense of belonging to a history of interdisciplinary innovation and genius that sets them apart from other biomedical practices; the second, however, has fashioned for its neurosurgical users a rather exclusive sense of belonging, still, to a tradition of disciplinary-specific innovation and genius that sets them apart from their colleagues in physics and radio-oncology. History, in other words, has come to serve among Gamma Knife users as a resource for creating a sense of community on one hand, and for creating divisions of organization and identity within that community, on the other. These creative processes without question play a role in the present-day practices surrounding the Gamma Knife, as the next chapter shows.

Chapter Three

Images and Image

In the last chapter I suggested that the Gamma Knife is a hybrid technology of sorts, the product of a convergence between surgery and physics, which was achieved in the context of a complex set of historical processes by the neurosurgeon and inventor, Lars Leksell, and his close working colleagues, physicists. From the writings of neither Leksell nor his colleagues, however, do we gain insight into the nature and quality of the neurosurgeon-physicist collaboration. Consequently, we are left with the impression that theirs was perhaps a fluid and harmonious relationship, untainted by any differences of opinion and position.

Today, we can see as one outcome of the historical convergence of neurosurgery and physics the coming together and interaction in clinical practice of neurosurgeons and physicists, and nowhere more tellingly than in the Gamma Knife Review Conference, a meeting held once a week at Hillcrest Hospital in which participants present, discuss, and select prospective patients for Gamma Knife treatment. This chapter examines this meeting. By way of a "thick description" (see Geertz 1973) of how its participants interact with one another, the chapter focuses on the "Gamma Knife Team," that decision-making body comprising three disciplines -- neurosurgery, physics, and radio-oncology -- whose members convene to discuss patients' problems and to assess whether or not these problems can be effectively treated with the Gamma Knife.

I will show that this assessment process is a complex undertaking that involves participants in an attempt to present, deliberate, and synthesize

several kinds of data, criteria, and concerns. The reason for approaching such an undertaking with a team is made clear in this context; it can accomplish, with the benefit of multiple perspectives and sheer numbers, what one person alone cannot. But, Gamma Knife teamwork also deviates far from the unified model of decision making that its members present to the outside world (using slides, for example, that depict before audiences at professional conferences a circle neatly divided into three equal portions labeled "neurosurgery," "physics," and "radio-oncology," under the caption, "The Integrated Gamma Knife Team"). Friction and oneupmanship also attend the Gamma Knife review process; team members use words, gestures, and observations to assess their respective proficiencies, skills, aptitudes, and disciplinary alliances and hostilities. In the Gamma Knife conference, in other words, power plays unfold in which participants seek to renew authority and control for themselves and their respective specialties, which appear to them in the context of "teamwork" to lose their privileged moorings.

I show that neurosurgeons and physicists are among those Gamma Knife team members who engage most frequently and caustically in such power play, which the third contingent of the team, radio-oncologists, try with placations and bricolage-like advice to minimize. In doing so I hope to demonstrate that the central clinical event in which patients are reviewed for Gamma Knife radiosurgery is a central social event also, in which aspects of the individual specialist's status, reputation, and command over Gamma Knife radiosurgery come under review. This focus will serve to make a point important to the overall aim of the dissertation, namely that notions of autonomy and relations of control prevail in and around Gamma Knife radiosurgery, which have been cultivated in the past, and that are not willingly relinquished. The chapter will also contribute

in a broader vein to the insight that there are interwoven into the processes of bioscientific observation, method, and decision making social, cultural, and political realities from which the destinies of patients are inseparable (see for examples of studies that have specifically explored the overlap between medical decision-making and its social imperatives, Bell et al. 1988; Coser 1972; McClain 1983; Nardi 1983; Mathews 1987; Kayser-Jones 1995).

The Conference Setting

The Gamma Knife team, which comprises three neurosurgeons, four physicists, three radio-oncologists, a nurse and a technologist, convenes and reviews prospective patients every Friday afternoon in a conference room in the Department of Radio-Oncology, about 30 meters from where the Gamma Knife is located. Since other medical teams also convene in this room it must always be reserved in advance, as the schedule on the door indicates. Inside, the furnishings are basic: a table with a dozen chairs, a desktop computer, an overhead projector, a screen, a bookcase holding several neurological and oncological volumes and journals. A human skeleton made from hard, white plastic dangles quietly in one corner; a rubber brain stands mounted in another. Without people, the room appears modest and stark. Unlike the lavish diagnostic theaters of 15th century Europe (see Ferrari 1987) or the well-demarcated space of an Ndembu divination session (see Turner, 1975), little belies its purpose or function.

Members of the Gamma Knife team enter the conference room from different places and at different times. The four physicists, who spend much of their time working on computer terminals close to the conference room, typically arrive first. On their heels come the Gamma Knife nurse and the Gamma Knife

technologist. Either a secretary or an assistant from the Department of Neurological Surgery follows, bringing with her into the room a metal cart containing brown-paper folders called "jackets". Filed in these jackets are computed tomography (CT) images, magnetic resonance (MR) images, angiographic images, and sometimes positron emission tomography (PET) images. Each kind of image provides a distinct perspective on the brain and each image in turn shows configurations specific to a particular patient. These images constitute the main reference materials in every conference.

Slowly, between 1:00 and 1:20 p.m., participants continue to enter and transform the room.[1] Chairs are pulled up and rearranged. Files, soda cans, and fast-food containers are soon spread across the table. Conversations begin about the past week's events, new publications, last weekend's outings to the golf course or the mountains. Paging devices make an entrance too, mercilessly propelling participants from their chairs just as they appear to have settled down. Frequently the participating neurosurgeons arrive late, a trend that more punctual participants note with comments such as "Where is Davies? Trust a *surgeon* to be late!" This preliminary period, as one Gamma Knife team member explains, provides a rare opportunity:

> Yeah, we start [the conferences] 'informally' as you put it, because, during the rest of the week, we are very busy and spread out. Even during [Gamma Knife] treatments, when we are in the same area, there isn't really much time to talk. The conferences give us a little time to catch up, compare notes and what have you. You could call it 'social bonding' I guess [smiles].

[1] Trickling in, participants also reduce the amount of time available to them for review; thus, tempers often flare as further pressure is placed on the review process once it gets underway.

From the positions that participants adopt in their chairs it becomes clear that the overhead projector and its screen will soon serve as focal points of the conference. The co-directors of the Gamma Knife team -- a male neurosurgeon and a male radio-oncologist, both white -- sit near one end of the table, closest to the projector. From their respective positions they enjoy an unimpaired view of the screen. They are able to reach and handle the images directly. Younger members of the Gamma Knife team and interns sit further back or off to the side. Visitors -- including myself -- typically sit right at the back of the room, parallel to the door, from where we need to crane our necks to see details on the screen. The diagram below approximates the spatial arrangement of people and materials in a typical review conference.

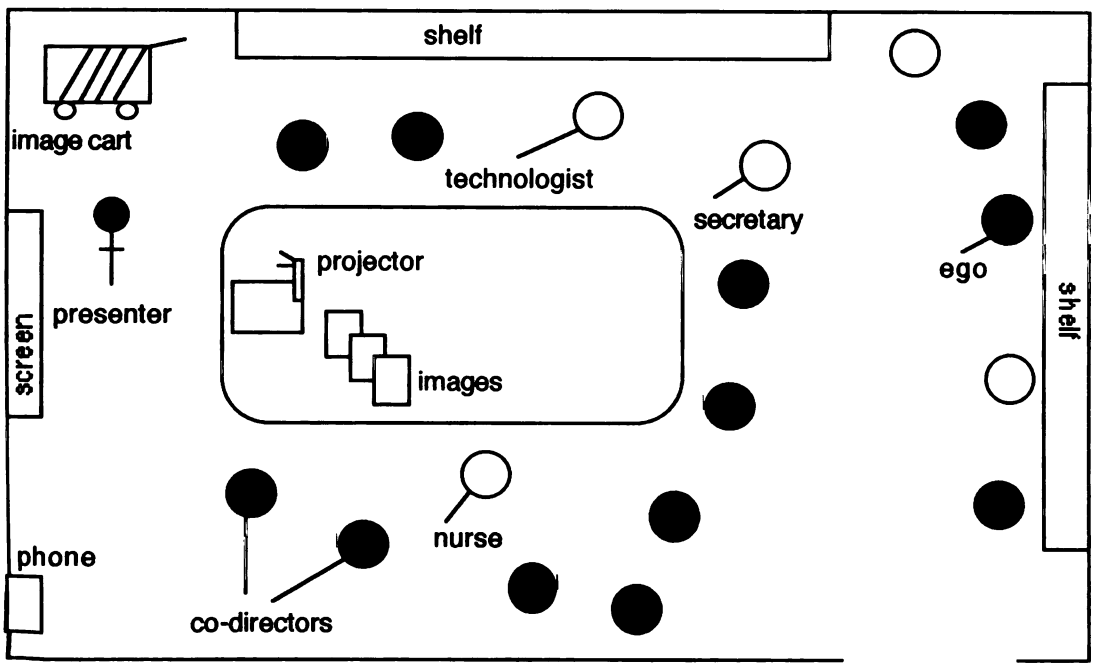


Diagram of the conference room during Gamma Knife review. Male participants and onlookers shaded. (source: Field notes)

The Conference Underway

When the lights in the room are dimmed, Gamma Knife Conferences begin. This usually happens around 1:20 p.m., (although the conference may be further delayed and even canceled should a team member, key to the scheduled proceedings, fail to arrive). Each conference proceeds on a patient-to-patient or "case-to-case" basis. Details on each case are sketched out on a scheduling sheet. This sheet makes known to all team members the patients' names, their referring physicians, their diagnoses, and the dates of their latest imaging procedures. If known, the names of patient's insurance plans sometimes also appear on this sheet. Team members typically spend several minutes perusing and amending this list at the outset of each conference, adding or deleting names and dates to reflect late developments. This done, they go on to present and discuss "new" cases -- patients who have never before been treated with the Gamma Knife at Hillcrest Hospital.

The review of a patient begins when the presenting physician, a member of the team listed on the scheduling sheet as the "Referring M.D.," selects that patient's MR, CT, or other films and presents them on the overhead projector. Only now, as the first image illumines the screen, do team members stop talking and bantering. All eyes are trained on the screen. The conference room is overcome with uncharacteristic silence. This period of silence, rarely a minute long, typically ends in expletives such as: "Whoa, look at that crater!", "She has no brain, it's all tumor," or "That's one big piece of pie!". Crude and impressionistic, these reactions nevertheless point to a fundamental strategy in

the early stages of viewing images. Rather than dwell on the overall appearance of an image, team members seek minutiae that lie well within the borders of the image. In their language, they look to "localize the problem". One team member uses a hunting analogy to clarify this narrowing of perspective:

> You should imagine you're hunting or tracking: you move, or ah, zoom in on small parts of the forest or the field or whatever you are in....focusing on details, because if you just look at the bigger picture, the whole thing, it'll escape you, whatever you are looking for.

Localizing the problem is not simple. Every image is crowded with visual obstacles and decoys. Team members avoid some of these by focusing on select areas and features. Other matters such as poor resolution or "smudges" on the film are inevitable and exasperating, and lead to comments such as: "This film doesn't project well" or, "smudges all over the place here". Interpreting images is further complicated by past procedures such as craniotomies and embolizations, which introduce into the physician's visual field scar tissue, replacements for missing bone, synthetic clamps, and other traces of previous interventions. These are referred to by team members as "wreckage": "We've got a diagnostic conundrum...she's been embolized a couple of times. Lot of wreckage in here". Wreckage, in other words, is medical clutter that frustrates or complicates visual diagnosis and, later, the actual planning of Gamma Knife procedures.

Issues arise from these visual constraints and lead to debate in the conference room. Looking at an image team members might disagree, for

example, on the precise location and size of a tumor or AVM. They might argue, especially in the presence of "wreckage," about the scope and the boundaries of the original disorder: "The question is: what's AVM and what's not" or, "I don't understand where her AVM is. Is this it?". The challenge at this point lies in identifying or "drawing a circle around" the disorder: a technique that relies on a team member's prowess at picking out fine degradations and shaded loci on each image, and piecing together from these the location or extent of the disorder.

Team members faced with this interpretive challenge also become educational. They point out to their colleagues (and interested visitors) potential pitfalls and interpretive dangers, as is evident in the following cautionary tale, aired by a neurosurgeon during a conference: "When I saw the MRIs I arranged for a ventriculoscopy. But as soon as I looked at the C.T. I canceled that".[2] The lesson being imparted her is that a particular set of images can mislead, and demands constant cross-referencing with others.

Determining the "size" of a disorder is closely linked to the initial task of locating the problem. Guesswork frequently characterizes this task, with comments such as: "Oh, I think that one's about two centimeters" or, "That's not five centimeters, no way". Here team members determine size simply by looking at the image, and by knowing beforehand the scale of each kind of image. Size is also stated implicitly among team members with such statements as: "I think we can do that one," or, "I don't know, that's a big piece of pie". Team members are here referring implicitly to an established radiosurgical principle: in order to irradiate effectively a disorder with the Gamma Knife, the disorder must not exceed three centimeters in diameter. This limitation, though taken seriously for

[2] A ventriculoscopy involves direct, diagnostic, inspection of a ventricle, in this case in the brain, using a device called an endoscope.

the most part, has also become a source of amusement among team members: "I know we are always accused of saying 'Oh, this tumor is two centimeters' [laughter]... But I don't think this one is *five* centimeters".[3] Size can also be more conclusively measured. When, for example, disagreement arises over the size of a tumor, a team member typically approaches the projector and places a piece of paper (or a business card) on the projected image. Then, by marking off on the paper two opposing points and holding it to a scale printed on the side or bottom of the image, the diameter of the tumor is calculated. Images function, in the light of this task, as tools or instruments to help determine the eligibility of a disorder for radiosurgery.

Size, once established, provides in select instances a sufficient basis for selecting a patient for Gamma Knife radiosurgery, as the following case illustrates:

> *The Case of Mrs. Weinhardt*
>
> Mrs. Weinhardt was introduced to a Gamma Knife conference by her referring physician, Dr. Hall, a radio-oncologist. He presented Mrs. Weinhardt by first presenting her images: "You can see that someone's been in here....done a resection...here and here. The nidus is...here [points]." A physicist comments: "Size is OK, we can target that - no problem". Dr. Hall asks a neurosurgeon: "What do you think?". "Sure, why not?". Dr. Hall: "OK, I'll call her".

Not all cases, however, are as clear cut. Team members must usually consider issues of treatability in addition to size, which lead them to consider a complex question: Given a human being with a brain disorder, and gamma rays which

[3] The accusation is that Gamma Knife specialists deliberately understimate the size of disorders in order to make them eligible for Gamma Knife treatment, an accusation, say Gamma Knife team members, which their competitors at other state and national institutions are fond of leveling.

destroy organic tissue at sufficient intensity, can we free, or at least partially relieve, that person of the disorder with these rays and at the same time avoid destroying the healthy tissue which surrounds it? This question, referred to by team members as "*the* question" in all stages of radiosurgical practice, cannot, of course, be conclusively answered until the results of actual treatment are made available. But "the *probability* of effectively irradiating without damaging adjacent structures," as one team member put it, reportedly can be determined at this stage.

Besides its size, the location of a disorder is in this context important. Should it present itself close to a vulnerable structure such as the optic nerve, this probability declines, as is also the case when a disorder is scattered throughout the brain in the form of numerous lesions, calling for repeated and unusually intensive irradiation. Combined with an oversized disorder, for example, a "bad" location can disqualify a patient from Gamma Knife treatment at Hillcrest Hospital, as the following case shows:

The Case of Mr. Herriot

> Mr. Herriot, a retired 67-year-old bank clerk, presented AVM indications on his MR scans to which team members initially reacted with the comments: "That's mega damage right there!" and, "Not sure we can obliterate that!". On further deliberation, team members also deemed Mr. Herriot's AVM "too close to the optic apparatus - he'll go blind for sure". The co-directors agreed to refer Mr. Herriot to "neurointervention -- maybe *they* can do something for him".

"Accuracy" is a key term that team members use to frame cases such as

Mr. Herriot's. They speak, for example, of "pinpointing," "depositing exactly," "blowing out" and "obliterating," and ask of one another the question: "Can we be on target with this one?". In using such terms and questions, team members implicitly take into account the inevitable spread of some radioactivity from the nidus to the surrounding healthy tissue.[4] This is referred to among team members as "spill-over," an occurrence that, if not properly accounted for in the planning stages of a treatment, can lead to partial or even total blindness, loss of hearing, and motor-dysfunction. The reality of these effects is starkly driven home: "We need to be accurate on her and target her precisely. Otherwise she's a blind woman". Accuracy here means also that team members' imaginations (and later their calculations) need to redefine the size of the target in order to compensate for radioactive spill-over. At once technical and cognitive, this task is highly praised when team members are singled out, on review of procedures conducted in the past, as having successfully accomplished it: "Right on, Harvey, you blew that one out!". Accuracy may also, however, serve to ridicule: "There's always the question of accuracy when *you* do it".

"Dosage" is yet another vital consideration in deciding the eligibility for Gamma Knife radiosurgery of a specific disorder. Team members bridge two questions in this regard: 1. how much radiation should we deliver to the disorder (calculated in *rad* -- radiation absorbed dose, or units of radiation), and, 2. how do we produce a desirable distribution of a given dose of radiation? Thus team members will ask: "If we treat this one, George, what would you give it?" and, "How would you distribute the dose on these [lesions], Kenneth?". Discussion here invariably tends the potential for increasing or decreasing the

[4] The nidus, consisting of a network of irregular, pathological vessels, is the actual point in an AVM where the blood flows or "shunts" from the artery to the vein. The established rule in present-day radiosurgery is that the nidus has to be "obliterated" in order to reduce the risk of a rebleed (see Chapter One).

radiation dose. When increased, it raises the likelihood of destroying the disorder, but also of boosting radiation spill-over. Decreased, the dose may prove less effective, yet safer. Sometimes, suggestions concerning dosage half-jokingly take into account a patient's expressed desire for intensive treatment: "He wants aggressive treatment. Well, he's come to the right door: We'll crank it up!".

Evaluating the Patient

During the presentation of a case, team members also assess the patient (rather than just his or her disorder). Although these assessments are typically fleeting and perfunctory, their role in the conference room are important: often they help answer the question of whether or not to select a patient for Gamma Knife radiosurgery. One aspect of discussion in this regard concerns the patient's financial backing. It happens, for example, that after discussing a particular disorder, a team member will suddenly recall or observe that the patient "belongs to" a medical insurance plan that accommodates poorly the costs of high-technology treatment such as Gamma Knife radiosurgery. A patient with an AVM deemed moments before as eminently treatable, for example, quickly became a less viable option, as the following exchange illustrates:

> Participant A: "Straightforward [AVM], really."
> Co-director: "Yeah, we could treat that, no problem."
> Participant A: "Hold on, looks like she's with [insurance company]"
> Participant B: "We'll have to beg them - who does the begging around here?"
> Co-director [to A]: "You've just wasted everybody's time."

Independently wealth patients are welcomed in contrast, for they reduce concern and hassle as far as payment for Gamma Knife treatment is concerned. Thus, in the case of a reportedly affluent patient from Argentina, willing to travel to the United States for treatment, a team member half-joked: "Damn, he could buy our Gamma Knife. Let's just get his check and do him". Such patients are sometimes referred to as "financially healthy".

A second route of assessing patients concerns their physical wellbeing, conventionally measured in radiosurgical practice with the help of a clinical model called the Karnofsky scale:

Description	Percentage
No complaints; no evidence of disease	100
Able to carry on normal activity; minor signs of symptoms of disease	90
Some signs or symptoms of disease with effort	80
Cares for self; unable to carry on normal activity or to do active work	70
Requires occasional assistance but is able to care for most personal needs	60
Requires considerable assistance and frequent medical care	50
Disabled; requires special care and assistance	40
Severely disabled; hospitalization indicated, although death not imminent	30
Very sick; hospitalization necessary; requires active supportive treatment	20
Moribund; fatal processes progressing rapidly	10
Dead	0

Sixty percent or higher on the Karnofsky scale ideally qualifies a patient for Gamma Knife radiosurgery. Team members claim not to select patients who score lower: "That would be self-defeating," commented one member, "because at the end of the day, treating patients who are, ah, far-gone, would mean we get a lower success rate". Comments by team members during conferences suggests otherwise: "Find out if she walks and talks - that's all we need to know". This comment, made during several review sessions in 1995, suggests that the cut-off score in actual practice is closer to 40 percent, a response perhaps to mounting intercenter competition and a diminishing patient population.

Finally, team members also turn their attention to the personalities of patients. These they piece together with information drawn from two sources: patients' medical records, which typically include notations on their habits and responsiveness to medical treatment, and, team members' individual and/or shared recollections of previous encounters with patients. Information drawn from these sources is distilled into two sets of key words and/or phrases: 1. those that signal positive personality attributes such as "good," clean," "strong," "nice," "cooperative," "communicative," "he's a soldier," "she's a trooper," and, 2. those that signal negative attributes such as "emotionally weak," "silent type," "not altogether clean," "wimpish," "uncooperative," "claustrophobic," "nervous type," "loses his/her nerve," "a bit nuts". The term "clean" refers to patients who do not smoke, drink alcohol, or take drugs. "Claustrophobic" patients are those known to complain about or resist being scanned in the MRI unit, an essential preoperative step in Gamma Knife radiosurgery (see Chapter Four). "Communicative" refers to patients who provide an optimum level of feedback:

who help the planning and delivering of Gamma Knife radiosurgery by offering information and answering questions about themselves.

No single personality trait determines the eligibility of a patient for Gamma Knife radiosurgery. Combined with other considerations, however, personality traits may help clinch the question of whether or not to treat a patient, as the following example illustrates:

The Case of William Brooks

> William Brooks was a 37-year-old man with a complicated AVM. He had previously undergone successive open-skull surgeries and one aborted embolization. On viewing his images, Gamma Knife team members concluded that due to its size and poor response to previous interventions, his AVM presented difficulties, but was deemed "still treatable". Mr. Brooks, however, was not; his referring physician pointed out that he was a "difficult customer," that he had "trouble walking," and that "he will probably refuse the MRI again". The Gamma Knife nurse, having previously tended to Mr. Brooks' imaging, added that he "loses his nerve quickly". Team members concluded that it might be best to "leave Mr. Brooks alone".

Faced with a complicated disorder with low response probabilities, in a patient known to be "difficult to handle" (because he is "claustrophobic," "not altogether clean," "physically impaired," and/or "wimpish"), for example, team members are likely to agree that such a patient is a poor candidate for Gamma Knife radiosurgery. By the same token, a favored combination among team members is a disorder that is deemed treatable in a patient who is considered "nice," "strong," and "co-operative".

The Gamma Knife conference, as I have so far shown, is an event made complex by the many criteria that enter into the selection, rejection, or deferral of

prospective patients and their disorders. These range from issues concerning the interpretation of images (location, size, proximity) and questions of accuracy and dosage, to a patient's financial background, physical status, and willingness to be compliant. This process of deliberation also evidences from the very outset a social side; light conversation is made, compliments and insults are passed, and terms and words laden with obvious masculine bravado are exchanged. These social features take on added meaning as the Gamma Knife team strives to synthesize the diagnostic skills and vantage points of its three participating disciplines, neurosurgery, physics, and radio-oncology. Tension and conflict may attend this process, not only because team members face issues that are complex and hard to settle, but because their professional statuses and means of understanding are often at loggerheads. The next section of this chapter provides ethnographic detail and discussion on the grounds for conflict in the conference room.

Conflict in the Conference Room

Arguments and oneupmanship are part-and-parcel of the business of deliberating and making decisions in the conference room. Though all members of the Gamma Knife team engage in them, the most prominent axis of dissent involves the neurosurgeons and the physicists, who are especially active in leveling jokes, critical comments, and snide allegations at one another. Friction between these two groups is noticeable already at the outset of conferences, when the punctual physicists are quick to make fun of the lagging neurosurgeons with comments such as "Trust a *surgeon* to be late!". More serious umbrage is taken at what the physicists perceive as the closed-

mindedness of neurosurgeons to the intricacies of planning and executing Gamma Knife radiosurgery. Says one physicist: "We try to embrace a whole range of subtle criteria and calculations while the surgeons, ah, just want it [the disorder] out...taken out". Thus, physicists are affronted by comments directed at them in the conference room by the neurosurgeons such as "You guys are getting too abstract," "Come to a real operation some day - I bet you'll faint," and "Come on down! You can't rate that difficult!". Physicists respond to this kind of needling with retorts such as "Give your blade [scalpel] a break" and "Try a little physics sometime - it might help you think".

Such ribald exchanges point to the impact in the conference room of a fundamental difference between neurosurgeons and physicists. The former work traditionally in a tactile world with structures (tissue, fluid, bone) that can be directly seen and manipulated. The physicists work in a world with structures (rays, particles, atoms) that escape the naked senses and that can only be indirectly observed and manipulated. This difference is evident in the metaphors that neurosurgeons use in the conference room, such as "knifing the tumor," "cutting away," "excising". Physicists privately frown upon the use of these terms, informing me that "they are not accurate; radiosurgery doesn't actually do any of those things". On top of their reportedly dubious phraseology, neurosurgeons often come to conferences directly from an operating room, dressed in a fashion that physicists consider symbolically inappropriate in the radiosurgical context:

> They're making a statement all right, that kinda goes 'Look, we've just come out of surgery -- where the real stuff goes down'. It's [their surgical dress] part of the surgical image. I suppose it gives them a sense of power. Ultimately, from our side -- the physicist's side -- this is a bit misplaced because radiosurgery has nothing in

common really with what they do in the operating room. The principles are very different.

Neurosurgeons appear to physicists as importers of (mechanistic) metaphors and symbols that obfuscate the true (atomistic) nature of radiosurgical practice, a tendency that physicists take as supportive of their claim, expressed to me in private, that the Gamma Knife is "really a physicist's technology."

By bringing metaphors and symbols into a context where they are viewed by some as inappropriate, neurosurgeons nevertheless also assert their own claim over the Gamma Knife, in an attempt to frame a technology unfamiliar to them in their language and knowledge domain. Yet, to accomplish this, they have open to them another, more effective avenue: neurosurgeons accuse physicists, on account of what they perceive as the abstract, intellectual nature of the physicists' field, of failing to consider the interests of patients. The little contact that physicists have with patients serve as a basis for making this accusation: "You [physicists] should spend less time at your computers" and "Can't you leave her [the patient] alone?". On one occasion a physicist, concerned with improving the planning of Gamma Knife treatments, suggested that a pneumatic device be used to "punch" small image-sensitive pins into patients' heads. He drew from a neurosurgeon the following rebuke: "These [patients] are people, not animals".[5] To rub salt into the physicists' wounds, a neurosurgeon may claim proportionately more time spent with patients by dominating discussions about their personalities (see above), even though these frequently involve negative assessments. In so doing, neurosurgeons pin

[5] A rebuke that most likely implies that physicists are blurring the boundaries between Gamma Knife research experiments (which are carried out at Hillcrest and elsewhere with beagles, rats, and other animals) and clinical practice (Adele Clarke 1996: personal communication).

onto their intellectual colleagues an image with which they themselves have been historically dogged: that of the uncaring caregiver, so exclusively focused on technical matters that they reduce patients to objects and rob them thus of their personhood (see Cassell 1987; Goffman 1961; Hirschauer 1991; Selzer 1974).[6]

And what of the radio-oncologists? Although they too on occasion bicker and critique, their collective role resembles more closely that of an arbiter. The radio-oncologists, in other words, constitute that contingent within the team that seeks most often to resolve disputes (rather than to initiate them). Their comments are placatory: "Calm down, you guys," and, "Forget that...let's look at the MRIs." Or they recommend that a case under heated review be referred to an 'outside' party: "Let's take this one to the interventional guys." When, over the matter of the pneumatic device the physicist and the neurosurgeon became embroiled (see above), it was a radio-oncologist who suggested that they "call in" an industry specialist for advice.

The radio-oncologists stand on comparably neutral ground, between the neurosurgeons and the physicists, a position that a radio-oncologist may hold with pride:

> Our field is by nature conciliatory. While other specialists may have problems seeing past the limits of their field, which are in some cases very limited, we work by incorporating knowledge from other fields.... You could say that the reason for us being here, in radiosurgery, is because we have been trained in the nature of neurological problems *and* in radiation treatment methods. Usually its one or the other.

[6] We are reminded here also of the longstanding conflict between surgeons and internists (Linda Mitteness 1996: personal communication).

Radio-oncology is perceived by its practitioners, in other words, as a praxis closer in form and function to neurosurgery and physics than either of these fields is to the other. This neurosurgeons and physicists acknowledge, saying that radio-oncology is "a kind of middle-ground" between them. Thus, each party shares in the presence of the radio-oncologists a sense of being among specialists who are sympathetic to their respective disciplinary positions and limitations; both parties find themselves among radio-oncologists in the "company of equals," to use a term coined originally by Parsons (see Freidson and Rhea, 1972). Brokers also, the radio-oncologists reinforce their powers of arbitration in a spatially symbolic way: both the Gamma Knife review conference and Gamma Knife treatment take place in the Department of Radio-Oncology.

Discussion

This chapter set out to describe the main review process for Gamma Knife radiosurgery at Hillcrest Hospital, a process that unfolds among team members from three specialties in the context of their weekly meetings in a conference room. These meetings typically begin with the telling of jokes and extramural stories, and the informal exchange of references and anecdotes, all of which help "bond" socially a team in a setting beyond which its members are often dispersed, encumbered, and seldom sure of each other's whereabouts and doings.

Beginning thus on a high social note, these meetings turn swiftly to the business of making decisions, which involves two main steps. First, viewing and reviewing images: selecting them, negotiating "smudges" and poor projection, "locating the problem," struggling with "wreckage," "drawing circles," and

calculating size and location. This step relies on the combined visual skills of team members and on the application of these skills to the disorders within patients (rather than the patients themselves). Second, making decisions involves reviewing patients, and concluding whether or not patients are "financially healthy," what level of resistance or cooperation they are likely to display, and whether they are able at least to "walk and talk". This step relies on written records and the memories of team members, and on assessing patients (rather than their disorders) with data derived from these sources.

Into this two-stepped process enter other considerations; assessing one another's performance is the most salient of these. Throughout meetings team members test and assess with words, jokes, and gestures their respective proficiencies, skills, aptitudes, and disciplinary alliances and hostilities, and communicate their assessments in the form of compliments and criticisms. A team member previously in charge of treating an AVM that shows signs of remission, for example, may be praised for successfully "blowing it out." A technical suggestion considered either too cautious or over-zealous, by contrast, may elicit criticism and derision. Metaphors abound in this decision-making process, and are used among conference participants as tools for interpreting, sorting, and appraising diagnostic data. Infused with notions of cleanliness and pollution, with analogies to hunting, with references to astronomy, and with war-like rhetoric, these metaphors, common rather than arcane, also establish among participants a lingua franca that bridges their different, highly specialized, terminologies, facilitating interaction and communication as a result.

The chapter has also shown, however, that not all participants subscribe to the same metaphors, and that some consider inappropriate or even ludicrous

the images and associations conjured up by others. Professional differences and concerns emerge in this context, and may inspire -- especially between neurosurgeons and physicists -- an ongoing verbal and symbolic tussle that focuses on respective disciplinary limitations and boundaries. Charged are those who engage in this tussle -- and those who attempt to ameliorate it -- with preventing what they see as encroachment on their respective fields of knowledge and sources of authority, and with countering claims by any one specialty that the Gamma Knife is exclusively its property. In sum, team members thus embark in the conference room on a complex process of deliberating the viability of treating patients with the Gamma Knife, a process in which material images -- MR, CT, and angiographic -- are by no means the only images that are intensely studied. The professional image of participants also fall under the purview of the review process.

Conspicuously absent from this review process are patients themselves. In their place appear scans and images, charts, and computer records. We might well ask in response: would the dynamics in the review process change if patients were present in the conference room, and if so, would patients benefit from these changes? I attempt below, in conclusion to this chapter, to partially answer this question by examining briefly a diagnostic situation in which patients *are* present.

Conclusion

Stephen Fishman, a journalist and sudden victim to an AVM, describes in his book, *A Bomb in my Brain*, his first diagnostic meeting with a neurosurgeon (Fishman 1988). After explaining that he wished to gain an idea of the damage

wrought on Fishman by his AVM, the neurosurgeon asked Fishman to parade up and down his office, raise one leg and then the other, stretch his arms and clench his hands, squat, wink, smile, and so forth. This Fishman did, while the neurosurgeon looked on, took notes, and remained silent. Though this call for such a decidedly physical demonstration seemed not to strike Fishman as profound -- he makes no further mention of it in his book -- it captures well how diagnostic encounters in neurosurgery (and in biomedicine generally) shut out almost all but what the physical body can communicate to the physician. This overture to biomedicine's Cartesian roots, famous for how deeply they are embedded in observable biological or physiological processes at the cost of what people feel, think, and know about their bodies, is evident even when in such encounters there is verbal exchange (see for example, Cassell 1991, 1985; Kleinman 1988).

Is the Gamma Knife review conference fundamentally different from the kind of event in which Fishman participated? I would suggest that it is not. Governing the conference are methods of procedure and analysis that are similarly embedded in observable processes, in localized bodily regions, and the prominence of facts over feelings. The absence of patients from the Gamma Knife conference room is thus significant only insofar as it allows physicians to exercise with added freedom and impunity their traditional forms of diagnostic inquiry and evaluation.

However, by focusing on the conference participants themselves and their interactions, I have shown that there also prevails in Gamma Knife teamwork an interdisciplinary social agenda, obviously made possible by participation in the conference of more than one specialist or specialty. It is in this respect that the Gamma Knife review process differs markedly from events

such as the one described by Fishman. Instead of a situation governed by a single professional whose diagnostic skills and authority go unquestioned, the Gamma Knife conference involves up to 12 medical professionals, who assert authority and seek control for themselves with regard to their respective specialities. Issues of power are rendered complex in this kind of situation. Roles are argued about, formerly stable and monopolized fields of knowledge and skill are challenged, entered into, shaken up. A drama unfolds, in other words, in which team members inquire into their respective (professional) statuses while at the same time inquiring into the (clinical) statuses of their patients.

It is this drama that conceivably sets the Gamma Knife conference apart from a one-on-one diagnostic situation, and not the exclusion of patients from the conference. This implies that the area most likely to be influenced by the inclusion of patients in the Gamma Knife review process are its social dynamics, and not its methods of procedure, analysis, and interpretation. Hypothetically speaking, the presence of patients might make Gamma Knife specialists pay greater attention to what they say (i.e. the use of expletives and terms such as "blowing out" and "wreckage") and might lead them to downplay arguments and discord. Beyond such concessions, which would simply render more subtle the existence and form of social relations among team members, not much may change. Current emphasis on singling out and discussing patients' disorders (rather than their *experience* of those disorders) in highly abstracted, bounded, terms would surely continue to dominate the review process.

Chapter Four

Symbolizing the Source of Recovery

I approach Joe Carpenter just minutes before he is wheeled into the Gamma Knife suite, taking advantage of one of those rare intervals when Gamma Knife patients lie unattended outside a machine or some other medical apparatus. Forty-five years old, stout, and sporting an incongruous tan, Joe is sitting upright on his gurney, dishevelled, and looking a little lewd in his diaphanous hospital robe. There are many questions that I would like to ask him but he appears tired and distracted, and I feel a little perverse at the prospect of asking them. Our eyes meet, we exchange smiles, and, to my surprise, he begins to talk quite readily, first about the apple farm that he owns and operates in the state of Washington, and then about that day something "popped" inside his head as he reached first base during a family baseball game. "It felt like I was hit by a Mack truck," he says, "only I couldn't see it coming." Overcoming my reticence, I ask how he first learnt about the Gamma Knife. "I think it was from a newspaper clipping, somebody gave it to my wife and she read it me after we found out about the AVM." "What made you think that it might be a good option for you,?" I press on. "Well I wasn't sure it was really, but it mentioned AVMs like mine, you know, deep, and that it worked kinda like a knife that got them out without opening you up." "Did you discuss the Gamma Knife with anybody else before -- " I cannot complete my question, for the Gamma Knife nurse has arrived on the scene, to wheel Joe into the Gamma Knife suite, saying, "OK, we're ready now, let's get you taken care of."

"One of the central efforts in healing," writes the anthropologist Byron J. Good, "is to symbolize the source of suffering, to find an image around which a narrative can take shape" (Good 1994:128). This chapter examines processes of symbolizing the source of *recovery*, and the finding of images around which to conceive the *end* of suffering, as a second and related effort in healing. It broadly examines, in other words, how AVM sufferers like Joe Carpenter have introduced into their lives images or narratives of restoration, and from whence these are derived, shaped, and focused.

I am interested in pursuing in this context two related processes: 1. how the Gamma Knife is positioned in popular and medical media as a therapeutic technology that resembles classic operating-room surgery in function, form, and outcome; and, 2. how this resemblance is cultivated further in the spatial and technical practices that surround and include actual Gamma Knife treatment. These two processes contribute, as we shall see, to the construction of the typical Gamma Knife experience as a medical rite of passage, in which patients feel strongly that they are moving -- or being moved -- from the (liminal) realm of suffering to the (incorporative) realm of recovery. This rite of passage, which I discuss with reference to its original conception by Van Gennep, is strongly ingrained with surgical connotations. Like operating rooms, Gamma Knife practices establish in their wake a discourse that promises powerful and swift progression from an old status to a new one, from being (sick) to becoming (better) (cf. Turner 1967, 1968, 1975). It is with this medicalized sense of recovery or repair that Gamma Knife patients are then discharged from Hillcrest Hospital, and against which they will formulate in the months (and years) to come their mounting feelings of plight, malaise, and medical betrayal.

The chapter begins with the role played by popular and medical media in

positioning the Gamma Knife as a preferred, technological source of recovery for people with AVMs, and as an instrument that embodies surgical-like powers that eliminate these disorders swiftly, powerfully, and expediently. From there, the chapter shifts to the admission of patients to Hillcrest Hospital, to the spatial and symbolic structure of their various "preoperative" procedures, and, finally, to their experiences before, during, and immediately after their Gamma Knife treatments.

Popular and Medical Media

Most Gamma Knife patients are admitted to Hillcrest Hospital for their treatments having garnered from various sources considerable amounts of information about the Gamma Knife. These sources include popular and medical media such as television, newspapers, promotional videos featuring the Gamma Knife, medical reports, hospital brochures, and more recently, the Internet. Stories and information from these sources are typically obtained and circulated with help from family members, friends, support groups, and physicians. What sorts of meanings and associations do patients glean from these sources of reportage? How do these sources construct the character and quality of interplay between patients and the Gamma Knife?

Important to note first is that there currently exist (in the United States at any rate) few critical accounts of the Gamma Knife, beyond a handful that question the economic wisdom of introducing into American medicine another high-cost medical technology (see for example, Anders 1994). Here and there also appear, in letter columns and Internet forums, short accounts by and of patients who feel, due to a perceived lack of progress or decline after their

Gamma Knife treatments, that they have been rudely shortchanged (see for example, Miller 1994; Spencer 1994). Prospective Gamma Knife patients may not necessarily evaluate their own options or chances anymore critically should there become available to them in the future more such accounts of the Gamma Knife. Indeed, most patients whom I interviewed report that they consciously steered clear of accounts that rightly or otherwise badmouthed Gamma Knife radiosurgery, citing as grounds for doing so "faith in my doctor" or saying, "all brain surgery is risky," and, "what else is there?".

Thus there prevails around the Gamma Knife an almost one-sided discourse, largely uniform in its unmitigated praise for the technology, and accessed by prospective patients. Let us then examine this discourse starting with what it most commonly features, namely a pedagogical blend of terms and images that promotes the Gamma Knife as a gentle and expeditious solution to grave afflictions that have traditionally demanded highly invasive action and prolonged hospitalization. Consider the following:

> Because the Gamma Knife uses painless radiation and a mild local anaesthetic, there's no shaved head, no incision, no lengthy recuperation. The entire procedure takes about half a day. The next day most people can resume normal activities - even go to work. [Extract from an advertisement run by the Neuroscience Institute in Atlanta, Georgia, 1991]

> The Gamma Knife not only successfully eliminates disorders, it does so quickly and with little or no side effects. Gamma Knife treatments last from 15 to 40 minutes. Patients do not feel any pain or discomfort during the actual procedure...and rarely experience symptoms afterwards. [From "Healing the Brain with an Invisible Blade," *Brainwaves*, Chicago Neurosurgical Center, Winter 1990]

> It is painless. There is no incision, no hair-shaving. And the person is basically ready to go back to work the next day. [Neurosurgeon John Walsh, quoted in "New Machine Allows No-Cut Surgery," The Herald Post, El Paso, Texas, February 23, 1993]

Sources other than newspapers and advertisements such as medical reports and texts, and brochures issued to patients before admission to Gamma Knife centers stress similar attributes, using terms such as "out-patient," "minimal recuperation time," "noninvasive," and "closed-skull" to associate the Gamma Knife with comfort, personal appearance, and speedy return to social independence and productivity. Central to these associations are case studies of people who have recently undergone Gamma Knife radiosurgery. Melodramatic and exultory, these case studies nevertheless lend to an otherwise abstract, second-hand narrative elements of first-person intimacy and an "ordinary-folks-like-you" appeal. The following excerpts indicate as much:

> A 46-year old woman suffering from a life-threatening tumor lies wide awake on a long, narrow table, her head beneath a huge steel helmet. While monitoring a three-dimensional image of her brain...her doctor flicks a switch. She feels nothing. This sounds like a scene from the latest Star Trek movie, but its really just another routine Gamma Knife procedure at CNC [Chicago Neurosurgical Center]. And the 46-year-old woman is not a Hollywood starlet -- she is Susan Wiersema, draftsperson and mother of three, from Kankakee, Illinois. [From "Healing the Brain with an Invisible Blade," *Brainwaves*, Chicago Neurosurgical Center, Winter 1990]

> Marvin Myers, a 54-year-old Brunswick man...became one of the first patients at the University of Maryland Hospital in Baltimore to undergo surgery -- without a scalpel in sight -- at the hospital's new $4 million dollar "Gamma Knife Center".... One of the first thoughts when he emerged from the large, helmet-shaped treatment chamber...was a fishing trip he and his coworkers were planning.

> He was discharged from the hospital the following day and went along on the fishing trip 10 days later, he said. [From "Marvin Myers Undergoes Surgery Without a Knife," News-Post, Washington DC Metropolitan Area, July 8, 1992]

The patients whom I interviewed report having been favorably impressed by reading narrative accounts such as these before opting finally for Gamma Knife treatment. "I didn't believe everything they [media reports] said," one patient told me, "but the parts about there being no cutting, pain, and a long stay in hospital sure sounded good." Several patients also reported that they felt comforted having read that the Gamma Knife was a high-cost technology, a numerical embellishment that appears time and again in both popular and medical media. "Something so expensive must be worth it," one patient said; "I began to think of it [the Gamma Knife] as the Cadillac of medical machines," another added, "safer, more comfortable, and way expensive."

Patients also reported that they would adopt in their private thoughts on the Gamma Knife and in their descriptions of the technology to family members and friends, words and terms widely used in popular accounts of the Gamma Knife.

> Sure I did that [described the Gamma Knife to others using terms and images from popular media], I still do. They [family and friends] want to know what it, what the Gamma Knife does, and you basically have to tell them what you've read and seen on TV. That the Gamma Knife uses these cobalt cells, that it's like a knife only it doesn't cut you open, and all the rest.

> I used to show them pictures I cut out from the papers, you know, diagrams and stuff. I had never laid my eyes on one [a Gamma

> Knife] before, in real life, but I knew it inside-out almost, from what I read. I felt like an engineer or something!

One key aspect of these media-based constructions of the Gamma Knife is that they help patients divert attention from the radioactive dimension of the technology, which most preferred not to think or talk about. Patients recall, for example, informing family and friends that "I'm going for Gamma Knife surgery," or that "I'm getting this type of surgery that's like laser treatment." No patient recalls thinking or commenting, for example, that they were due to receive "radiation therapy" or that their treatment would be "radioactive" in essence. Popular media too shy away from accounts that stress this essence, even to the point where gamma rays are written about without direct mention of their radioactive properties. A cloak of illusion thus settles around the subject of the Gamma Knife when it is broached among perspective patients, one that even those who consider themselves better informed may not wish to rend:

> There's no two ways about it: this was going to be radiation -- my husband was going to be exposed to a high dose of gamma radiation -- the same form of radiation, incidentally, that eventually killed most of the Hiroshima and Nagasaki people. But there he was -- we were! -- talking about this radiation machine as if we had nothing to fear, as if it were totally harmless! I think he knew it too, that it was far more dangerous than we wanted to let on. But we both just shut up about it. What good would it have done to talk about it?! It just would have bred more fear, more anxiety, more sleepless nights. [Sally Winfrey, married to a Gamma Knife patient]

Medical documents and accounts are consistent in several respects with popular media in their depiction of the Gamma Knife and Gamma Knife treatment. Consider, for example, the information brochure that is sent to patients by the Department of Neurological Surgery at Hillcrest Hospital, about three weeks before their scheduled treatments. Printed beneath a formal department letterhead the brochure announces "that [it] will give you and your family information on the Gamma Knife procedure, your pre-operative workup and admission to [Hillcrest Hospital]." Throughout the brochure appear terms and words that possess obvious surgical connotations, including "preoperative," "Neurological Surgery," "gamma knife" (sic), "your neurosurgeon," "radiosurgery," "anaesthesia." The brochure also advices the following, under the heading, "Before the Procedure":

> The night before the procedure you can stay at a hotel or guest house near the hospital or with family or friends in the area. You should not eat after midnight. Do take your regular medications the day before and the morning of your gamma knife procedure. Bring your medications to the hospital with you so you make take them throughout the day as necessary. You should wash your hair the night before the gamma knife procedure.

The brochure continues, under the next heading, "What to Bring With You to the Hospital":

> Personal toilet articles and, if you wish, a light robe and slippers are all you need to bring to the hospital. Slipper socks are provided for your use in the hospital and robes are available should you not bring one. You might like to bring reading material. Do not bring valuables, jewelry or large sums of money to the

hospital.

Notice in the first excerpt that patients are adviced not to eat after midnight, and to wash their hair -- preparatory measures that respectively call to mind two mainstay features of classic surgical procedures, the administration of anesthetics, and a paramount desire for cleanliness (see Hirschauer 1991; Katz 1981). Beyond these features, the brochure lends itself with its advice to the perception that the Gamma Knife experience will resemble a rite of passage. Patients, it implies, will be separated from normal life and everyday articles and eating habits. They will become hospitalized patients, temporarily liminal and marginal, by having their personal symbols of identity -- clothes, jewelry, and other accessories -- removed and replaced with generic items that the hospital routinely provides. The final stage of this passage, that of reincorporation, or a return to normality and "normal activities," is also effectively promised:

> Immediately after treatment is finished, the frame is removed and you will return to the nursing unit. Patients may experience some headache once the frame is removed. Not having eaten all day may add to the discomfort. Medication for headache will be ordered for you should you need it. You may resume normal activities, eat and drink as you feel able.

We shall see later that Gamma Knife experiences are in actuality also shaped or constructed as rites of passage, in which a patient is made to feel under the impact of a range of medical activities and ritual preparations that he or she is moving -- or being shifted -- from the status of sufferer to the status of

recoverer, a feeling central to the emotional or psychological condition in which a patient will leave the hospital and return home.

Another medical document that encourages association between the Gamma Knife and surgical procedures is the consent document. Presented to patients for their perusal and signature on the morning before the start of their "preoperative work-up," the consent document is entitled "Authorization for Surgery or Special Diagnostic or Therapeutic Procedure." The first line on the form reads: "I authorize,_____ MD., and associates to perform the following operation(s) or procedure(s):_____, and to do any other operation(s) or procedure(s) during the specified operation that his/her judgment may dictate for my well-being." Below this line, the consent form slips into unambiguously surgical terminology, calling attention to the nature and purpose of "the operation," and to "the administration of anesthesia." Patients whom I spoke to about the consent form say that its surgical terminology did not strike them as unusual or out of place when they read and signed the form; only much later, months after being discharged from Hillcrest Hospital, do patients recall this terminology as having been decidedly misleading (see Chapter Five and Six for further discussion).

The Framing Procedure

Gamma Knife patients are from the very outset of their experiences in Hillcrest Hospital further introduced to designations, places, and practices rich in surgical connotations. The first arena in which these connotations unfold is "Pre-OP," a large room on the fourth floor of Hillcrest Hospital flanked by operating theaters, signs that read "Surgical Personnel Only," corridors through

which bustle people clad in surgical masks, gowns, gloves, and "booties." In Pre-Op itself stand pitched, like in some nomadic camp, several dozen white screens, behind which patients are ferried, undressed, and prepared for their respective treatments. To each of these screens is attached a laminated sign that reads "Cardiology," "Vascular Surgery," etc. Travelling the length of Pre-Op one is thus strongly invited to think, should one not previously have done so, that most of its occupants are destined for the operating room. The thought may prove unsettling:

> When they pushed me in there, I thought, 'what am I doing here? Have they got me mixed up with somebody else? Everybody here looks like they're headed for the operating room! That's not the kind of surgery I was supposed to get!' I said something to the nurse, I can't remember what, and she laughed and said don't worry, we're not going to any operating room. it was just for preparing for the imaging. That was one thing the nurse said that definitely made me feel better. [Robert Jones, Gamma Knife patient]

Furthest from the entrance of Pre-Op stands a screen that bears the sign, "The Gamma Knife." After 6:00 a.m. the area behind this screen, no larger than two or three phone booths, becomes like the rest of them the focus of a whirlwind of activities, carried out on a patient by the Gamma Knife nurse, a technologist, and attending neurosurgeon. These activities include undressing the patient into a hospital robe, administering an IV (saline solution) line, seating the patient, checking and arranging equipment, and asking the patient such questions as: "When last did you take your medications...how does the IV feel...had problems with that allergy lately...you don't have dentures or wear

contacts, do you?". Not all clinical, banter and jokes interject these activities and inquiries: "That robe looks good on you, Jake," or, "Now we're gonna shave your head."[1] Throughout the procedure (and those that follow) the Gamma Knife nurse, the technologist, and the neurosurgeon use the patient's first name.

Beyond these preparations, the main purpose of the patient's transitory stop in Pre-Op is to apply the Leksell Stereotactic Frame, which, as I noted in Chapter Two, is a device that Lars Leksell invented to bring greater precision to neurosurgical operations. Now routinely used to help image patients and so gain accurate data for planning treatment, the application of this frame seems at first to have nothing in common with operating-room surgery. Yet as we will see below, it does in fact serve to reinstate two features key to most surgical procedures, physical compliance of patients and disease-localization, so that application of the frame achieves that shift in emphasis from the patient-as-person to the patient-as-disorder that also underlies the administration of general anesthesia and other materially based rituals of the operating room. To understand how this shift is accomplished, I first describe the frame and then illustrate in detail how it is applied.

We recall from Chapter Two that the Leksell frame is a "stereotactic" device; it helps arrange or order things three-dimensionally. Comprising four light metal bars with Y, X, and Z axes that are known as "Cartesian axes," the frame serves to "enclos[e] the head both physically and conceptually within a microcosm where every point can be precisely defined in space" (Ganz 1993:8). The diagrams below depict the geometrical principles on which the frame is based.

---

[1] One much-touted advantage that Gamma Knife radiosurgery presents over neurosurgical procedures such as craniotomies is that patients need not have their heads shaved; this almost all patients are aware and appreciative of beforehand. The joke is thus shared as a vain -- some might say inconsiderate -- attempt to instill in patients a sense of false alarm.

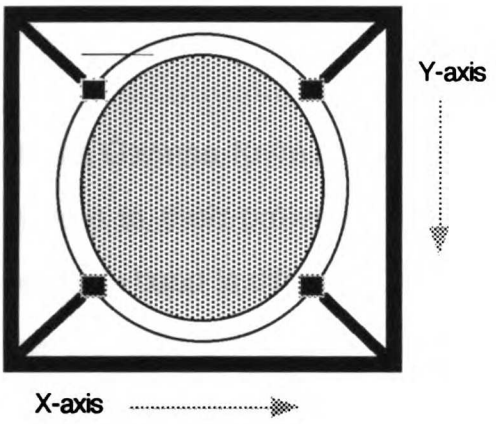


Diagram 1
(source: Field notes)

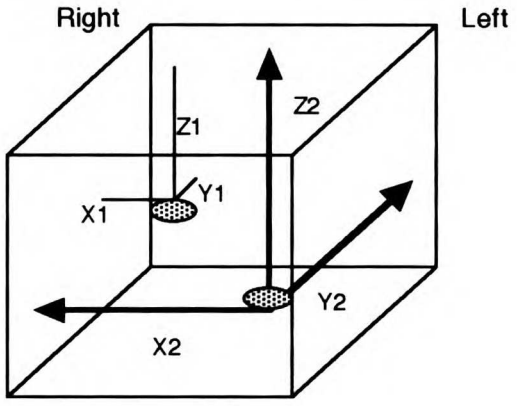


Diagram 2
(adapted from Ganz 1993:8)

Above, Diagram 1 depicts (from a bird's eye-view) the frame on the patient's head, bringing geometrical uniformity to a bodily structure that varies in size, shape, and volume from patient to patient, and that would otherwise frustrate through its unique attributes the physician's quest to localize intracerebral disorders and plot their irradiation. Diagram 2 depicts the Cartesian axes X (or lateral coordinate), Y (or anterior-posterior distance coordinate), and, Z (or vertical coordinate) that allow the physician to establish an exact point or target in the squared-off space of the frame, and to overcome thus the variegated and obtuse qualities of flesh, fluid, and bone. Ganz describes the process this way:

> [The frame] relates the position of intracranial targets to visible cranial or extracranial markers. The markers used today consist of a frame which is also a Cartesian axis system. The targets are related to the sides of the frame by perpendiculars dropped from the frame to the target. As can be seen [in Diagram 2], only one point is identified by the values X1, Y1, Z1 just as only one other

> and quite distinct point is identified by the values X2, Y2, Z2. Thus any intracranial location can easily be identified in relation to the frame which is fixed to the head. [Ganz 1993:8]

Or, as Gamma Knife physicians at Hillcrest Hospital put it when explaining the system to their patients, "The frame helps us image your AVM," and, "Each person's head is different...the frame makes them the same." Such explanations are typically offered in response to patients' questions in Pre-Op, as they nervously watch the neurosurgeon assemble the frame. Few have seen or even heard of the device before, beyond some who have gleaned from the brochure prepared for "patients and their families" by the Department of Neurological Surgery, the following details:

> The head frame acts as a guide for the precise location of the brain lesion. The frame is put on with you sitting in a chair. It is not necessary to shave your hair. Local anesthesia is used. Your neurosurgeon will anesthetize the four pin sites which anchor the frame. The discomfort you feel from the injections is transient. If necessary, additional medication to relax you can be given. You may feel a sensation of pressure as the head frame is secured. This subsides once the frame is in place.

The application of the frame, which begins with the patient seated in a chair or on the edge of a gurney behind the Gamma Knife screen in Pre-Op, soon consigns to the realms of euphemism such terms as "discomfort," "transient," and "subsides" in the description above. After having assembled the frame, the attending neurosurgeon takes charge. First he holds the frame over the patient's head, looking to isolate four points to which he can align and fix

the frame. Using a red-colored substance called Sensorcaine, he then dabs two small circles on the back of the patient's head and one above each eyebrow. These are called "pin sites". The Gamma Knife nurse in the meantime prepares a hypodermic syringe which the neurosurgeon will use to inject into each site a local anaesthetic, Novocaine. Once she has done so, she hands the syringe to the neurosurgeon, positions herself behind the patient, and places her hands on his or her shoulders. Faced at this point with the square-shaped frame, four damp spots on the head, and a syringe in the neurosurgeon's hand, the patient's remaining doubts or illusions about the exact nature of the procedure fall away.

And invariably the patient reflects as much. Pale suddenly, and breathing in gulps, he or she slumps or pushes backward and away from the neurosurgeon, but as far only as the backrest of the chair and the hands of the nurse. These serve to restrain the patient as the neurosurgeon introduces the hypodermic needle to each of the four pin sites, aiming to anesthetize them. As he proceeds the patient can all but cringe and balk from the pain, and occasionally yell: "oh my God, oh my God" or "This sucks...this sucks!" -- expressions of distress to which the Gamma Knife nurse will responds calmly and authoritatively: "Breath deep, breath deep...that's good" and "You can take it, you're strong...it'll be over soon," as she maintains a firm grip on the patient's shoulders.

Once he has anaesthetized all four pin sites, the neurosurgeon uses four metal pins and a screwdriver to apply the frame to the patient's head. Each pin is fractionally screwed into the bone beneath the four anesthetized pin sites until the frame is firmly fixed or "anchored". During this stage of the procedure, the patient occasionally winces or says, "That hurts"; the neurosurgeon then

stops momentarily to administer additional anaesthetic. Once he has all four pins and the frame in place, the procedure is complete.

Patients feel both shaken and relieved once the frame has been applied. As the attending neurosurgeon steps back, signaling the end of the procedure, they typically let out a deep sigh of relief. Some may raise their hands to their heads and tentatively touch the frame, searching for analogies to describe their altered appearance: "I must look like Conan the Barbarian" or, "If my kids saw me now, they'd think I'm an alien".[2] All experience tightness, pressure, and a sense of confinement around the head. "It's like your head's gripped in this invisible vice," said one patient. Most say that while they grow accustomed to this sensation, they remain anxious over the coming hours that the anaesthetic will wear off and that pain will resurge around the pin sites (as in some cases it does, eliciting once more a hypodermic response).

From the attending neurosurgeon's standpoint, the application of the frame is a procedure essential for gaining accurate preoperative data, but one that he considers unsavory and thankless. Though he accepts its technical value and even reports seeing in the appearance and function of the frame "something aesthetic," he does not find its application particularly satisfying or rewarding, as the following comment illustrates:

> No, it's not really rewarding...what's to reward? You use a syringe and a screwdriver and a little common sense.... So you need to align the frame properly and anchor it well -- just by watching one or two procedures just about anyone could do that.

[2] There are no mirrors in Pre-Op, or any other area in Hillcrest Hospital with which Gamma Knife patients have contact; the likelihood that patients might experience shock on clearly viewing themselves with the frame anchored on their heads is thus minimized, or managed.

The neurosurgeon is also disconcerted or "put off" by the framing procedure because it prompts movement, moaning, and other signs of distress from patients, particularly as he anaesthetizes their pin sites. Though he is eventually inured by repeatedly performing the procedure, he remains uncomfortable with patients' reactions, or to be more accurate, with the capacity of patients to react:

> Our training is in the OR where our patients are put under...that's how we know them, you know what I mean? Now with the frame, with the Gamma Knife, we're facing a conscious, talking, moving individual...someone who reacts to your every move...to whose moves *you* have to react. It's really a different ball game.

Discussion

The first preliminary procedure in Gamma Knife radiosurgery helps provide medical personnel with data essential in planning patients' treatments. These range from data about patients' medications and medical histories to the frame-related data that will help team members calculate a trajectory for the Gamma Knife. On another level, however, the procedure also involves patients and medical personnel with one another, in an environment and in the context of devices and actions that define in no small measure the nature of their involvement. Referred to as the first "preoperative procedure," which is carried out in "Pre-Op" amid signs and symbols steeped in surgical connotations, the framing process unfolds effectively on the doorstep of the operating room. The application of the stereotactic frame strengthens this proximity. Highly invasive and painful, the framing procedure marks for Gamma Knife personnel the onset

in their patients of a period of compliance or inertia not unlike that achieved with general anaesthesia. Anchored to the frame patients will move in the coming hours only gingerly and with difficulty, and will further temper their behavior lest the pain they have experienced resurges. In applying the frame to patients Gamma Knife medical personnel thus gain not only a means for collecting clinical data, but also incidentally establish a powerful psychological basis for maintaining patient-compliance.

The neurosurgeon also localizes with the frame, first by concentrating his efforts on the patient's head, and second, by cognitively changing with the concepts on which the frame is based a unique and variegated part of the patient-person into a uniform spatial construct, or quantifiable object. Serving now just as an anchoring platform, the patient's head (and body) are rendered insignificant, or tangenital to the clinical enterprise at most. In doing so the frame also transforms the identity of those to whom it is applied, or, more accurately, replaces those attributes and qualities that allow a person to feel human with features beyond humanness, resembling the outlandish and the alien. Both these processes -- of compliance and localization -- recall the "gestalt switch" with which operating-room rituals so profoundly transform surgical patients into objects, or biological vessels that contain the surgeon's main locus of interest, the disorder itself (see Hirschauer 1991).

However, the framing procedure is also tellingly different from most presurgical procedures, especially from the neurosurgeon's perspective. Equipped with syringe and screwdriver instead of a scalpel and forceps, the neurosurgeon regards himself during the framing procedure as mere technician or torquesman. Furthermore, unlike the inert, silent, and predictable objects in his classic professional domain, the operating theater, the framing procedure

presents him with subjects who move, speak, and who may act erratically. The neurosurgeon is thus not just technically preoccupied in the framing procedure, but involved also in a process of adaptation to that with which he is historically unfamiliar: mediocre or menial labor on the one hand, and the expressed emotions of patients on the other.

Finally, the way in which the framing procedure is described to patients provides evidence that its stressful aspects do not go unnoticed; attempts are made to minimize or play down these aspects, which after all starkly question the claim that Gamma Knife radiosurgery is painless and noninvasive. The use of such low-key phrases as "put on," "discomfort," and "transient" to describe the framing procedure in the information brochure provided to patients is a case in point. Patients are also euphemistically treated shortly before the procedure; their questions about the frame are met with comments regarding the frame's clinical application to imaging processes or issues of uniformity rather than with details regarding its actual application to patients. Timing and location are in this context also telling; the framing procedure is performed early in the morning -- at least four hours before treatment -- and several floors away from the Gamma Knife suite, in a part of the hospital where stark and invasive action should not strike one as unusual. Thus the framing process also is temporally and spatially distanced from the Gamma Knife, or the therapeutic side of Gamma Knife radiosurgery.

The Magnetic Resonance Imaging Procedure

Having applied the stereotactic frame, the neurosurgeon disappears from the Pre-Op room and leaves the patient in the care of the Gamma Knife

nurse and technologist, who assist the patient onto a gurney and wheel him or her to the magnetic resonance imaging unit (MRIU). No larger perhaps than a garage designed for parking two medium-sized automobiles, the MRIU is constructed around a console with closed-circuit video monitors, and an adjoining chamber that houses the large General Electric imaging machine, behind a door bearing a sign that reads: "Warning: No Pacemakers, No Metallic Implants, No Neurostimulators".

At the console sits the supervising operator of the MRIU. She tends to the imaging, as well as answers internal telephone calls from physicians and secretaries who wish to schedule patients with her usual refrain: "We're overbooked. Yes...I know...I understand...OK, maybe I can squeeze him in later." The MRIU's schedule is typically backlogged; the Gamma Knife nurse therefore frequently first stations a patient outside the unit, or temporarily wheels him or her elsewhere to prevent a traffic jam.

Once admitted to the unit Gamma Knife patients are prepared for magnetic resonance imaging, a procedure from which Gamma Knife personnel obtain films that indicate to them whether or not a disorder has changed or altered since it was last imaged, a vital consideration in planning Gamma Knife radiosurgery. Towards this end, the Gamma Knife nurse and the unit operator first transfer the patient onto a gurney designed to fit into the MRI machine. This is an awkward process since the patient is by this time unable to move freely (on account of the Leksell frame and the IV line). Still, the patient is urged on: "Come on, roll over towards me...a bit further, that's it". Once the patient is on the MRI gurney the Gamma Knife nurse folds up and snaps into place its hinged sides, which work much like those on a bunk bed. This step, taken to prevent the patient from moving during the imaging procedure and jeopardizing the

quality of the films, typically elicits from patients the response, "you're locking me in". Next, the nurse helps the unit operator fit a box-like device or "adaptor" over the existing stereotactic frame on the patient's head. Simply described to curious patients as a device that "helps with the imaging," this adaptor serves to compensates for any misalignment between the frame and the gantry of the MRI machine. At the same time, it serves to further immobilize the patient.

As these preparations take place, the unit operator asks the patient questions aimed at preventing the introduction of metals into the magnetically-run MRI machine, a second hazard to the production of quality images: "Do you have any metal in your body...have you ever worked in a metal shop...?". Any jewelry or trinkets are accordingly removed from the patient for the duration of the imaging process.[3] Finally, the Gamma Knife nurse tucks a blanket around the patient's feet and lower body, "to keep you warm", and inserts foam plugs into the patient's ears, because "it gets kinda noisy in there" [the MRI machine]. The patient is now ready for imaging.

The MRI machine consists of a narrow tube into which the gurney bearing the patient is slotted. A few centimeters separate the patient's face from the curved ceiling of this tube; he or she is unable to move or see outside. Once in the machine, the doors of the imaging chamber are closed; the patient lies alone. The unit operator moves to the console and activates the machine. Inside, the patient is greeted immediately with noise, despite the earplugs he or she has ben supplied with: "like a giant clack-clack," said one patient; "I thought a helicopter was going to land on me," said another. Outside in the consol area one only hears a faint hum as the imaging begins and continues, for

[3] This measure, absolutely imperative in the eyes of MRI technicians, sometimes disconcerts patients who are wearing crucifixes, Saint Christophers', or other symbols of religious devotion, luck, and fortune. "I put it [a gold crucifix on a necklace] on to help me through this day, and they take it off," said one patient.

approximately 20 minutes. During this time the unit operator remains at the console, now and then adjusting a dial, and keeping an eye on the video monitors. The Gamma Knife nurse meanwhile uses this interlude to catch up on her record-keeping, grab a cup of coffee, and exchange pleasantries.

Typically patients reenter the world outside the MRI machine with gratitude. Some, especially those with repeated prior experience of MRI imaging, bear the discomfort of having been confined in the machine with stoicism, commenting that "it wasn't as bad as last time" or asking jokingly of the Gamma Knife nurse, "do I get to join the veterans club now?", or "Where's that cigarette you promised me?". To such patients the nurse and the unit operator respond with exaggerated delight, calling them "troopers" and "wonderful to work with". Other patients, however, complain on their reemergence of induced cold, stiffness, neck and back pains, and claustrophobia -- a complaint most frequent among relative newcomers to the MRI machine, who describe their experience as having involved "breathing problems," "feeling trapped," and "wanting to struggle".[4] These and like complaints are handled (and their potential escalation forestalled) by the nurse and the unit operator with such consoling gestures as a pat on the back, and comments such as "well, now you have it behind you".

In contrast to adult Gamma Knife patients, those under 12 years of age do not consciously experience the imaging process, nor present the Gamma Knife nurse and the unit operator with the same kinds of procedural constraints that adult patients do, since younger patients undergo MRI imaging after being administered a general anaesthetic. This procedure, typically performed by a

[4] The experience of claustrophobia in MRI machines is not limited to Gamma Knife patients; numerous medical reports point to its occurrence (and persistence) among MRI recipients generally (see for example, Dantendorfer et al. 1991; Granet and Gelber 1990; Fishbain et al. 1988; Phelps 1990).

pediatric anaesthesiologist, ushers into the MRI unit a set of actions and responses that differs substantially from those described thus far.

Like adult Gamma Knife patients, their younger counterparts may need to wait some time before being admitted to the MRI unit. They also experience the process of being moved onto the MRI gurney. On one hand, this step is made less awkward for the patient, the nurse, and the unit operator on account of the lightness of younger patients. On the other hand, younger patients tend generally to react more anxiously and with greater sensitivity to this preparatory step than adult patients. "That is why we put them under -- for their own benefit," the Gamma nurse explains. Before doing so, younger patients are constantly talked to and fussed over, asked about their hobbies and favorite TV shows, and comfortingly touched on their shoulders and cheeks.

Once the anaesthesiologist has administered the anaesthetic and patients lose consciousness, however, a marked change of behavior sweeps over the nurse and any other medical personnel present in the MRI unit. Their fussing over patients stops. Instead of talking to patients they talk about them, often focusing on negative aspects of their characters, conditions, and backgrounds. Their physical handling of patients becomes tactless, especially as they manipulate patients to apply the stereotactic and MRI frames. The case below helps illustrate these changes. It shows how activities and dialogue around Gamma Knife procedures undergo once more a kind of "gestalt switch" reminiscent of operating-room procedures and how they transform patients into "patient-objects" (see Hirschauer 1991:293).

The Case of Marcus Green

Marcus Green, an 11-year-old AVM sufferer, is wheeled into the

MRI unit with a large teddy bear propped up near his feet, which Margie, the Gamma Knife nurse, has obtained for him. Both Margie and the anaesthesiologist talk and tend soothingly to Marcus up until the anaesthetic takes effect. With Marcus unconscious, they start discussing his mother: "She just did not want to stick around, just dropped him off...an 11-year-old kid, can you believe that?" While Margie continues to comment on and berate Marcus' mother, the anesthesiologist flips through a computer magazine that he has resting on Marcus' legs. Mullins, a pediatrics neurosurgeon, bursts in. Without glancing at Marcus or asking any questions about him, Mullins quickly assembles the stereotactic frame, muttering "I'm so busy...I'm so busy...I'm so busy". Once he has the frame assembled, he addresses Margie and the anaesthesiologist: "Hold up his head, no, no...yes, like that". He calls over the assistant: "Hold the frame level while I do the pin-sites". Some confusion ensues, hands and arms get tangled, and the anaesthesiologist says: "This is one heavy head". Mullins wants to know: "What am I?" The anaesthesiologist responds, "You're the surgeon, you're the surgeon". Mullins laughs and says, "you mean I'm the screwdriver!" -- and begins screwing the frame onto Marcus' head. To attach the MRI frame (over the Leksell frame), five people stand around the unconscious Marcus trying to get the frame onto his head. Mullins urges them on with directions: "No Bill, that's not-- higher Margie, higher". "What a production!" Margie sighs once both frames are in position, and Marcus is finally ready to be imaged.

Discussion

Though the MRI procedure is not as painful and unnerving for patients as the framing procedure, it is still a source of considerable tedium and stress: patients are made to wait beforehand, they are moved and shifted about, their bodies are further manipulated and confined. Those rendered unconscious appear fortunate in escaping or being spared these experiences. In anaesthetizing these patients, Gamma Knife personnel are benefited on their part: no complaints or objections are forthcoming, the imaging process will not

be jeopardized by the patients, and personnel are free to engage in open, critical interaction. These benefits, however, are attenuated: anaesthetized patients are inert and deadweight, conditions that turn the framing and imaging procedures into "a production." Total patient compliance in the MRIU therefore amounts to less than total convenience.[5]

Circumstances differ around conscious, sensate patients. They are physically and verbally capable of assisting and resisting medical personnel before and during preparations for imaging, capabilities that medical personnel maximize and minimize respectively. The nurse and unit operator can also impress on conscious patients that they are in caring hands by providing them with blankets and earplugs, and by later consoling those who have experienced fatigue or distress during imaging. Though these placations may appear minor in the context of the MRIU, they take on significant proportions for patients in the context of the angiographic procedure, to which the chapter now turns.

The Angiographic Procedure

The next and last "preoperative" destination for Gamma Knife patients is the angiographic suite, reached at Hillcrest Hospital by taking an elevator several floors down from the MRI unit, usually via a visit to a bathroom outside of which the Gamma Knife nurse informs patients: "This is the last time you'll be able to go for a while."

---

[5] This is true also of other procedures in Gamma Knife radiosurgery, including treatment, and may be true also in the context of any medical procedure that involves moving unconscious patients and applying to them various devices and equipment. Such situations question the extent to which general anaesthesia benefits physicians by rendering their patients unconscious, one not breached often in research on the objectification of surgical patients (see for example, Hirschauer 1991; Katz 1981).

In the angiographic suite patients are introduced to a setting that resembles an operating theater, replete with medical personnel dressed in green scrubs, and surgical masks and gloves, trays containing an assortment of glinting instruments, bright overhead lamps, a video monitor, and stark green walls. Two large, glass panels allow observers to peer in.[6]

Unlike most operating theaters, however, the main function of the angiographic suite is diagnostic: here patients' disorders will be further imaged by means of a radiographic technology known as a fluoroscope, a bulky overhead device erected at one end of the room. The fluoroscope is used to produce films called angiograms; these render visible in detail the blood vessels that supply the brain, including stricken or pathological vessels.[7]

On admission to the angiographic suite, its medical personnel (rather than the Gamma Knife nurse and technologist) immediately move the Gamma Knife patient face-up onto an operating table beneath the fluoroscope. An attending nurse then pulls a sanitized green sheet over the patient, ordering him or her to "keep from moving". Besides leaving uncovered his or her face, this sheet has holes that expose two tablespoon-sized areas on either side of the patient's groin; these another nurse swabs and sterilizes. Blood pressure gauges are then fixed to each of the patient's arms. Soon the video monitor blinks on; eye-sockets and other structures within the patient's head become visible. In final preparation for the procedure, a length of coiled plastic tubing, called a radiopaque catheter, is placed on the patient's covered chest.

Once the patient has been readied and the neurointerventional surgeon

---

[6] Though I was present on two occasions in the angiographic suite itself, these glass panels were my most frequent station.

[7] To separate them from angiograms that depict blood vessels in other bodily regions, the films produced in the case of Gamma Knife patients and other sufferers with brain disorders are referred to medically as cerebral angiograms. For a fascinating account of the historical rise and significance of cerebral angiography, see Fishman 1988:147-152.

has arrived and scrubbed-up, the angiographic procedure begins. Via a small incision that he makes on one side of the patient's groin, the surgeon feeds the catheter up through the patient's body, through a femoral artery, then a carotid artery, and finally into the afflicted area in the patient's brain, constantly glancing at the video screen to monitor his progress. He proceeds slowly and delicately; though no more than two millimeters in diameter the catheter can damage or even break through artery walls, or be easily and perilously misfed, especially in the convoluted regions of the brain.[8]

When the surgeon has the catheter in position, he uses an injection to introduce into it a fluid substance known as radiopaque contrast dye; this he coaxes through the tubing until it disperses into the blood vessels in and around the patient's AVM. Once dispersed, the contrast dye is imaged with the fluoroscope, a comparatively swift undertaking after which the surgeon removes the catheter, and signals the end of the angiographic procedure. Nurses then bandage the punctured area near the patient's groin, remove the sheet and attachments, and move the patient back onto the gurney and out of the angiographic suite.

In recollecting their angiographic procedures, immediately afterwards as well as much later, Gamma Knife patients consistently single out two experiences: 1. the pain and discomfort of having the catheter inserted into them, and 2. their failed attempts to communicate with medical personnel. Testimonies such as Mrs. Ellen Johnson's, a 47-year-old AVM patient, are in this context common:

---

[8] One informed AVM sufferer writes on the subject of angiographies in the United States that patients who undergo these diagnostic procedures run the risk of complication and death on a national average of 1:1000 due to catheterization foul-ups (see Fishman 1988).

> It [the insertion of the catheter] felt like my body was being scrubbed out with a pipe-cleaner. I remember asking the doctor if it should feel this way, I thought maybe something was wrong, but I don't remember his answer.

Another patient, Mr. Tyrone McDonald, recalled a similar experience, but with illuminating reference to his recollections of a past angiographic procedure:

> I don't know how, but somehow I forgot about it [his previous angiographic procedure]. But when I saw that catheter it came back to me -- the pain and that burning feeling. I wanted to know why they needed to do another one, I can't remember who I asked -- I couldn't see very well -- but I didn't get an answer. Later the nurse, the one for the Gamma Knife, she told me.

Patients add that they experienced considerable backache and general bodily fatigue in addition to pain induced by the insertion of the catheter. "Afterwards I felt like a bus had parked on my back for two hours," said one patient. Many recall trying to shut out or at least partially relieve the pain and discomfort of the procedure by thinking about favorite movies or books, vacation itineraries, sporting events, or possible gifts for an upcoming birthday. Lastly, patients also recall being especially relieved or grateful when the Gamma Knife nurse finally retrieves them from the angiographic suite.

Discussion

Though efforts may be made to "talk patients through" other sorts of angiographies (Mitteness 1996: personal communication), this does not appear

to be the case with cerebral angiography. Even patients who have undergone this procedure at other medical centers in the United States report on the lack of doctor-patient communication and the object-like status that they feel they have perforce adopted during cerebral angiography. Consider, for example, the words of Steven Fishman, reporting on a cerebral angiography that he underwent in a highly regarded hospital in New York:

> [At first] I felt like a member of the crew, an illusion I merrily maintain until Berenstein punctures the artery in my right thigh. We aren't working together; they are working on me. I am the patient, etherized on the table, except I am not etherized.... I feel as if I am gone or lapsed or am really invisible.... I don't want to meddle. I can hear my mother say to the handyman, come to fix a leaky faucet, 'You're the expert, so I'll just get out your way.' I adopt a similar attitude, according to whose rules it would be not only intrusive but impolite for me to stop the proceedings and, for instance, demand an explanation of what the hell is being done to me now. [Fishman 1988:146]

Gamma Knife patients at Hillcrest Hospital experience in the angiographic suite a similar sense of being worked on and not with, and refrain for the most part from asking questions or demanding explanations lest the disrupt the event, or break the expert's concentration. Thus they come closer in the angiographic suite to classic invasive surgery than in any other setting, experiencing in its midst what operating theaters and their incumbents are renown for: rendering patients anonymous, in an atmosphere of disregard for their thoughts, feelings, and emotions. This process is evident in the use of such symbols of anonymity as the operating sheet, in the carrying out of activities around and on patients as if they were unconscious (of which the use of patients' chests as resting surfaces for the catheter is emblematic), and in the typical lack of response that

greets them when they do venture to ask questions or voice concerns about the procedure.

In this context it is important to note that the treatment meted out in the angiographic suite to young, unconscious Gamma Knife patients differs in no remarkable way from the manner in which their conscious, adult counterparts are handled; a change in conduct or attitude such as occurs among Gamma Knife personnel working with unconscious patients in the MRI unit is not evident. The sentience of patients is therefore not a prerequisite for diminished personhood in the angiographic suite; patients are treated as objects whether or not they are conscious (though the unconscious are obviously spared the discomfort and alarm that conscious patients endure). Patients are also notably compliant throughout their angiographies, and do not struggle physically or verbally against their surgeons. This may be due in part to fatigue and physical restriction (to the operating table, the sheets, and the Leksell frame), and to the association of the angiography with surgery and surgeons, which encourages patients to remain quiet and inert lest they disrupt the delicate plumbing of their most inner bodily regions.

The technical care and precision required to safely complete the angiographic procedure may partly explain why patients are handled as they are: both nurses and surgeons avoid all but the most perfunctory verbal contact with patients for fear of losing concentration and control in the realm of physical contact. But another, less technical reason also presents itself. In the angiographic suite, which services as quickly as it can a wide range of hospital departments, medical personnel encounter Gamma Knife patients as ships in passing, individuals whose names, identities, and idiosyncrasies are less well known to them than they are to Gamma Knife personnel.

The angiographic procedure unfolds on institutional terrain on which Gamma Knife personnel are minimally involved. Given its stressful impact on patients and disregard for their identities, this amounts to a form of professional disassociation that allows Gamma Knife personnel to socially reassociate patients with themselves after the procedure as members of a kind of medical moiety more caring than any other. Patients' reencounters with the Gamma Knife nurse and technologist after the angiographic procedure signal, as a result, not just the completion of yet another painful and uncomfortable procedure, but contact once more with medical personnel who know and use their first names, who respond to their questions and comments (however briefly), and whose conduct toward them merits in the light of their angiographic experience all the more appreciation.

I have been concerned so far with exploring media representations and three sets of procedures -- the framing procedure, the MRI procedure, and the angiographic procedure -- and how these reestablish around Gamma Knife radiosurgery various features of surgical practice, including conditions that minimize the Gamma Knife patient's personhood and that render him or her compliant. My discussion of media representations helped show how patients adopt well before their admission to hospital a social vocabulary with which they envision the Gamma Knife as both surgical (in the hope that it will address with surgical-like speed and efficiency their problems), and unsurgical (in the hope that they will be spared such surgical effects as invasion, pain, scars, and prolonged hospitalization). My data and discussion on the three "preoperative" procedures focused on the material, terminological, and spatial means that render patients compliant, and that effectively reinstate them without the need for general anaesthesia in the object-like position held by surgical patients.

The next section examines the Gamma Knife procedure itself, both as an event shaped by patients' "preoperative" experiences and as an event complex and rich in experience and emotion in its own right. I focus closely on the thoughts that patients develop during the procedure, and on the incorporation into their procedures of terms and images that ostensibly lend a greater measure of realism and progress to an otherwise seemingly abstract and static event. The structure and outcome of the event, as we shall see, are complex and prophetic.

The Gamma Knife Procedure

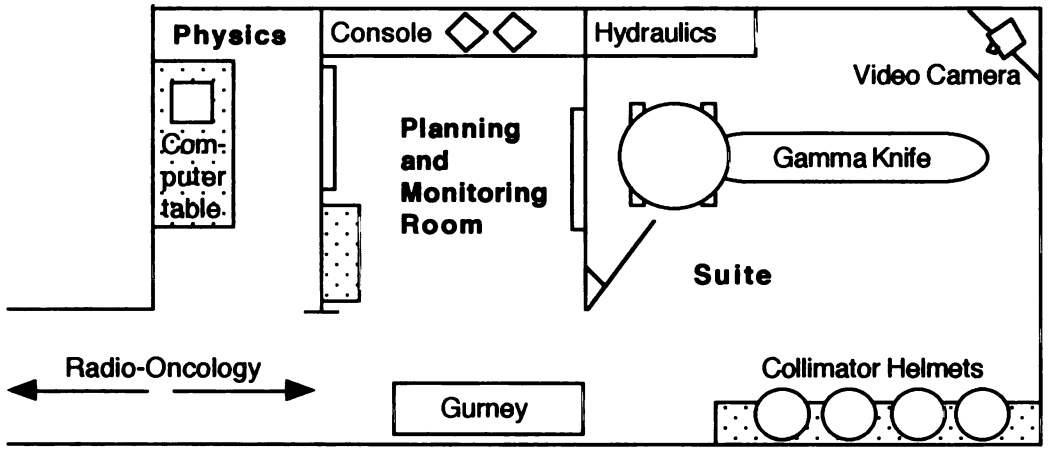
On completing the angiographic procedure a Gamma Knife patient is wheeled, looking and sounding both exhausted and relieved, into the Radio-Oncology Department, reached by descending via corridors and elevators into the basement of Hillcrest Hospital. Comparatively spacious, discreet, less harried, and expensively furnished, here both architecture and atmosphere are noticeably different from the other places in the hospital that patients have occupied. This observation does not bypass patients, tired and stressed as at this point they mostly are:

> It was like a new world. Everything was more spacious, you know? And friendlier, there were these big airy pictures on the walls, the people -- the doctors -- smiled and looked more friendly. It didn't seem so rushed and cramped as the rest. [Meredith Mann, Gamma Knife patient]

> After that angiogram all I could think was, 'Please God, not another one like that, not another damn operating room!' 'Where's the noninvasive part? This was supposed to be quick and easy!' I got

> a bit more hopeful when we got down there [the basement], I mean, I was still tired and scared out of my wits -- don't get me wrong -- but the place just *looked* a lot more pleasant. [Joe Carpenter, Gamma Knife patient]

Patients are stationed in an area at the end of one of the basement's pleasantly retrofitted corridors that is layed out as follows:

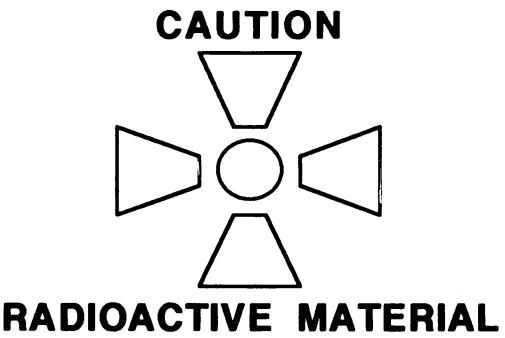


Gamma Knife Setting
(Source: Fieldnotes)

The door beside which the patient is consigned is electronically operated; it remains open outside of actual treatment time. From this position the patient can look into the room ahead, the Gamma Knife suite, which is sometimes also called "The Operating Room," and flanked in some Gamma Knife facilities (though not in Hillcrest Hospital) with a "Scrub Area" (see Lunsford et al. 1990:380). Doing so, the patient would see in the suite its pastel pink and blue veneer, the picture of parapets and palm trees on its far wall, the row of

outlandish-looking titanium contraptions (known as collimator helmets) on the oak cabinet that stretches along its near wall, and part of the bulkish Gamma Knife, squatting in the upper half of the room.

In the adjoining area, from where Gamma Knife personnel operate and monitor the Gamma Knife, the patient can see other materials: two small computer monitors, a console with several switches and lights, a desk and its chair, a surface for illumining images, and a white board with felt pens in its gutter. Though obscured somewhat because the door is open, the patient can also see on the outside surface of the suite door a sign that announces:



From his or her station (or any other that will be allocated to the patient in this setting) the only areas that the patient cannot see into are the physics and dosimetry room, and the area housing the hydraulic equipment that moves the shielding door and "patient couch" on the Gamma Knife. Both enclose perhaps the most vulnerable technologies linked to Gamma Knife radiosurgery: not infrequently does the main computer screen in the physics and dosimetry room black out inexplicably to outbursts of "Damn! and "Oh shit!" from the physicists; the hydraulic equipment in turn is known to have failed in other medical centers on more than one occasion, leaving the patient stranded in the radioactive field

of the Gamma Knife.[9]

A patient is not alone in the radiosurgical setting before his or her procedure; members of the Gamma Knife team are in the vicinity preparing for treatment. The Gamma Knife nurse and the technologist are both busy in the console area and the Gamma Knife suite, alternating between paper work, checking on various equipment, making telephone calls to summon a team member or a lagging set of images. A neurosurgeon and a radio-oncologist typically pore over images, figures, and calculations in the console area, seemingly unaware that the nearby patient can overhear them "obliterating the nidus" or "delivering the shots." In the physics and dosimetry room the physicists are at work, processing in a Hewlett Packard computer the various data gathered from the MRI and angiographic units.

The duration of these preparations, and therefore the amount of time a patient must spend waiting outside the Gamma Knife suite, depends on the following factors:

The availability of team members: like review conferences (see previous chapter), Gamma Knife procedures are delayed by as much as 20 minutes due to the absence of a pivotal participant, usually a neurosurgical team member, held up through delays in other parts of the hospital.

The availability of preoperative data: in the ideal scenario, the various images required to plan a treatment will have all arrived for processing in the

---

[9] In the event of a power failure, the hydraulic equipment releases reserve pressure that automatically moves the "operating table" or "couch" and so also the patient out of the Gamma Knife, and that closes the shielding door for safety. In 1995 I saw pinned to the notice board in the control room a letter from Elekta Inc., informing the Gamma Knife team at Hillcrest Hospital of two recent incidents elsewhere in which these hydraulic back-up systems failed to activate during treatment. The letter concluded that although such incidents were extremely unlikely to repeat themselves, all Gamma Knife teams should know how to intervene manually during such emergencies. Steps for manually removing stranded patients from the Gamma Knife were listed. "A nasty prospect," commented one team member who noted these steps, "not just for the patient but also for us" -- on account of the radiation to which team members too might then be exposed.

physics and dosimetry room before the patient arrives; this seldom happens. Like certain team members, images are prone to lag on their routes from production sites (such as the MRI unit) to places where they are processed (such as the physics and dosimetry room). This slows down the treatment planning process.

The complexity of a case: while the complexity of some cases is anticipated in the review process where they are accordingly allocated more time than others, interim developments can present team members with complexities that cannot be anticipated. For example: a patient has an AVM that team members deem during the review process "simple" to treat. On the patient's day of treatment, team members note changes in the location and size of the AVM. Images are rediscussed, dosage levels are redefined, and angles of penetration are recalculated, easily adding 30-40 minutes onto the time the patient is made to wait.

Technical problems: problems with equipment further delay treatment. Computer "crashes," dosage miscalculations, flickering or black-out video monitors, and occasionally erratic behavior in the Gamma Knife's hydraulic system may surface and require attention minutes before a scheduled procedure -- problems that defy regular checks to isolate or predict them.

Delays due to one or more of these factors are not usually announced to patients, who assume therefore that they are just par for the course. "it would just upset them," rationalizes one team member, " to know that things can go wrong and that they must wait for them to be rectified." Thus, a visage of order, predictability, and business-as-usual is ingrained in the setting and sequence of Gamma Knife procedures, and also on the Gamma Knife nurse's face when finally she arrives to wheel a patient into the Gamma Knife suite, and towards

the Gamma Knife machine.

In contrast to all prior procedures, from the stereotactic framing to the angiography, there prevails in the Gamma Knife suite, once a patient has been wheeled into it, an almost-celebratory atmosphere. Everyone seems ebullient and cheerful; the Gamma Knife nurse informs all in the suite with a broad smile how "strong" and "full of courage" her patient has been so far, and the attending neurosurgeon, now decidedly jolly in comparison to his demeanour in Pre-Op, jokes with both the patient and the nurse, eliciting with his wisecracks even a chortle or two from the physicists hovering in the background. In contrast also to the places in the hospital that the patient has passed through, stark and lacking in privacy and warmth, the Gamma Knife suite and its colorful fixtures, discreet design, and soft lighting lend to this atmosphere an intimate and almost festive appeal.

The first step towards treatment once the patient has been brought into the suite involves moving him or her from the gurney and onto the padded extension of the Gamma Knife. Gamma Knife personnel call this extension "The Couch," although it is referred to in Gamma Knife manuals and medical reports as the "Operating Table." Thus, as they help shift the patient from the gurney, with assistance sometimes from one or two of the physicists, the Gamma Knife or the attending neurosurgeon may comment, "OK, let's get you on The Couch, [John], that's it, almost there, wow, you like pizza, don't you!" Once the patient is on the couch, the neurosurgeon wheels across the room and carefully lowers over the patient's head one of the contraptions from the equipment cabinet, a collimator helmet (see above). He then uses a specially-adapted set of tools to callibrate the stereotactic frame, still on the patient's head, with the collimator helmet. Essentially blindfolded by the helmet and unable to move his or her

l, the patient can from now on only hear and feel what is being said and e in the suite. As the neurosurgeon proceeds with his callibrations the nt hears and feels, for example, "First shot....coordinates X and Y...100," the *tink* of a tool adjusting something, hands nudging here and there. The osurgeon may on occasion misplace one of his callibration tools, and eal thus to the patient for help: "Hey [Joe], check under you left leg for that wdriver. You found it? Great." Though apparently unintentional and minor, displays of medical forgetfulness nevertheless put patients at ease, and even inspire in them the feeling that they are making small contributions to roceedings around them, despite being unable to see or move:

> While they were getting me ready? I remember they talked and joked quite a bit. At one point, I think it was Dr. [Bloggs] said that he had lost something and I said, 'It's right here, under me' because I could feel this screwdriver or something had slipped between my legs. So he said, 'Come on, [Joe], stop hiding my tools!' and we all laughed because I said, 'Damn, I needed a new one to work on the Ford.' [Joe Carpenter, Gamma Knife patient]

Once on the couch with the frame and the collimator helmet callibrated, atient is technically ready for the first "shot." Yet, before this is delivered, e takes place a remarkable interlude. In the window of time created een preparing the patient on the Gamma Knife and delivering the first d of treatment, any relatives, friends, or well-wishers who have come with atient to Hillcrest Hospital, and who have thus far been consigned to ng rooms and cafetarias, are now invited into the Gamma Knife suite to see atient. Like an usher at the cinema the nurse or another member of the

mma Knife team will summon and direct them in. All enter with shy curiosity nted on their faces: wives, husbands, boyfriends, girlfriends, lovers, partners, thers, sisters, aunts, uncles, friends, and neighbours, sometimes in a cohort l at other times alone. Many bring cameras -- to take a photograph or two of r relative, friend, or loved one lying, with the collimator over his or her head, the Gamma Knife, which most have so far seen only in newspaper articles, on television. Some visitors ask questions of the patient or offer comments h as "How ya doing, [Bill]?," and, "Hang in there, [Mary], it's almost over." A iceable difference in conduct between male and female visitors is evident. n typically keep from walking close up to both the patient and the Gamma fe, preferring to ask from a distance their questions, make their comments, take photographs. They look ill-at-ease, move their weight from one leg to ther, and ask of Gamma Knife team members questions that shift the focus ttention in the suite from patient to technology: "How heavy is that machine way?" or, "What 's that helmet-thing for?" or, "I bet these walls are five feet k." Even in the context of close kin and deep concern do visiting men gaze ay, as it were, from the form on the machine, conduct that later, once ushered n the suite, they may not feel especially proud of, and yet are able to onalize:

> She's my wife, I said to myself, who's lying alone and scared on this huge machine, and there I'm staring off at other things, asking about this and that, and not going anywhere near her. Now I'm asking myself 'Why, why didn't you go up to her and comfort her or something,' and all I can think of is that it was too weird, the whole set-up, everyone gawking at her, like she was some kind of freak, and pretending to care. I guess I didn't want to be part of that, I care more about her than anyone knows, but I just wanted to get out of there. I hope she'll understand. [Paul Johnson, husband to a Gamma Knife patient]

Women, by contrast, typically take their time during these visitations to communicate with and comfort patients on the Gamma Knife. Walking directly up to patients with comments such as "Hi honey," and, "Oh, look at you," they talk to the patient, frequently touch them, and relay from people in the outside world messages of encouragement and support, for example, "Uncle Harry says he's thinking of you," or, "Your mom's baking a cake for when you come home." Later, once they have been ushered from the suite and back to a waiting room or a cafeteria, women too, however, may view these visits as rather strange, even shocking:

> When I saw him [her husband] lying there on that machine with that giant helmet on his head I thought, 'Oh my God, what are they doing to him!' He couldn't move a muscle and he had this -- this *thing* bolted on his head! He was pale as a ghost, paler than I've ever seen him. I talked to him as much as possible, just talked and talked, trying to take his mind off it, off the machine and that thing on his head and the hospital. But it wasn't real, it wasn't private enough. I could sense that he felt uncomfortable, that he was getting embarrassed because other people could hear us. It was like talking to a condemned man!

> To see him [her son] like that, all alone and helpless -- it was shocking. I just wanted to run out and get away. But I knew he needed me, so i talked to him, and massaged his leg a bit. He had thrombosis once -- probably the doctors don't even know that. He said, 'That feels good, Mom,' and his voice sounded so tired and trembly. I thought it was because he was scared but later he told me it was because of the all the stuff they did to him before -- before they put him on the machine.

Patients in turn later typically express mixed feelings about these visitations, saying that it was "good" or "comforting" to hear a voice or feel a hand familar or intimate to them, but that they also felt uncomfortable, sometimes to the point of wanting the visitations to end:

> Why I felt uncomfortable? Because of the way I must have looked -- lying all flat with the frame on my head and the helmet. I know it shocked them [his wife, brother, and oldest son]. And because of the lack of privacy -- I mean, it's one thing for a doctor or a nurse to undress you and see you to the bathroom and all that, but to have them hovering around when your family's there! I was very conscious of that. [So you wanted the visit to end?] Yeah, I did, but not only because of those reasons. I wanted to get the whole procedure over and done with!

Such patients do not have long to wait; visitations are shortlived. After several minutes visitors are ushered from the suite, leaving in their wake echoes of "See you later," "God-speed," and "Good luck." Members of the the Gamma Knife team now also leave the suite. The neurosurgeon checks his callibrations one more time, the nurse informs the patient, " "OK, we're going next door now, this won't take long. There's a microphone in here, so we can talk." The door to the suite, operated with a push of a button in the adjacent monitoring room, closes. The patient lies alone.

> It got very quiet. I heard them leaving -- their footsteps -- and I heard the door close with a little swoosh. Then it was so quiet I could hear my heart beating, boom, boom, boom, quite fast. I closed my eyes, and tried to tell myself I was at home, on the

porch, trying to take a nap [Susan Morrisey, Gamma Knife patient]

> When I heard them leave I thought, "Oh-oh, why are they leaving when this thing is supposed to be so accurate? If they're scared of being a couple of yards away while the machine is going, shouldn't I be doubly -- triply -- scared with me right on it? I tried not to think about it. [Angel Fernandez, Gamma Knife patient]

At some point -- the patient has no accurate way to gauge time -- the couch on which he or she is lying begins to move, and the shielding door on the Gamma Knife opens.

> You start moving, and there's like a *rrrrrrrrr* noise, until you hear a little clunk and you stop moving. You're kind of puzzled for a second, but then it hits you -- your head is inside the machine, in the radioactive part -- and your mind starts racing. [George Emerson, Gamma Knife patient]

As patients realize that they are now "in" the Gamma Knife, directly exposed to its field of radiation, the floodgates of emotion, memory, and imagination open wide. Out pour images and stories that patients latch onto in order to keep still, gripped as they are by a fear that even the smallest movement -- the batting of an eyelid, the curl of a finger -- will throw the machine out of alignment, and cause the radioactive rays to miss their target.

> I always heard them talk about *accuracy* -- accuracy this and accuracy that -- and it went through my mind like a mantra, so that I thought that if I tried to move that maybe my movements would throw the radiation off-target. So I stayed very still. Didn't bat an

eyelid. Didn't say anything into the microphone, because that would make my mouth move. Maybe I was being paranoid. But, you know, you read about how powerful these rays are, and you'd be dumb to mess with them. [Robert Mitchell, Gamma Knife patient]

We went birdwatching in Hawaii one summer; I remember sitting on a log in this forest. There were no other tourists around; all you heard was birds. It was very peaceful. I remembered that when I was on the Gamma Knife. I tried to keep very still like I was then, and to remember the names of the birds I saw, all their colors and songs. [Hal Corbett, Gamma Knife patient]

My TM classes helped me. I just cleared me mind, and focused on this flower on a porcelain dish I have at home. The idea is to blend with it, to see yourself still and peaceful like that. [Angel Fernandez, Gamma Knife patient]

Five minutes...ten...fifteen? There is little that allows patients to register with their senses how time is passing: no ticking clocks, no mechanical sounds, no shift in light or temperature, not the slightest vibration. Time is an agent whose passing is disclosed only to those outside, now chatting amiably in the control room about upcoming conferences or weekend plans, waiting for the first "shot" to run its course.[10] Inside the suite patients begin to feel suspended, drifting as though launched into a vast sea without a compass, a horizon, or stars by which to comprehend direction, or distance travelled.

I started to feel like I was floating, like I was in a space ship or something, and there was no gravity. I was excited and scared all in one...like I was beyond the earth, but not anywhere that I could really place. That song kept going through my head, about Major

11 The control consol is equipped with a primary and a back-up timer that control the duration of each Gamma Knife shot; the technology itself is thus every procedure's main timekeeper.

Tom -- you know it? -- he's floating out in space and the people on the ground can't reach him. [George Emerson, Gamma Knife patient]

I remember seeing something on TV once about the Dead Sea -- and how you could float on it on your back and not sink. That's kind of how I felt. And [that] I was turning slowly, but not in any way that I could tell in which direction. Thank God it was slow, now that I think of it -- else I might have thrown up on their million dollar machine! Hah! [Meredith Mann, Gamma Knife patient]

Clunk...rrrrrrrr -- after a segment of time indeterminate to patients (about 20 minutes) something disengages, and they slide out of the machine. The door to the suite opens, and patients hear footsteps approaching. "That's it, first shot's over -- how ya feeling?"

It was so quiet before they came in, it sounded like she [the Gamma Knife nurse] was shouting. It shook me, and I woke from this half-sleep I was in. I was immediately concerned, I thought, what's wrong, why have they stopped the procedure? Then I remembered that they did it by shots, and this was obviously the end of the first one. So I said that I was fine, and that I just nodded off a bit. [Angel Fernandez, Gamma Knife patient]

When they asked me that, all I could think of was: It's working right? It sounds a bit dumb, but that's really what I wanted to know. Because you can't tell when you're lying there...it's so quiet. They could have forgotten to turn the thing on for all you know. They should put a light or an indicator in there so that patients can see it's running. [Did you say anything at the time?] Yes, I did. I asked, 'You didn't forget to turn it on?' One of the doctors laughed, and said, 'Sure we did -- that's the magic of these machines, you don't feel anything at all.' [Susan Morrisey, Gamma Knife patient]

> My back was a little sore and I had a cramp in my leg. I told the nurse, and she came over and massaged me a bit. That felt very good. I asked how many more shots. She said three, but that they wouldn't take long. I suppose in the end it didn't, but it sure felt like it. [Juliene White, Gamma Knife patient]

> What really got me was that I couldn't tell how long I had been in the machine. Ten minutes? A half-hour? Who knows? I thought -- still before they came back in -- 'Whoa, they've forgotten about me! I'm being zapped to kingdom come!' So that's what I asked her. [Sorry, what did you ask?] Oh, how long I'd been in it, in the radiation. I asked it kind of jokingly, you know, 'You guys didn't forget about me, did you?' She [the Gamma Knife nurse] said, 'No, don't worry, we kept our eye on you.' One of the other ones said that he had gone off for lunch, but that he thought he made it back in time. I knew he was joking, though. [Bobby McLean, Gamma Knife patient]

Intervals between shots testify to concerns that patients have, ranging from physical discomfort to concerns over whether or not the Gamma Knife is working. During them patients may voice their concerns, while Gamma Knife personnel, notably the Gamma Knife nurse, attempt to placate them. Yet these intervals are in fact not observed for this purpose. Rather, they are intended to allow members of the Gamma Knife team access to the suite to recallibrate the frame and the collimator helmet for the next shot, according to the distribution protocol that the team tailors to patients' disorders before their procedures. The intervals therefore end, whether or not patients feel ready, once the next shot has been set-up, a process that typically takes no longer than five minutes. The Gamma Knife team then retreats from the suite, and once again patients are on their own.

The second shot, and those that follow, are in every structural respect

identical to the first one. Patients are again moved into the field of radiation, the suite again grows silent once the couch engages, and the passing of time again becomes hard to reckon. In the minds of patients, however, there now takes place a subtle shift, as though there had been held up for them to see, in the interval between shots, a map or a chart that plotted the course or direction of their procedures, and from which they have drawn reassurance and comfort.

> It's hard to explain how I felt, but I felt better, I wasn't feeling like I was floating around anymore. During the first shot I felt like that. I mentioned that to the nurse [after the first shot] and she said that was quite normal, many patients felt like that. She said if it made me feel uncomfortable I should try and focus on one thing. So I did -- I counted sheep, the way you do before going to sleep. That way I could figure out how long the next shot would take. It kept me mind busy and it actually worked! [Meredith Mann, Gamma Knife patient]

Patients begin also to visualize with tactical realism the machinations of the Gamma Knife.

> Weird, but I started to think of Bagdad, you know, Desert Storm, and those missiles they sent in. I think they were computer-controlled, much like the Gamma Knife in a way. I imagined the rays to be like those missiles -- very accurate, taking out just what they were supposed to take out. [Robert Mitchell, Gamma Knife patient]

> I had heard about this thing called visual therapy, where cancer patients help themselves get better by seeing the good cells munch up the bad ones. [From your Gamma Knife doctors?] No, it was from a book or a TV show, I think. But they do sort of encourage it, now that I think about it. All that talk about targets,

> rays, shots, and so on. I heard it all the time. So I started to think of the machine as this big bow and the rays like arrows. I imagined that the, my, AVM was the bulls eye. Real close so it couldn't miss. [Juliene White, Gamma Knife patient]

> I tried to visualize them, the rays, you know? First I asked myself: What shape are they, are they long, round, or what? Then I tried to imagine them being like arrows or missiles and the AVM being the target. I tried to see them shooting through the holes in that sieve thing over my head. [Julie Campbell, Gamma Knife patient]

The term "shot" gains in this visualizing process a ballistic meaning, rather than the more insidious connotations of an injection "shot." Patients see the Gamma Knife's rays, for example, as "missiles" that "shoot" or that "are shot" at close range through their helmet openings at the "target." Once invoked, these images and themes may lead patients in many directions. They mentally embellish and attempt to synthesize, for example, the size, shape, dimension, and impact of the images or metaphors that they have chosen to reconjure the Gamma Knife, its rays, its trajectory, and their disorders. A vast quasi-technical landscape seems to open before them, one that may range from what they have heard their physicians speak about to the wider world of warfare and modern military technology. Notably, patients enter this landscape with an obvious psychological filter in place, one that screens from their imaginations the haphazard, often indiscriminate nature of modern warfare -- the bombs that blow up entire towns and cities, or the missiles that go astray and miss their intended targets. Patients also limit their image-making to a distance over which technologies (such as arrows and missiles) cannot conceivably miss, and to such connotations of arch-accuracy as "surgical bombing," and to the precision-planning and careful execution that they imagine these activities to include.

Atomic bombs or a Stalin's Organ, shuddering precariously as it releases wave after wave of missiles at a target unseen and possibly on the move, are not, in other words, the kinds of technologies that Gamma Knife patients are inclined to visualize and dwell on.

At the end of the patient's last scheduled shot, when the couch moves out of the machine and the door to the suite opens one final time, members of the Gamma Knife team approach the patient projecting a sense of completion and due celebration. "Ta daaa!" the Gamma Knife nurse may announce, followed by comments such as "Well that's it" or "It's all over -- piece of cake, wasn't it?" from the nurse and other members of the team. The collimator helmet is removed, the Leksell frame is detached, and the patient is helped off the machine and out of the suite. Visitors may once again be on hand, this time to congratulate the patient with "well-done!" or "atta-boy!" The nurse invites them to "come up" to the nursing unit where "we'll see if we can find [the patient] a bed to relax and something nice to eat and drink." The atmosphere is convivial, and marks not only the "end of what is really quite a drawn-out business" for the patient, as the Gamma Knife nurse told me, but also the end of another demanding procedure for the nurse and other members of the team.

Patients are typically caught up in the celebratory nature of this moment, despite the fatigue that now inevitably sweeps over them. About to be reunited with family and friends outside the suite, they may cast their arms out wide and also call out "Ta daaa!" or ask rhetorically, "Doesn't this look more like me?" Any discomfort or embarrassment at having previously appeared with the frame and the helmet as "weird" or alien is now forgotten. "I felt like my old self again," said Joe Carpenter, "except -- *except* -- my AVM had just been zapped into history." Other patients too share this notion, one that couples for them a sense of

release from the technologies to which they have been recently consigned with a sense of having crossed a threshold that now separates the recent past, the onset and course of their suffering, from the present and future, their recovery and restoration.

> It felt really strange when they took the frame off, as if something had left me or lifted from me. I know it was probably just that I had gotten used to the pressure on my head, and that that disappeared when they took it off. But it was also like another kind of pressure dissappeared -- the emotional pressure of having this AVM, which everybody, not only myself, was feeling before. [Anne Mills, Gamma Knife patient]

> For me it was like the end of a football game, back in my college years. Everyone was crowded around me [in the nursing unit] like in a locker room. I was tired, tired, tired. I even had like these helmet-bruises on my head [from the frame]. But I wasn't thinking about them. I was thinking, 'Damn, we won -- /won -- I ran the field today' -- boy, did I ever! [Bobby McLean, Gamma Knife patient]

Shortly, patients are escorted by the Gamma Knife nurse to the nursing unit, where they typically spend the night in a ward for "observation" purposes, before being discharged the following morning. Major complications as a result of Gamma Knife treatment are not expected to befall patients during this stay in the nursing unit, due in part to the latency of the effects of gamma radiation (see Chapter One). Of the 41 patients I interviewed, eight developed headaches and nausea, perhaps the most common immediate side-effects of Gamma Knife treatment. Still, patients are kept in the nursing unit overnight "just to be on the safe side," as one team member put it. (Note also that it is with this limited hospital stay that the Gamma Knife is hailed by many sources as a major

technological advance over open-skull surgeries, which typically require due to their invasive nature up to two weeks of postoperative hospitalization.)

Patients are permitted to eat and drink "as they see fit" in the nursing unit. They may also receive visitors, and it is thus quite common to find them in the nursing unit shortly after their Gamma Knife procedures amid a huddle of family members, friends, or relatives. Most patients sleep fitfully that night, and wake in the morning to nurses and attendants who bring them breakfast and escort them to the bathroom to wash and use the bathroom. Unless the patient feels seriously unwell, he or she is discharged by 10:00 or 11:00 a.m. The patient's Gamma Knife physician and nurse typically facilitate this, by asking how he or she feels, by explaining the "do's and don'ts" that the patient should observe after leaving the hospital, and by helping the patient to 'sign out." The patient is also reminded that his or her first "postoperative" MRI procedure will be performed in about six months time, to "see where we stand," or to "check on your progress." The patient is encouraged in the meantime to "resume their normal activities" but to "take it easy -- no basketball or deep-sea diving!" If they should experience any "physical problems," also, they should not hesitate to call; the appropriate telephone numbers will be provided to them again. Following a handshake or a pat on the shoulder, the physician then leaves the patient, who then in turn gathers up what few possessions or accessories he or she might have brought along, and leaves the hospital.

Discussion

Neurosurgeon Christer Linquist comments in his review article on the Gamma Knife that actual treatment with the technology "is a non-dramatic finale

of the [entire] Gamma Knife procedure for the patient" (Linquist 1996:188). The ethnographic data that I presented above suggest that this is by no means the case. Though not dramatic in the sense that any perceivable biophysiological actions take place, Gamma Knife treatments nevertheless contain all the elements of a complex personal and psychological drama, which unfolds amid emotions, memories, and images that form and reform and shift this way and that as patients grapple with concerns and expectations, recollections of things past, and what they hear, feel, and visualize in the Gamma Knife suite. Below, I discuss this drama and its emotional, spatial, and symbolic aspects in order to understand the constructed nature of Gamma Knife procedures. My aim is to pay particular attention to the fashion in which these events (that could surely be mistaken as diagnostic in orientation -- and similar in design to an MRI procedure for example -- were it not for the discourse that surrounds them) are structured as therapeutic in orientation. To this end I introduce as an analytic framework for discussing my data Arnold Van Gennep's concept of "rites of passage," which, as we shall see, is perhaps the most appropriate and informative way to plumb this complex and rather bizarre biomedical situation.

"Rites of passage" is a term first employed by Van Gennep in his classic and pioneering account of cultural status changes and the rituals that widely accompany them (1909; trans. 1960). Since then, anthropologists and others have in many contexts revealingly identified -- from barmitzvahs in North America to initiation ceremonies in Africa -- the three stages that Van Gennep postulated as central to all rites of passage: separation (*séparation*), transition or liminalty (*marge*), and incorporation (*agrégation*). Each of these stages may be enacted both physically and psychologically, and introduce an individual or a group under their collective agency into a new, culturally prescribed identity,

status, and life (or death) phase. People ritually enact these stages, according to Van Gennep, to mark and make sense of "particular and temporary events such as pregnancy, illnesses, dangers, journeys, etc." (Van Gennep 1960:189). Such events, argued Van Gennep, are widely associated with "*territorial passage*, such as the entrance into a village or a house, the movement from one room to another, or the crossing of streets and squares" (Van Gennep 1960:192. Van Gennep's italics). A change of "social categories," whereby individuals or groups leave old identities and positions and derive new ones involves, in other words, both an actual and a symbolic change of residence, a 'fact [that] is expressed by the rites of passage in their various forms" (Van Gennep 1960:192).

It is such change in residence (and resultingly in position) that may be identified also as being at the center of all Gamma Knife procedures, and that allow one to see shaped into them the life-changing schema of a typical rite of passage. This schema can be characterized as follows:

Separation: Entrance into the Gamma Knife suite marks for patients a separation from their status *as patient-sufferers*, just as entrance into Hillcrest Hospital marks for them a separation from their status as *persons*. That is, patients are made to feel that now, as never before, they are on the brink of a new phase in their lives, a phase that spells the end of suffering and the onset of recovery, resolution, and restoration. Crucial to the shaping of this distinction are three stages of separation that collectively distance Gamma Knife procedures from "preoperative" or diagnostic procedures, and from all other places and practices in Hillcrest Hospital. The first of these stages involves patients in an actual, territorial passage via corridors and elevators from the angiographic suite (and other diagnostic sites) to the basement of Hillcrest

Hospital, which constitutes with its discreet, spacious architecture "a new world" as one patient, Meredith Mann, commented. The stationing of patients beside the door to the Gamma Knife suite marks a second, impending, stage of separation. There they are left alone as final preparations are carried out around them, for the first time in view and earshot of most members of the Gamma Knife team. Then they are wheeled into the suite, effectively crossing a symbolic threshold to a separate residence or "territorial unit" (see Van Gennep 1960:193), which is made to appear all the more separate or distinct with the warning sign on its door, its colorful decor, and the presence of its main showpiece, the large and unique-looking Gamma Knife. The placing and preparation of patients on the machine itself is also part of this second stage of separation, involving as it does the covering of the patient's eyes with the collimator helmet, and the further physical restriction of his or her body. Both these steps prevent the patient from seeing and moving, and amount thus to a sensory separation from the real or physical world.

The third and final stage of separation involves the ushering of relatives and friends in and out of the suite by members of the Gamma Knife team, who serve no less in this role as modern "guardians of the threshold" (see Van Gennep 1960:21). With a patient already on the Gamma Knife and surrounded by family, friends, or other wellwishers, the suite is briefly host to a ceremony such as precedes the start in some cultures of a pilgrimage or journey, or such as marks in others the ritual separation of people from their old residences or houses as they move into new ones (see Van Gennep 1960:23-5). By chatting with and hoping to consol the patient with thinking-of-you's and promises of gifts, by taking photographs, or even by avoiding contact with the patient, visitors to the suite enact a brief yet emotional rite of departure, secular in some

cases or accompanied by profane invocations (such as "God-speed") in others. Both patient and visitor are then (literally) separated from one another as the latter is ushered from the suite. In their footsteps soon follow the Gamma Knife personnel; once the door closes, the separation process is complete, and the patient enters a transitional or liminal phase.

Transition or liminality: Two features typically accompany periods of liminality or transition in a rite of passage, isolation and indeterminancy (see Van Gennep 1960:114, 18). Both features are evident once a Gamma Knife procedure gets underway. A patient is left alone, and is spatially isolated by thick walls and a door that is sealed from the outside, much as circumcision initiates and healing apprentices are confined in Africa and elsewhere to specially-constructed huts or lodgings for the duration of this middle phase of their initiations (see Funani 1990; Turner 1967; Van Gennep 1960). And, like these initiates, their cultural counterparts, patients occupy in the Gamma Knife suite a position between two worlds or realms, that of the sufferer and the recoverer, or the untreated and the treated. The onset for patients of silence, the suspension of time, and the feeling for many that they are floating or drifting aimlessly are further expressive of their isolated and inbetween (or liminal) position. The Gamma Knife helps shape and maintain this position in two ways: 1. by suspending the patient on the couch or operating table, much as elevated seats, biers, and other ritual platforms in various cultures suspend in an intermediary or liminal position those who are supported by them (see Van Gennep 1960:186), and, 2. by suspending the patient in a sensory vacuum, which closely resembles in its attendant darkness, lack of mobility, and the absence of sounds the insensate and indeterminate status that people (or more accurately, that nonpeople) typically hold during novitiates and other ritual

periods of confinement and isolation.

Patients also occupy a liminal or marginal position in the Gamma Knife suite in the sense that they are engaged or caught up in mental struggle, which features attempts to visualize, make sense of, and symbolize the source and nature of their therapies. Here note that patients on the Gamma Knife introduce and think about images and metaphors that are rich in connotations of liminality, suspension, or of being between worlds or concrete places. George Emerson, for example, said that "I started to feel like I was floating, like I was in a space ship or something, and there was no gravity," a feeling shared also by Meredith Mann, who felt suspended, as if on the Dead Sea. Recall also that patients are experiencing these feelings while they are visually and physically confined to the Gamma Knife and isolated in silence in the suite. Robbed thus of physical sensation, patients can be said to be in a position tantamount to that held by patients under general anesthesia, who, incidentally, are known also to feel that they are floating or suspended while laid out on that most liminal of medical platforms, the operating table.

Patients are on the Gamma Knife in a liminal or transitory position in another sense also. Clues to this are evident in the underlying theme in the visualization among patients of scenarios such as surgical bombing strikes and the Gulf War, and of objects such as "targets," "missiles," "bows," "arrows," and so on. The theme that underlies this visualization process is clearly one of war and combat, or of intense struggle, confrontation, and overcoming. Two things are important about this theme. First, it is a theme about transition, one with which Robert Mitchell, Juliene White, Julie Campbell, and other patients attempt to single out and see their disorders as disembodied targets that are *in the process of* being attacked and destroyed. Second, it is a theme that involves

transition. That is to say, patients undergo a mental transition by shaping as positive and beneficial their focus on war and combat, which embrace after all a wide range of scenarios and outcomes, including plans and missions that go wrong, targets that are missed, and battles that are lost. The theme of war and combat, in other words, is one that patients subconsciously work over and restructure in order to bar from consideration its potentially disasterous results. It is in this sense that patients also occupy in the Gamma Knife suite a position that they themselves help to suspend or separate from the world-at-large and how it realistically operates; they too help shape themselves into "becoming bodies" (see Strathern 1996:63-106).

In summary, patients are in a liminal or transitory period while isolated in the Gamma Knife suite. Alone and sensorily deprived, they lie separated from all standard or normal rules and modes of identity and being. Their position is intermediary, one that they hold "betwixt and between" (see Turner 1985:263) their former position as untreated sufferers and their future position as treated recoverers.

Incorporation: The end of a Gamma Knife procedure marks for the patient the end of his or her term as untreated person and patient, and the start of a new life-phase, of recovery and normalization. Several activities contribute spatially and symbolically to this process. There is the return into the suite of most members of the Gamma Knife team and their signalling that the treatment is complete. Unlike intervals between shots, during which the nurse and a neurosurgeon may be the only ones to enter the suite, the final shot is followed by the return into the suite of the technologist, physicists, and radio-oncologists, and of expressions ("Ta-daa!" or "It's all over") that signal to the patient the end of the procedure. Members of the team then remove the collimator helmet, and,

more importantly, the stereotactic frame from the patient's head, symbolically dismantling or reversing in the process the objectified or abstracted identity that was imposed on him or her during the framing procedure in Pre-Op. The patient can now also move without the former (physical and psychological) inhibitions that the frame imposed, and see again. These activities, which serve to end the patient's hospital ordeal, serve also to suggest the end of their ordeal as AVM sufferers, as Ann Mills implied when she commented that the removal of the frame involved the feeling that "another kind of pressure disappeared -- the emotional pressure of having this AVM."

Like escort parties that arrive to ceremoniously lead novice Buddhists or African diviners from seclusion (see for example, Van Gennep 1960; du Toit and Abdalla 1985), the Gamma Knife team then leads the patient from the Gamma Knife suite, retreating across the threshold that earlier marked the patient's entrance and seclusion in the suite. There follows a reunion of sorts, as the treated, unframed, patient is received by kin and friends amid relieved smiles and congratulatory comments. The Gamma Knife nurse promises food and drink, the lifting of a dietary taboo such as marks the incorporative phase of rites of passage in many other cultural contexts (see Van Gennep 1960: 20, 24). This food and drink the patient receives in the nursing unit, his or her last station before being discharged from Hillcrest Hospital the following morning. To this end, the patient is prepared for discharge in a fashion that symbolizes closure, or a final release from the icons and practices that marked their liminal status in the Gamma Knife suite specifically and in the hospital generally. He or she is provided first of all with a breakfast, is invited to wash and clean, and then has returned to him or her any clothes and personal possessions that were removed into the hospital's safekeeping the day before. Note how these measures and

their timing correspond, for example, with a Brahman's "return" to social life when "he takes off the signs of the novitiate (belt, stick, antelope, skin) [and] bathes and puts on new clothes" (see Van Gennep 1960:106). Moreover, like the postliminal reading or recitation to a novice Buddhist or just-ordained priest of a list of rules or desiderata, the patient's physician arrives and recounts to the patient what he or she should and should not do on leaving the hospital. This includes instruction on what to eat, what to expect in terms of minor symptoms and side effects, and how to conduct oneself for the next several weeks -- much of it communicated with confidence that "things should be just fine" and that life for the patient will prove normal and satisfying once more. And, like officiators at most incorporative ceremonies, especially religious ones, the physician does not invite the patient to speculate or ask questions about the course of their immediate futures. His questions and comments to the patient are closed-ended, prescriptive, ritualized. This done, the patient is "signed out," an act that marks with formal, institutionalized authority the end of the patient's term of hospitalization and his or her status as patient and the start of social life as full person beyond.

The schema that I have discussed above, involving separation, liminality or transition, and incorporation, also can be applied more broadly to the entrance, stay, and discharge of a Gamma Knife patient in Hillcrest Hospital. I have indicated as much by emphasizing the role and enactment of thresholds and other spatial and symbolic markers in and around Gamma Knife procedures, which mirror and reexpress the separation of patients from society when they enter a hospital, their transformation in its confines into patients or liminal diagnostic and therapeutic objects, and their incorporation at discharge back into society as people and treated subjects. Thus, passage into and

through both the Gamma Knife procedure and Hillcrest Hospital may be said to operate hand-in-hand in shaping the Gamma Knife experience into a rite of passage, one that in all likelihood is enhanced by the claimed separation or independence of biomedical thought and action from society (see Gordon 1988; Good 1995; Lock 1988).

Rites of passage such as the one I have described are not unique in biomedicine to Gamma Knife procedures or Hiilcrest Hospital. They are also evident in surgical contexts, for one, where they reach perhaps a most refined, epiphanous form. What Stefan Hirschauer (1991) has described in his article, "The Manufacture of Bodies in Surgery," for example, is no less than an elaborate rite of passage, in which patients are spatially and symbolically separated or "dislodged" from their former identities, "transformed" (through narcosis etc.) into liminal beings, and then restored or "brought back" to their bodies and the world beyond the operating theater. Katz (1981), to cite another example, shows us how rites of sterility and cleanliness before, during, and after operations help remove ambiguity and mark symbolically the territorial passage of patients through operating theaters, from medically untouched to repaired.

At work in these and other medical rites of passage is a claim to power that lies also at the core of all Gamma Knife procedures and how they are spatially and symbolically positioned -- a claim to change and transform, or, to resort one last time to the writings of Van Gennep:

> [T]o separate and to be reunited, to change form and condition, to die and to be reborn. [T]o act and to cease, to wait and rest, and then to begin acting again, *but in a different way*. [Van Gennep 1960:189. Italics added]

Gamma Knife procedures have this claim inscribed into them, into the spatial separation of patients from their diagnostic procedures, into the symbolic distinction they attain through isolating patients from the outside world, into the vocal, celebratory reunion that ends their procedures. Gamma Knife procedures are consequently shaped or positioned with a beginning, a middle, and an end as total, orderly, and complete therapeutic experiences. As such, they can been interpreted as texts or narratives close in the structure that informs how patients experience them to a classic novel or story, constructed as completed works, or, to use the words of Hans-Jost Frey, a literary theorist, "as finished products, as texts that lack nothing and in which nothing is superfluous," and from which "a reassuring wholeness begins to appear" (Frey 1996:33). Gamma Knife procedures -- their ritual structure -- invite patients to look back at their therapies as such stories, and to read their emergence from the Gamma Knife suite and Hillcrest Hospital as a definitive end, a conclusion, a synthesis established.

Conclusion

"All medical encounters, no matter how mundane, are dramatic episodes," write Carol Laderman and Marina Roseman (1996:1). This is true also of the medical encounters that I have discussed in this chapter, from encounters with media representations to framing procedures and Gamma Knife treatments. They are all witness to more than the sum of their technical parts. That is, the people who participate in them express or act out relations and meanings that transcend and deliver commentary on things beyond their immediate context (see Laderman and Roseman 1996). I have tried to illustrate

throughout this chapter that this is so. Popular and medical media are not just impartial sources of information about the Gamma Knife; they are also rich with terms and descriptions that position the technology as an advanced surgical invention that eliminates serious disorders with the power and precision of a scalpel, but without the often messy, slow, and intrusive work that the use of this classic surgical technology involves. The stereotactic framing, MRI, and angiographic procedures are in this respect also about more than the collection of clinical or diagnostic data, their primary, expressed, function. They involve, for one, the transformation of the ailing person into patient, and the consequent adoption by that person of a compliant, object-like status, whether or not he or she has been "put under." Similarly, the Gamma Knife procedure is about more than the delivery of gamma radiation to the patient's disorder. The procedure involves, as we have seen, symbolic items and actions that shape it into a rite of passage, from which patients emerge feeling altered, changed, and renewed, even though there is no physical or even clinical evidence for them to point to and support these feelings.

From start to finish, Gamma Knife procedures and the technologies with which they are carried out -- from the stereotactic frame to the Gamma Knife -- seem vastly different from other kinds of medical procedures and technologies. This is an illusion, because Gamma Knife related procedures and technologies are experienced as structurally and socially similar to other kinds of medical procedures and technologies, notably those that one would typically encounter in an operating room. Even the nature of relations between patients and Gamma Knife personnel is in this sense similar, and in no regard better expressed perhaps than when Gamma Knife personnel depart from the Gamma Knife suite and leave a patient alone in it. In doing so, personnel abstain at a

decisive moment from facing the patient person-to-person, and establish between themselves and the patient a venerable physical distance no different in essence from that conceptual distance that surgeons in operating rooms establish between themselves and their patients (cf. Benjamin 1985:233-4).

Changes in the nature of experience in biomedical settings do not follow naturally or seamlessly from change or innovation in the material conditions of biomedical practice. Rather, experience is set to change when, in some cases, the discursive and symbolic conditions around new technologies remain largely unchanged in terms of the meanings, relations of power, and practices that flow from them. Continuity in this regard sets up an emotionally charged situation, one in which patients may discover, on leaving the site of their treatments, their prospects diverging radically from the swift and emphatic intonations of repair and resolution previously impressed on them. The next chapter considers the scope and implications of this divergence.

Chapter Five

Stories With No Endings

So far I have been concerned with processes whereby the Gamma Knife and Gamma Knife treatment are associated with people, instruments, practices, powers, and proximities that traditionally characterize operating-room surgeries and their incumbents and outcomes. I have focused on several levels on which these processes of association unfold: 1. a historical level, on which the naming and enrolling of the Gamma Knife and radiosurgery have served as a means to shape the machine and its use as natural extensions of existing neurosurgical tools and traditions (Chapter Two), 2. a micro-political level, on which two similarly incisive discourses, that of the scalpel and that of the radioactive atom, serve as means for Gamma Knife team members to contest and assert claims and relations of authority and control (Chapter Three), and, 3. a symbolic and discursive level, on which surgical associations have been established through the adoption among patients of media representations, through the sequential, spatial, and conceptual nature of their hospital experiences, and through the construction of their Gamma Knife treatments as surgical-like rites of passage (Chapter Four).

This chapter explores the implications of these levels of association for patients and their experiences once they leave Hillcrest Hospital. It asks: what kinds of psychological and social implications follow for patients in the "postoperative" context from the association of their Gamma Knife treatments with surgery, surgical, and otherwise incisive discourse? It examines, in other words, the influence and impact on Gamma Knife patients of the construction of

their treatments as a form of surgery, and the difficulties that this construction poses for them once they leave Hillcrest Hospital. These difficulties, I show, stem in part from the fact that patients experience thoughts and feelings after leaving Hillcrest Hospital that fail to conform to the expectations and sense of expedience latently impressed upon them before and during their Gamma Knife procedures. The intense, exalted nature of their Gamma Knife procedures and their swift release from Hillcrest Hospital, for one, leaves patients feeling oddly alone, stranded, and steeped in bathos. Against the backdrop of a seemingly interminable wait for clinical verification of their progress, for another, awareness dawns on patients that they have left Hillcrest Hospital neither sick nor better but as people trapped somewhere between these two states, as though once more they have been consigned to the liminal, isolated phase of their Gamma Knife procedures.

The chapter shows that there exist social considerations that compound this awareness, such as the sense among patients that their kin and friends see them no longer as sufferers because they have undergone Gamma Knife surgery. Moreover, patients feel that normal, reconstituted, conduct is now expected of them, and that they can no longer maintain claims to being sick in the wake of their perception that others now see them as having undergone surgery, and as having therefore been repaired and restored to normality. Emotional tensions mount both in patients and between patients and those around them, which are in turn exacerbated in the long run by the onset of radiation-related "complications" such as loss of hearing, and an unshakeable fear among patients of experiencing another life-threatening hemorrhage.

Therefore, I am broadly concerned in this chapter with how discursive constructions in biomedicine play out beyond its local, institutional settings on

an individual and social level. To this end, the chapter presents and discusses data about patients' feelings and experiences in the context of their journeys away from Hillcrest Hospital, their first days and weeks at home, the impact of their first "postoperative" scans around six months after their treatments, and their feelings and perceived positions in relation to others after the first year. The conclusion returns to the notion of narrative construction to suggest that, in contrast to the definitively linear, bounded structure of their experiences in Hillcrest Hospital, ex-Gamma Knife patients find themselves involved over time in a seemingly infinite odyssey towards health, or in personal stories that seem never to end.

Returning Home: First Feelings and Interpretations

For Gamma Knife patients, leaving Hillcrest Hospital and undertaking the journey home constitutes a perfunctory, fleeting interlude in contrast to all that has happened to them in the last 24 hours and much that will happen in the next 24 months and beyond. Yet it is an interlude that also sets a stage, one key to the personal and social dramas that will unfold in and around patients in the near future. It is a crucial moment for feeling and reflection when, for example, a patient stands on a busy sidewalk with a tote bag in hand, her back to the manicured facade of Hillcrest Hospital, waiting for her husband to bring the car around. Then as well as later, sitting in a car or an airplane, she may well begin to ponder -- for the first time beyond the confines of the hospital itself -- over her recent experiences, and what they amount to. Mrs. Julie Campbell:

> I thought about many things [on the way home]. My getting there [to Hillcrest Hospital], the horrible frame-thing, that cold MRI

> machine, the angio procedure, and being on the Gamma Knife. In some ways it felt like so long ago since I'd been through all that, but it was really less than a day. They were like pieces of a puzzle -- my thoughts I mean. I couldn't quite put them together. Like I couldn't remember how we got from the place where they did the angio to the Gamma Knife place. I was awake, I know, I remember the nurse talking and me saying something, but for the life of me I can't remember how we got there. Did we go up or down, did we take the stairs or an elevator? I suppose it's not important. But at that time, on the way home, I thought for some reason that it was. [Did you feel different then, while you were traveling home, compared to when you were traveling to the hospital?] Yes, I felt relieved that it was over. Very relieved. And I felt a bit, I don't know, *strange* that it was over. Just like that [snaps her fingers]. [Can you say more about this feeling?] Yes, it was -- it was the closest thing to how I felt right after my divorce. Funny that I should say that, but it was really quite similar. I was glad that was over too, when it ended. We didn't have the best of relationships. But I also had this feeling afterwards, this strange feeling of emptiness or that I'd lost a part of me. Like it was cut off, this part that was making me miserable, but that was still part of me. Does that make any sense?

Mrs. Campbell is pointing to a sensation that rose from inside her as she left Hillcrest Hospital, one that speaks via analogy about being "cut off" from her recent Gamma Knife encounters and the relationships struck up in them. This sensation inspires mixed emotions: profound relief that these encounters and relationships are a thing of the past, on one hand, and regret or lament that they have ended so abruptly, on the other. Note in Mrs. Campbell's commentary how *physical* her description of these emotions is: how, like the emotions that accompanied her divorce, they signal a leave taking from some highly intimate, if unwelcome, part of her. This second part of her statement is not unrelated to the first, in which she talks about struggling to recall and puzzle together the sequence of her hospital experiences. Taken together, Mrs. Campbell appears to be saying that she felt as if her memories of the actions and attentions

impressed on her during the past 24 hours were somehow working themselves loose, as if her ability to remember was being lost or taken from her in the wake of her departure from Hillcrest Hospital.

Other patients share Mrs. Campbell's feelings on this score. Though they may articulate them differently or less vividly, they also experience feelings of detachment, severance, and even abandonment on leaving Hillcrest Hospital. Some seek naturalistic explanations for these feelings:

> I don't really remember the ride home much except that it was raining. [Sally] -- my wife -- was driving. The rain beat on the windshield and I stared at it for what must have been hours, the wipers going *thwak thwak thwak*. Weird, but I think what I felt most, then, was lonely -- this incredible loneliness. Maybe it was the rain, and the grayness. [George Emerson, ex-Gamma Knife patient]

Others place these feelings in the context of specific things that their physicians have told them:

> He [a Gamma Knife physician] told me that we'd probably only see each other again in six months time. For my first scan. That worried me immediately. I mean what if anything happened to me before then? I asked him that, and he said not to worry, to call if anything happened, or to see my doctor back in.... He was an excellent doctor and familiar with my case, he said. Still, I was worried. Suddenly it was like they'd grown disinterested in me, and were handing me down to someone else. [Paul Carter, ex-Gamma Knife patient]

Still other patients provide explanations that point to the perceived nature of their experiences in Hillcrest Hospital:

> I wouldn't exactly call it fussing, what they did. But they did pay attention to me, constantly. If it wasn't the nurse it was one of the doctors, if it wasn't one of them it was the nurse. They made me feel special, in a way, like I was the center attraction. Even when I was on the machine [the Gamma Knife] by myself -- I felt sort of special just to be there. The next day, when I left, that completely disappeared, that feeling. I stood near the entrance [of Hillcrest Hospital], I remember, waiting for my sister to bring the car around. All these people were walking in and out, and there were cabs, ambulances, and buses, and I thought, 'I'm just another one, just another job that's gone in and out.' I thought, 'the nurse -- she's probably already forgotten my name.' I think that's why I felt this feeling of being alone, alone in the world -- I was abandoned on the sidewalk. Not just after some check-up or minor thing, but after surgical treatment for this major problem [Margaret Dean, ex-Gamma Knife patient]

> The thing was -- it's hard to explain -- but the thing was that I'd just spent probably the most intense day of my life with these people, getting radiation surgery for this bomb ticking away in my head. It sounds strange to use the word 'intimate' to describe it, but that's what it was. Being undressed and dressed by them, moved around, touched, asked personal questions, and all these very intimate things. So you feel that they get to know you really well, but not just in these ways. They also know you, ah, medically speaking. They know what your problem is, where it is, how big, what it looks like, etcetera etcetera. They know you inside out. And that, I think, was a big, big comfort. But then you get out, drive away, and it hits you that you don't have that comfort anymore -- it stays back there, in the hospital -- and you realize you're on your own. You have your wife and kids and whatnot, but it's not the same. *They're* not the ones who were working on you, who have the expertise. They're not the ones who cut you off and leave you. [Michael Mansfield, ex-Gamma Knife patient]

In the first commentary in the sequence above, Mr. George Emerson displaces his feelings of "loneliness" onto the dull weather, reluctant perhaps to investigate mentally less naturalistic sources or reasons. Mr. Carter displays no such reluctance in the second commentary; he is worried because his Gamma Knife physicians appear to have "grown disinterested" in him by wanting to limit their future face-to-face interactions to his first postoperative scan in six months time.

Two sets of explanations somewhat more elaborate than the others are presented in the third and fourth commentaries. Mrs. Margaret Dean explains her feeling of loneliness with reference to the abrupt ending to the medical attention paid to her during her stay at Hillcrest Hospital, and that she retrospectively says made her feel "special" and like a "center attraction." Mr. Mansfield says almost the same thing. He stresses the "intimate" nature of his hospital experiences, which he says begins with yet also extends beyond physical and verbal handling to the medical knowledge and "expertise" displayed by his physicians. Robbed suddenly of this specialness, intimacy, and direct proximity to the competence of medical staff, both Mrs. Dean and Mr. Mansfield remember beginning and undertaking their respective journeys home feeling alone, and profoundly abandoned.

In all, these commentaries suggest that leaving Hillcrest Hospital signals a retreat from what patients perceive as a crucial locus of experience, care, and intervention. Importantly, patients imply or say outright that this is a retreat undertaken not by themselves, but by physicians and medical staff. "[I]t was like they'd grown disinterested in me," reports Mr. Carter. "I was abandoned on the sidewalk," says Mrs. Dean, using the passive tense to imply that her Gamma Knife physicians and staff did the abandoning. "They're not the ones who cut

you off and leave you," says Mr. Mansfield, expressing the same sentiment outright. Thus we may see their commentaries not just as explanations for their first feelings after exiting Hillcrest Hospital, but also as a critique of their need to exit, and the severance of patient-physician ties through institutional custom. (I discuss the nature and implications of this severance in more detail later.)

Underpinning this critique is also a sense shared by Mrs. Dean and Mr. Mansfield that the serious, (allegedly) surgical nature of their treatments contrasts sharply to their swift discharge from Hillcrest Hospital. Here note especially Mrs. Dean's comment that she was abandoned "[n]ot just after some check-up or minor thing, but after this surgical treatment for a major problem." Having just had a form of surgery for a life-threatening illness, she is saying, she deserves better than to have been thrust out onto a sidewalk. In this context, we might view the end of Gamma Knife surgery and the end of a patient's brief stay in Hillcrest Hospital as similar to that "retreat from the patient-body" that Hirschauer identifies as characteristic of the end of operating-room surgeries:

> Common to all of them [the end of operations] is the retreat from the patient-body. Towels and sponges soaked with blood are pulled out.... Sheets are collected, the operating room is tidied, and the patients are wheeled out towards the recovery room. There they will be heaved on to their beds, and leave the operating department in the direction of the intensive-care unit or the ward. [Hirschauer 1991:302-3]

Except there is a key difference: unlike the kinds of surgeries that Hirschauer describes (major cardiovascular and abdominal surgeries among other kinds), after which patients may remain in hospital for observation and care purposes

for several days or even weeks, Gamma Knife patients like Mrs. Campbell, Mr. Emerson, Mrs. Dean, and Mr. Mansfield leave the site of their "surgeries" the very next day; for them, in other words, retreat from their bodies is far more swift, emphatic, and total, and signals not just the surgeons' withdrawal from their bodies, but also the withdrawal of medical interest and support from their lives.

We will see below that there are several factors that compound this feeling of withdrawal and its impact on Gamma Knife patients, including a lack of bodily-borne evidence that undermines their sense of surgical passage and transformation in the short term, and the virtual absence of meaningful follow-up by those who carried out their Gamma Knife surgeries in the long term. These factors typically came into play once patients attempt to resume life at home and at work. Yet, the stage for this attempt is set in view of their swift discharge from a highly intense set of experiences in Hillcrest Hospital.

These experiences, as we saw in the previous chapter, involve also considerable exaltation. Patients are led to feel that they are undergoing not some mundane set of procedures, but a physical conversion that is exalted or elevated through the medium of ritual as surgical in orientation and outcome. In contrast to this feeling, discharge from Hillcrest Hospital cultivates feelings of let down and anticlimax. Leaving the locus of their "surgeries," in other words, involves for patients an experience steeped in *bathos*: that "ludicrously abrupt transition," the dictionary tells us, "from an elevated to a commonplace style" or position (see Morris 1969:112). Patients feel how this transition literally takes them from the hospital to the sidewalk and symbolically from the spatial center of therapeutic attention to its margins, or from being a body that is addressed, handled, and manipulated, however painfully and brusquely, to becoming a body that is medically passed by, ignored, or merely glanced at.

Returning home from Gamma Knife surgery involves patients in a tumble of feelings, impressions, and emotions. That medical moiety to whom they have just hours before entrusted their bodies and prospects in the most intimate fashion, the Gamma Knife team, is nowhere in sight. Moreover, by discharging patients with the reminder that they will most probably only meet next in six months time, for their first postoperative scan, the team effectively expresses its disinterest in their patients' well being at a crucial time, namely just as patients begin the long haul to recovery. Patients feel abandoned and neglected as a result. Bathos adds to these feelings; from the exalted, extraordinary position they have recently occupied, patients come swiftly down to earth to the commonplace and ordinary business of waiting on sidewalks, of getting into cars and airplanes. In all, patients begin to think and feel that their Gamma Knife physicians have rather rudely disengaged themselves from their bodies and their worries. All patients whom I interviewed reported that they experienced this disengagement as disconcerting or daunting; some, however, reported that it only began to seriously trouble them once they had returned home. The next section considers patients in the context of their return home, and how their feelings and social interactions unfold in the immediate wake of their Gamma Knife treatments.

Home: The First Days and Weeks

"It was a Saturday and I'd been home for three days. My husband had organized this barbecue, a 'celebration,' he said, 'for my coming home a new woman,'" Mrs. Mira Lowenstein, a 62-year-old Gamma Knife patient, tells me. She continues: I didn't want it at all, this fuss, and I didn't want to see any

people. I told him so. But he insisted, and said it would be good for me to be around our friends and family." In this way a homecoming from Hillcrest Hospital may be marked in a family and among friends by different perceptions of its importance or necessity. Family members and friends may feel the need to celebrate in some way, while the person for whom the celebration is held may feel exactly the opposite. What underlies this difference in perception, and how does it set the tone for interaction in the postoperative context between Gamma Knife patients and their families and friends?

This section attempts to answer these questions by exploring what Gamma Knife patients say about their homecoming, what kin and friends say, and what remains unsaid between them. It does so against the backdrop of the onset of that period of latency which involves, according to biomedical convention, a considerable delay before the "desired effects" as well as any "complications" arise from the delivery of gamma radiation (see Linquist 1996:185, quoted in Chapter One). From the Gamma Knife specialist's standpoint this period is clinically uninteresting, largely devoid of signs and outcomes that speak of the microphysiological impact of gamma radiation. For the Gamma Knife patient, however, deep and disturbing emotions ensue with the onset of this period, in part because their realization grows that they have become uninteresting objects of clinical study, and in part because this period of latency begins to act as the most unsettling form of proof yet that their recent Gamma Knife experiences constitute in their wake something far from traditional operating-room surgery. It is the interplay of emotions around these realizations that this section examines.

The barbecue that Mr. Harry Lowenstein had conceived to celebrate his wife's return home as a "new woman" went ahead. Mr. Lowenstein had done

most of the organizing; he had called and invited family members and close friends, gone to the supermarket to buy food, drinks, and charcoal for the fire, told his two teenage sons, Marty and Joe, to rake and clean up the backyard. Mr. Lowenstein had also bought a large chocolate cake for his wife, which he left in his car in the garage so that he could present it to her after the barbecue as a surprise.

The barbecue went off smoothly enough. About two dozen people arrived, relatives and close friends of both Mr. and Mrs. Lowenstein. After everyone had eaten, Mr. Lowenstein went to his car in the garage to bring out the chocolate cake. Back in the yard, where she had been minutes ago, Mrs. Lowenstein was, however, nowhere to be seen. "She said she needed to go to the bathroom," someone called out. Mr. Lowenstein, still carrying the cake, went back into the house to check. But Mrs. Lowenstein was not in the bathroom, nor, seemingly, was she anywhere in the house. So Mr. Lowenstein put down the cake, and started to search for his wife in earnest.

Mrs. Lowenstein had, in fact, gone for a short walk in the neighborhood. "She said, when she got back, that she needed to be alone for a few minutes, away from people. But I still don't understand it, why she had to just disappear like that," Mr. Lowenstein told me months later, when he and I sat down for an interview. I had asked Mr. Lowenstein if he could think of any "problems" or "changes" in his wife's behavior when she returned from her Gamma Knife surgery; it was this incident at the barbecue that he raised, and that I also later asked Mrs. Lowenstein about. Each had very different views and explanations. Mr. Lowenstein, though he conceded that his wife might need "time to herself" in the light of her "devastating" illness, felt that there existed occasions when it was inappropriate for her to exercise this need, such as the barbecue. "People start

to wonder and get funny ideas," he said, "when you -- one of the hosts -- just up and leave." Moreover, Mr. Lowenstein added that the barbecue "was an important thing for me also," and that it signaled a "new beginning for me and my relationship with my wife -- which was under a lot of strain by that time because of her illness." He had also felt snubbed when he brought out the cake and his wife was nowhere to be seen or found. "I know she didn't know about it [the cake], but giving it to her was supposed to be, you know, sort of symbolic. Instead, there were basically just crumbs left when she got back."

Mrs. Lowenstein told me that she was "sorry" that her husband had taken her disappearance from the barbecue "so badly," and that she had, after the guests had left, apologized to him. "But I also reminded him that I told him before that I didn't want any kind of celebration, that I didn't feel up to it." After the barbecue, Mrs. Lowenstein says, her husband demanded an explanation from her -- why she didn't want a celebration. "'I don't have an explanation,' I said to him, 'I just didn't feel like any hoohah.' He didn't accept that, I could see, but it was true." I asked Mrs. Lowenstein about her walk, and if she remembers thinking anything along the way.

> Yes -- and I'd prefer you don't mention this to my husband -- but I thought -- and I still do -- that it was all so *stupid,* this barbecue celebration. Even though it was sweet of my husband for thinking of it. I know that. But anyway, I thought about them coming up to me -- my brother, sister-in-law, and friends -- and patting me on the back and congratulating me as if I'd just won a prize or something. 'Gamma Knife surgery -- wow!,' they were all saying. I thought, why are they congratulating me? What are we celebrating? What was *I* supposed to be celebrating? That I was a new woman? My old self again? Look at me now [three months later] -- I'm still nowhere, I still don't know what's going on!

I asked her also about her return to the barbecue:

> I would have liked to stay out 'till everyone had left. But I couldn't, because I knew my husband and the others would get worried. So I went back, and said to everyone that I just need to stretch my legs a bit. Some of them gave me funny looks, you know, and asked me if I was OK. I said yes, just fine. What else was I supposed to say? 'No -- I'm not OK, I'm still sick, I've just had this fancy surgery and now there's nothing to show for it? *Then* they'd really have thought I was going round the bend.

One of the key aspects of Mrs. Lowenstein's comments that one should note is that she feels that other people perceive her as having undergone a major change, while she perceives herself as being "still nowhere," and as having "nothing to show" for her "fancy surgery." In sharp contrast to the views of others, who may see her as now beginning life anew -- as "a new woman" -- Mrs. Lowenstein feels that she is still grappling with her old identity and concerns as a sufferer, while others are prematurely celebrating her release from suffering. Into the conflict of perceptions and emotions that surrounds Mrs. Lowenstein's return home from Gamma Knife treatment, in other words, enter differing ideas about her medical and social status and identity. To put this another way: patients like Mrs. Lowenstein may experience on their return home the feeling that society is retracting their right to still being sick, and that it is unduly demanding an end to their time as sufferers.

Other patients and family members also report having experienced such conflicts, especially in the first days and weeks after patients return home. These conflicts have several things in common. First and most obviously, they

arise in the wake of a patient's Gamma Knife treatment. This sets them apart from other, previous, sorts of conflicts insofar as they include consideration, conscious or otherwise, of the fact that a patient has now undergone a major therapeutic event. Second, they unfold around actions (or inactions) on the part of a patient that are interpreted by others as transgressive -- typically not in a seriously flagrant fashion, yet seriously enough to offend the personal and social sensibilities of a spouse, a partner, or some other close individual. These transgressions include sudden disappearances from social events (barbecues, church, Sunday luncheons), dress styles that are perceived as inappropriate or unconventional, decisions on the patient's part to do uncharacteristic or "weird" things (go shopping at 1:00 a.m, eat four or five candy bars one after the other when he or she has never been known to have a sweet tooth), neglect of domestic or other duties that the patient had performed even up to and on the day of their departure for Hillcrest Hospital (household bills, laundry, watering plants). Third, these conflicts are typically not resolved; they are remembered even months after they occur, lingering as events that a spouse may still be struggling to understand, as Mr. Lowenstein indicated, or that a patient recalls to characterize and justify their current feelings and thoughts about themselves, as Mrs. Lowenstein indicated.

Interpretation of these kinds of conflicts and their timing might begin most appropriately with the observation that illness and healing are accompanied in certain social situations by a micro politics of resistance, in which personal suffering serves as a medium to react against local power imbalances and/or broader injustices (see Scheper-Hughes and Lock 1991; Taussig 1987; Ong 1987, 1988; Lock 1990; Kleinman and Kleinman 1991). Some expressions of resistance in this context are direct and dramatic. Aihwa Ong describes, for

example, violent episodes of spirit possession among Malaysian women working in multinational factories, and how these episodes signal opposition to the encroachment of global and regional trends on their lives and identities (Ong 1987, 1988).

Others, however, may be indirect and less dramatic. I would rank among these more subtle, indirect expressions of resistance incidents in which Gamma Knife patients overstep in small yet meaningful ways various social boundaries and conventions, attempting as they do so to counter -- with more than vague disclaimers -- the perception of others that now, in the wake of their Gamma Knife surgeries, their suffering has surely come to an end. Conversely, patients attempt through transgression to communicate the message that they wish still to be perceived as unhealed individuals. The fact that patients are loath to celebrate their homecoming -- to symbolically mark their return home among friends and family, for example, as a "new woman" -- hints at this wish. So too does the fact that patients communicate their resistance with behavior that borders on the aberrant. "When she starts dressing weird like that," said one kinsman, "I wonder about her, mentally, if you know what I mean." The brain and its state of health can be made a locus of inquiry in more ways than one. Furthermore, acts of transgression among patients ensue of course in the wake of their departure from Hillcrest Hospital -- and feelings of undue severance, abandonment, and bathos. These acts may therefore be doubly important, signaling resistance not just to the celebratory claims of others that their suffering is over, but also to the suspension of their patient privileges and the onset of a long period of medical disinterest in their bodies, let alone their feelings.

Several patients reported to me that they experienced "very little" or "no"

conflict or "problems" on their return home from their Gamma Knife treatments. Notably, these were patients whose kin reportedly understood well that Gamma Knife treatment did not signal, as one patient put it, "the be all and end all." These patients reported that their spouses, partners, or other kin grasped that they had a "long way to go," and that they would have to "hang in there" until their physicians could provide positive proof of the disappearance of their AVMs and the attending reduction of hemorrhage-related risk. Consider, for example, the following two comments, the first made by a male patient about his wife and the second by the sister of a female patient:

> No, she's been very understanding. Mostly about the fact that this is ongoing, an ongoing story, with my AVM. It doesn't just end with the treatment, it isn't just gone suddenly. And she knows that. [Why do you think she knows that?] Because she's been by my side since it started -- and she knows what it's all about, the treatment and the latency and all that. She's read all about it...really did a lot of research. In fact, she was the one that cautioned me that this wasn't going to be like real surgery, no quick-fix results or anything like that. It makes it a bit easier, I think, knowing that she knows the ropes that way.

> My family and me, we'd arranged this little homecoming thing for her, a cake and some balloons and stuff, for when she [the patient] got home. But then, like halfway through it all, she just burst into tears and said, "but I don't feel anything, I don't feel like this is over." I know *I* was surprised, that she thought we were making it out to look that way. It made me think about the kind of message we were sending her, that suddenly she's supposed to be better and not worried, you know? I always try to remember that. [] Now it's like we both understand where she stands, and that it's *still* a long way from over. That's the hard reality, but it helps when you recognize it.

Two different avenues of support and understanding are illustrated in these comments. The first leads from a kinsperson's ongoing research and grasp of the protracted nature of Gamma Knife treatment and its dissimilarities with other forms of surgery, and the second leads from a kinsperson's reflection on the "kind of message" that she and her family were creating and sending in view of their celebration of a patient's homecoming. Also note how in the first comment the patient uses the word "treatment" rather than "surgery," or "Gamma Knife surgery;" it suggest that both the patient and his wife have arrived at a mutual understanding of the dissimilarities between Gamma Knife treatment and "real surgery," which has better prepared them for the "ongoing" and unfinished nature of Gamma Knife treatment. In the second comment the same level of understanding is evident in the sister's grasp of the "hard reality" that the patient's healing process is still a "long way from over." Moreover, neither patient nor kin in both these cases reported what one might construe as transgressive behavior intended on the part of patients to signal to others their unhappiness with how they are being perceived. Comforted by the knowledge that their kin possess a more open-ended, dynamic, grasp of their treatments, in other words, patients may feel no need to resort to transgressive acts in order to signal dissatisfaction. Their status as sufferers remains socially acknowledged. Though only one aspect of their wider postoperative experiences, this kind of acknowledgment may lend itself in the long term to the making of a social environment more conducive to recovery and emotional well being than otherwise might be the case.[1]

The transition from hospital to home and the social complexities involved

[1] More detailed and comprehensive research than I was able to conduct might also in the future reveal why some postoperative interactions are more harmonious or less conflictual than others. For now, I can only speculate that some kin have grasped more fully than others the drawn-out and *un*surgical-like nature of Gamma Knife treatment and its effects, either through background research or by listening more closely to what patients are saying between the lines.

are also exacerbated for some patients, once more, by the exaltation of their treatments as "surgeries." This is most strikingly evident in view of a burden of proof that reportedly obliges patients to display some physical inscription or by-product of their surgeries, as though their words were not enough to describe and reconstruct these with credibility and authenticity. This feeling reaches its peak over the first few days and weeks after their treatments, when patients are most likely to engage others in questions and answers about their experiences at Hillcrest Hospital. Consider in this context the following statements:

> I have this friend who had open-heart surgery not so long ago, about the same time I went in for my Gamma Knife surgery. He has this big scar running down his chest -- he shows it off all the time. And it's weird -- people are fascinated, just fascinated! It doesn't matter where he is -- at work, at home, at his club -- it's become a topic of conversation, that scar. Me, on the other hand -- I have nothing to show, no scars, no nothing. Sometimes I wish I did. [Mr. Bill Moerman, ex-Gamma Knife patient]

> I kept getting this feeling that everyone, my sister and daughter included, were looking at me and saying with their eyes, 'so you had surgery, where's the scar, show us the scar' as if I was supposed to *prove* to them that I had this -- this surgery. But there weren't any. I kept having to tell them it wasn't *that* kind of surgery. [Mrs. Julie Campbell, ex-Gamma Knife patient]

> I never thought about it before afterwards, after the Gamma Knife surgery, and how it wasn't really surgery at all. *Real* surgery leaves you with -- with something...*real*. Like the time I was hospitalized back in the early seventies, for my appendix. I remember waking up all dopey and disoriented in the hospital bed [afterwards] and thinking, "Where am I, what's going on?' Then I saw the bandage down there, on the side of my stomach, and remembered what I was there for. Later my doctor brought me the appendix in a jar -- it was kinda gross really, but at least I could see the results right there, in a jar, in front of me. I kept it for quite a while, my kids loved to gross their friends out with it. [Mary-Anne Walcox, ex-Gamma

Knife patient]

These statements are made, of course, in the light of the fact that Gamma Knife surgeries leave behind on patients' bodies only four small wounds or bruises, produced by the application of the Leksell frame to their heads (see Chapter Four). These heal rapidly; typically they are no more than pinprick-like marks by the time a patient is discharged from hospital. Thus, patients return home to family and friends bearing very little in the way of icons of travail (see Kleinman 1988:68) with which to enrich and support stories about their surgeries. Such bodily icons speak also of *effect* -- the effect on a person's body of an event, a happening, an ordeal. They say, irrefutably, something dramatic has happened to me, and I have been changed as a result. Put another way, the Gamma Knife undermines, due to its noninvasive nature, the reconstruction of Gamma Knife experiences as medical "war-stories," which tend to instill -- in both the narrator and those to whom they are narrated -- the greatest appreciation for suffering, courage, and endurance when they are embellished with scars, wounds, and amputations.[2]

The comparison that some patients draw between themselves and others who do bear surgical inscriptions suggests that they see their stories (in contrast to others') as uninteresting and even boring, lacking as they allegedly do the vivid and dramatic qualities with which subjects of surgical intervention normally command social attention, credibility, and awe. In a broader light one might say that Gamma Knife patients find the reconstruction of their therapeutic narratives difficult or troublesome, especially when they feel that what is expected of them are narratives of high drama and travail. This perceived difficulty is at one level

[2] My thanks to Phoebe Platt for pointing out this connection between war stories and the (often-unspoken) use of bodily-borne evidence to support them.

rather odd. After all, Gamma Knife patients have undergone procedures -- notably the application of the Leksell frame, the angiography, and isolation in the Gamma Knife suite -- that are dramatic, painful, and vivid in their own right, and that potentially lend themselves to dramatic and vivid reconstructions. Furthermore, most patients underwent these procedures conscious and sensate. Patients like Mr. Moerman, in other words, have at their fingertips a strong rejoinder to the exhibitionism of their surgical counterparts, and ought to be able to say, "indeed, that's a fine scar, but consider this: I was awake before, during, and after my surgery, and not only could I tell you all about it, but I could tell you also what I had to put up with as a result."

Patients do not report, however, that they engage at any point in such competitive verbal exchanges, or in attempting to reconstruct their Gamma Knife encounters as more dramatic or heroic than those that friends or acquaintances have undergone in operating theaters. Why not? Mr. Moerman again provides a telling comment:

> My friends don't really want to know about my Gamma Knife surgery. Some have asked, but they get bored and distracted quickly, because I have to go into quite a lot of detail about it. I mean, it's not like regular kind of surgery where you can just say 'they took me in, cut me open, and took this out or put that in.' It's far more complicated than that...it [Gamma Knife surgery] gets you into a lot of technical stuff that most people don't follow. So you come across as trying to be superior, trying to show off what you know. That makes people feel stupid, so they shut off. So I just shut up.

Social discourse about operating-room surgeries, Mr. Moerman implies, is rooted also in the stark simplicity with which they inscribes patients, and the fact

that people are generally familiar with their rituals and outcomes. Talk about them reportedly inspires a common sense of knowing; patient and lay person both have understandable information to share and exchange. Gamma Knife surgeries, by contrast, are technically obscure. Talk about them in turn obliges a patient to introduce esoteric knowledge and information that patients feel bore their listeners and make them appear naive and "stupid." In response to this perceived contrast between common and esoteric knowledge, Gamma Knife patients may prefer to remain silent or "shut up" about their experiences and procedures, sensitive to an unspoken cultural dictum that may be used to label the informed lay person a know-it-all and a blow-hard.

There are exceptions. The wife of one Gamma Knife patient reports, for example, that her husband "couldn't stop talking" in the first couple of weeks after his treatment about the technical ins-and-outs of Gamma Knife surgery. At first she allowed him to "go on endlessly," feeling that his talking about Gamma Knife surgery provided an important outlet "for what he'd gone through." But soon she began to feel "embarrassed for him":

> People -- our best friends even -- had no idea what he was spouting off about, and they started to think he'd gone a bit dotty...talking about gamma this and targeting that, as if he thought he was a physicist or a surgeon or something. So I sat him down one afternoon and told him that I was getting embarrassed for him. Not in those words, of course. I said that maybe he should be a little more -- more, uhm, *understanding* that not everyone knew as much as he did. That it was only polite. He took it quite well, I think. He got a lot better around other people about that.

In this case, the wife of a Gamma Knife patient feels obligated to remind her husband of the cultural dictum that latently inspires other patients to remain

largely silent about their Gamma Knife experiences. She has helped, in other words, to moderate her husband's social discourse about the Gamma Knife, given her perception that it constitutes a claim to knowledge and expertise that make others feel uncomfortable or inadequate. In doing so she believes she has ultimately "saved face" for her husband (see Goffman 1961). On quite another level, however, she may well have curtailed an act of transgression similar to those I discussed above, whereby patients seek to moderately infringe social convention in order to oppose the idea that their suffering has ended.

This section set out to describe aspects of patients' experiences once they return home from their Gamma Knife treatments. It explored differences of perception between patients and kin and friends, and how these set the tone for interaction in the "postoperative" context. Typically these differences center on unspoken and divergent interpretations of the significance of patients' return home after Gamma Knife surgery. Behaving unconventionally in this context may constitute an attempt by some patients to communicate their anxieties and fears about the loss of their identities as sufferers, and to resist this loss. Others, however, may be more secure in knowing that their partners and relatives grasp the open-ended nature of their healing trajectories, and thus perceive no need to behave waywardly. Also in the context of coming home, we have seen that patients feel that the absence of bodily icons of travail undermines the credibility of their stories and narratives about their Gamma Knife encounters. This feeling further problematizes their social interactions on their return home, and may add to their alienation from those around them.

Reconnecting: The Discourse of Postoperative Imaging

From a biomedical standpoint there is little reason to image a Gamma Knife patient postoperatively before six-eight months have lapsed. An MR or angiographic scan before then would probably show no veritable signs of change given the slow-working, sub-cellular action of Gamma Knife radiation (see Chapter One). At six-eight months, however, Gamma Knife physicians do expect to see some change -- in the form of grayish-white areas (including "ghost vessels") in and around scanned disorders that tell them that radiation-induced necrosis or cell death has appropriately set in. Thus, just as patients may find themselves deep in an emotional trough after months of not knowing where they stand clinically speaking, the telephone may ring and news may come that it's time now for their first round of postoperative imaging. Such news signals for patients the start of a highly charged emotional experience, centered on what their physicians will interpret from and tell them about their brain scans. This section examines that experience, illustrating that it is, above all, a complex one. This is because it occurs not just following patients' disconnection from their Gamma Knife physicians and a long period of going without clinical verification of their status, but also in relation to the dominant role assumed by images and data abstracted from them in the postoperative meeting between physician and patient. The impact on patients of this meeting is also shaped, in other words, by the placing of images and their interpretation at the center of attention. This section therefore examines patients' interactions around six-eight months after Gamma Knife treatment in view of their overall experiential status in the postoperative context and in relation to medical images as the primary focus of their postoperative encounters with physicians.

Before I begin with my case studies, one more important introductory point must be made. The kind of postoperative meeting that I describe below is one in which patients and/or their kin are provided with evidence of positive clinical change; the news from their physicians, in other words, is "good." Two reasons underlie my focus on this kind of meeting. First, meetings in which physicians furnish evidence of positive change are, statistically speaking, more common than meetings that furnish evidence of no or adverse clinical changes. This can be extrapolated from the fact that Gamma Knife treatment for AVMs typically yields more positive than indeterminate or negative signs of clinical change at six to eight months and beyond (see postoperative figures cited in the next section from Kondziolka et al. 1993). Second, I also focus on positive meetings in order to illustrate that even in the best of situations patients and their kin find themselves dealing with numerous difficulties, from their personal feelings to their social relations with others. The scope of these difficulties will be made clear in this section and the next.

"So, ah, how was the drive up? Traffic not too bad?" I am sitting in a waiting room in Hillcrest Hospital opposite Susan de Moe, Mrs. Campbell oldest daughter, trying to start a conversation. We are the only people in the room. By now her mother is probably in the MRI machine, undergoing scanning for her first set of postoperative images. Susan's face looks pale and drawn, and she has bags under her eyes. For the better part of a year she has cared for her mother, visiting her daily, cooking and cleaning for her, cheering her up, and otherwise trying to helping her. Susan is also a secretary in a law firm, a wife, and a mother to a six-year-old boy. She stares into the glacial reaches of an Ansell Adams photograph -- the waiting room is another one of those tastefully decorated hospital spaces -- as she answers.

It was OK. There was a wreck...slowed us down for a while. She was quiet, very quiet. Nervous. Hoping. All of it lumped together. We had to stop once by the road so I could clean the lipstick she'd smeared onto her chin while we were driving. It was very bumpy. She wanted to look good, she said...healthy. She'd put on a new dress and this sweater I'd bought for her, for good luck. And she'd had her hair done...yesterday.

"Healthy? She wanted to look 'healthy'?"

Yeah, healthy. Better. She worried that if she looked, you know, sloppy and if her hair was all messed that her doctors would notice that. And put it down to her condition...her brain going. I told her they were going to look at her scans, not at her. She didn't take any notice, just carried on fussing with herself.

"In what ways is this visit important to you? What are you hoping for right now?"

Good news. I'm hoping for good news...we both are. It's gone on long enough, this waiting and more waiting. Months of it. I've told her -- how many times? -- I've told her that she's better, that the danger's past. But she doesn't believe me, she wants to hear it from her doctors. And of course she's right, I'll give her that, because what do I know? I'm no neurosurgeon. I tell her that -- that the danger's past -- to make her feel better and worry less. It's been a huge invisible vice on her life, this worrying and worrying. And there's nothing I can do. Nothing I can say. We whisper, you know. On the phone or when I'm over there, at her place, we whisper. And tiptoe around, like there's a baby asleep somewhere. I told her to turn up the ringer on her phone so she can hear it better, because sometimes she doesn't answer. You have any idea what that's like? To call someone you know is there, someone with this *thing* in their head and they don't answer? She won't do it. She says the vibrations are bad, that they could trigger

it. She refuses to do it.

Susan starts to sob quietly. I look around and offer her a paper napkin from a stack I see beside the coffee maker, which hisses and spits another percolated tear into its plaster filter as I reach over. "Thanks," she says, "and sorry. I'm not usually the teary-eyed type." "That's OK," I respond, "that's OK." Then we sit in silence, waiting in the waiting room for the news bearers to come.

The viewing box in the Department of Neurological Surgery has clipped onto it four MR images, two fresh from the MRI unit, and the other two -- "preoperative" images -- produced before Mrs. Campbell entered the Gamma Knife suite seven months ago. Dr. Platt (wearing a white doctor's coat over a suit and tie), Susan de Moe, and Mrs. Campbell -- herself fresh from the MRI unit, where she had, eyes closed and praying, lain once more in the clattering General Electric imaging machine -- stand before them; I stand behind them, off to one side. No-one speaks; we are all looking at the images, Dr. Platt perhaps more intently than the rest, pursing his lips and muttering, "mmm... mmm" now and again. What is going through Mrs. Campbell's mind at this point? Later, when we convene in a campus cafeteria before Mrs. Campbell and Susan undertake the drive back home, I ask her this question; she answers:

> Good Lord, it was like the moment of judgment. Those images, I was thinking, they hold the key to my future. And Dr. [Platt] -- he's about to read off the judgment. Then he didn't say anything for a while. Only 'mmm, mmm.' That didn't sound good, I thought. I got so terrified at that point, that the news would be bad. I was looking at the images then too. They were so bright with the light behind them. The white blobs -- there were white blobs on one of them -- I was staring at them, and they got bigger and bigger. I was thinking, 'No, no...that's the AVM -- it's grown, it's grown! Thank goodness you were there [she says to Susan], else I might have

fainted!

"Ghost vessel," Dr. Platt announces, pointing with his index finger to a streak of white on one of the new MR images. Mrs. Campbell and her daughter look at him inquiringly. "That's good, a good sign," Dr. Platt says, "means it's been involuted." Mrs. Campbell looks visibly pleased. "I didn't know what a 'ghost vessel' was or what 'involuted' meant, but the news that it was a good sign was good enough for me," she will say later. Dr. Platt continues to stare intently at the images, replacing several times the ones on the viewing box with others from manila envelopes that rest on a table behind him. They make a short warbling sound as he extracts and clips them up.

Dr. Platt steps back, and turns his attention to Mrs. Campbell. "OK, what I'm doing is this. I'm comparing the MR scans we took just before you went onto the Gamma Knife to the ones we took this morning." He turn his eyes to Susan de Moe. "The bottom line, when we compare them like this, is to establish if the target has changed or stayed the same. If it's changed we ask, 'has it changed for the better or for the worse?' If it's stayed the same, well, it's tricky to assess why. Could depend on may things, timing of the scan, the dose, etcetera." He pauses, and switches his attention back to Mrs. Campbell. The atmosphere in the room is now electric. Anticipation, hope, dread -- all the emotions that Mrs. Campbell and Susan de Moe have stored away over the past six months and longer seem to have seeped into the air.

I took her hand then, it was ice cold. And she was trembling. I felt myself getting angry. Part of me wanted to say -- scream at him -- why are you dragging this out? Don't you have any idea what you're putting her through? What she's been through already?

> Look at her, for God's sakes, *look* at her! But another part of me was saying -- to myself -- don't disturb him, he's just doing his job, he wants to get this exactly right, he wants us to know how he's going about this. [Susan de Moe]

Then Dr. Platt looks at Mrs. Campbell, and speaks: "In your case the target appears to be changing -- and for the better. That vessel there suggests it, and the necrosis that appears to be taking hold...here." Dr. Platt points at one of the scans again. "The nidus here, on this morning's scans, also looks smaller. When we get right down to it, we're talking maybe 20 to 25 percent obliteration so far. That's good. I'll want to show these scans to some of the others, but I think they'll confirm." Dr. Platt turns his attention back to Susan. "How's she been doing? OK? Good." And back to Mrs. Campbell: "Any headaches, spells of dizziness, that sort of thing? Some? Headaches or dizziness? Both? Ok. Mild, or...? Mild? Good. That's to be expected -- it fits with what we're seeing." He starts plucking the MR images from the viewing box, saying, "Let's go to my office and talk about what's next." Mrs. Campbell and Susan seem not to hear. They are hugging each other behind the doctor's back.

> When he said that finally, 'for the better,' it was -- I can't explain it...I almost burst into tears. Tears of joy. The hours and hours -- months! -- of sitting in front of the TV and lying awake in bed thinking, what's going on, what's going on, all that time just flashed in front of my eyes. I almost didn't hear what he said after that, I was so happy. [Mrs. Campbell]

> I think it just paled into insignificance, everything he said and asked her -- and me -- after that. After he said it was changing for the better, that she'd made real progress. All the worrying, her headaches and spells of dizziness -- and they really had us worrying when they happened -- just didn't seem important

anymore. They seemed light years away. [Susan de Moe]

In his office Dr. Platt outlines to Mrs. Campbell and her daughter what he expects will happen -- "clinically speaking" -- over the next six to eight months. "Further obliteration....," "necrosis....," and, "...changes that we'll pick up angiographically on your next visit." At this last comment Mrs. Campbell palls slightly. "I have to have another angio -- angiography?" Dr. Platt looks surprised that Mrs. Campbell looks surprised. "Yeah, it's routine then. More conclusive than MRI." "Oh," is Mrs. Campbell's only response. Susan reaches over and squeezes her mother's hand. "You can do it," she says quietly. At Dr. Platt she then directs a question: "So her chances are looking good now? I mean, she can carry on normally...?" Dr. Platt answers: "I would say the risk of a rebleed appears to be reduced already. She can go about doing what she normally does -- short of playing basketball or mountain climbing, I'd say. But that's not on your agenda, is it?" He smiles at Mrs. Campbell, who shakes her head to indicate that no, they are not. "So it looks promising now. But we'll have a much better idea when we -- when we image again in six months time," Dr. Platt ends his response.

Next, Mrs. Campbell asks Dr. Platt about noise, whether it could be "bad for my condition." Dr. Platt looks puzzled. Susan explains that her mother is "afraid" that noise -- like the telephone ringing, banging doors etc., -- might trigger another hemorrhage. "Oh I see," Dr. Platt says, "No, I don't think it's likely to lead to hemorrhage; we don't have any evidence for that. Really vigorous exercise maybe, but not phones ringing and so on. But, you know, if it makes you feel better..." He leaves it at that. The meeting is almost over. Dr. Platt enters some notations into Mrs. Campbell's chart, Susan asks if they can get a copy of

her mother's scans, and Dr. Platt says yes, but that there's a fee involved for making the copies. Susan asks how much, Dr. Platt says about 50 dollars, Susan says "that's OK," and Dr. Platt says that he'll have his secretary order them and sent to her. Finally, Dr. Platt stands up, walks his patient and her daughter to the department elevator, wishes them well, and says goodbye.

Before continuing with this descriptive account, let me pause briefly to discuss some of the central aspects of this meeting and others like it. First of all, they are clearly shaped by an awesome sense of anticipation, the focus on a single moment of months of waiting and not knowing. This anticipation, which embraces both hope and dread, is readily tangible, almost visceral. Mrs. Campbell and her daughter are overwhelmed into silence by it, hands grow ice cold, anger rises and clashes with reason and restraint in its wake. Note also Mrs. Campbell's comment, "I almost didn't hear what he said after that, I was so happy." In fact, "almost" is somewhat off-target: when I later mentioned Dr. Platt's questions about headaches, dizziness, and so on, Mrs. Campbell looked puzzled and said, "I don't remember those." So strong is the anticipation that patients may forget in the wake of its fulfillment that they have been asked potentially important questions about their conditions.

The MR images themselves -- both preoperative and postoperative -- clearly also play a vital role in shaping the meeting. Placed side-by-side, they visually fill in the gap between Mrs. Campbell's preoperative and postoperative life. They help establish the meeting as a symbol of continuity, in other words, that binds the past and the present. Dr. Platt's explanation to Mrs. Campbell and her daughter of what he is doing at the viewing box, namely "comparing the MR scans we took just before you went onto the Gamma Knife to the ones we took this morning" clearly reinforces this bond. In this context MR images act in a way

not unlike images one might see in a before-and-after commercial, speaking of linear progress and outcome, and of personal transcendence from disorder to order.

The relocation of the meeting to Dr. Platt's office diffuses the tension and excitement that developed around the viewing box. Loosened from the riveting visual grip of the MR images and their interpretation, the meeting now also accommodates discourse of a more personal or subjective nature. This is evident in Mrs. Campbell's questions -- the first she asks during the meeting -- about undergoing another angiogram and her fear that noise might trigger a hemorrhage. But these questions are perfunctorily dealt with. The angiogram, Dr. Platt implies in his short response, is non-negotiable. Mrs. Campbell must grit her teeth and undergo it or else risk having her progress go unmonitored. The fear of noise that Mrs. Campbell confesses to Dr. Platt dismisses with a brief reference to lack of evidence and by saying, "[b]ut, you know, if it makes you feel better..." These are, in short, extraneous issues, unrelated from a biomedical standpoint to the "true" cause and nature of Mrs. Campbell's disorder.

Clearly this meeting is rich in emotion, dialogue, visual interpretation, and that "discourse of hope" that other researchers have also observed as characteristic of exchange between biomedical physicians and their patients (see for example, Becker and Kaufman 1995; Good et al. 1990). Yet its scope does not end there; the impact of the meeting extends well beyond Hillcrest Hospital, as we learn if we continue to follow for a while in the footsteps of Mrs. Campbell and her daughter. After Dr. Platt sees them into the elevator, Mrs. Campbell and Susan de Moe retire to a campus cafeteria, where I catch up with them and ask about their feelings and impressions concerning the meeting. They excuse themselves and undertake the drive home an hour later. The next

day -- a Friday -- Mrs. Campbell and Susan go about their separate chores, both still elated by the previous day's "good news." Susan drops her son off at school and goes to work feeling as if "this huge weight" has lifted from her shoulders. Mrs. Campbell gets up earlier than usual, "chipper" for the first time in months. Among the first things she does is turn up the ringer on the telephone, giggling over her past "silliness about noise." She plans a busy day: shopping, going to the hardware store, buying flower seeds, doing a bit of gardening, cooking dinner for her daughter, grandchild, and son-in-law. Around noon she feels tired, a headache sets in. She tries to ward it off mentally, recounting Dr. Platt's words, "changing for the better, changing for the better, changing for the better...." But her headache lingers, and seeds of doubt and self-concern begin to germinate again. She wishes the scans would arrive so that she has "something visual" to pin her hopes on, to help her "ignore these cruel messages from my body."

The scans -- copies of her original MR images -- arrive ten days later, along with a bill for $55.24. Mrs. Campbell will gratefully write a check for the full amount; to her, they are "worth every cent." Why? Why are these images so important to her -- as well as to other Gamma Knife patients, many of whom report that they or their kin also requested sets of images during or after their first postoperative meetings? In Mrs. Campbell's case we have come across one reason already, namely that she would like "something visual" to pin her hopes on and to help or ignore the "cruel messages" from her body. Other patients echo this desire, saying that they would "feel a lot better" or "much happier" if they had a visual reference with which to remind themselves of their progress. "I wanted to hang onto them because they showed that the danger was getting smaller," one patient said.

Yet there are other reasons also. Once obtained, MR images may serve in the context of a patient's interaction with kin and friends as ersatz inscriptions that fill in the gap left over by the absence of bodily-borne icons of travail. They come to act, in other words, as a kind of secondary material means with which patients may lend visual credibility to their therapeutic narratives, and shape social reflection and interaction concerning their conditions and progress. Importantly, images play this role as biomedical products, bearing on them the invisible stamp of biomedical objectivity and authority. Consider the role played by postoperative images in the following two situations, for example, both of which arose shortly after patients underwent their first round of postoperative imaging. I describe these situations below as I described them in my field notes.

Situation 1:

> Mrs. [the patient] told me she got copies of her MR images in the mail last Friday. She was "very glad," she said, "because I started worrying again." She said she made lunch that Friday and invited her "best friend" and her daughter-in-law over. They'd spread out the images on the dinner table after dinner, "which I wiped down real well first." She explained that they'd sat around and looked at them "oh, for about an hour." Her daughter-in-law, she said, recommended that she get them mounted or plastic-wrapped or something so that they wouldn't get 'messed up.' "I've looked at them every day," she said, "thinking, I've got you now, I've got you now." She plans to take the images to her local neurosurgical specialist "so that he can draw a circle around the part that's dead," she said. "That way, I can see exactly where I am," she said.

Situation 2:

> We were five -- Mr. [the patient], his wife, their "middle" daughter, her husband, and some friend of the family, whose name I can't remember. They were having lunch when I got there, and offered me some. I started asking questions afterwards, trying to make them general so everyone could feel they could say something. It

was a bit awkward. [] Then I asked this question of Mr. [the patient], "Do you feel in any way different about yourself and your condition now, compared to how you felt before the [postoperative] imaging?" He thinks for a moment and then starts talking, saying, "First of all, I feel..." But he doesn't get far because his daughter butts in and says, "show him the scans." He stops, nods a bit, and his wife gets up and gets them from a drawer in the sitting room [where we are] and gives them to [the patient]. He sorts and puts them in some order, and then holds them up one-by-one for me to see. They're MR images of his brain and what's left of his AVM, nestled in the middle. He talks as he's holding them up, pointing out "the gray spot here," "the nidus you see there," and "that's necrosis, right there." When he's done with one image he puts it down and one of the others picks it up, looks at it, nods, and passes it on. Like holiday pictures. I'm thinking, this is weird. He's not saying anything about how he FEELS. He's giving me a quasi-technical rundown of the images instead. This goes on for about five minutes or so, with the others nodding and keeping quiet. Then his wife collects the images and puts them near her on the table and Mr. [the patient] stops talking. Everyone looks at me as if expecting a comment or the next question. So I ask something about the images, whether they look at them a lot, or show them to others. Yes, sometimes, they say, and the daughter starts telling a "funny story" about that. I get the feeling that she's not comfortable talking or hearing about her father's feelings, that the image-thing helped deflect that....

The extent to which postoperative images may be venerated or deified as icons of progress is profoundly evident in the first situation described above. The patient is "very glad" when the images arrive, hosts what is effectively a celebratory meal, and directs at the images over the following days a mental chant full of vindication, "I've got you now, I've got you now." Reinforced through this chant is a sense of the "otherness" of her disorder, as though it were a demon that has taken hostile refuge in her body, but that now, looking maimed, she is in a better position to exorcise. On the images the locus of her suffering materializes, in other words, as a living object that belongs to a world other than

the one that she would desperately like to inhabit, an object and its world that the images help her define and keep her distance from.

The second situation described above speaks readily of the social roles that images may play in the postoperative context. We may begin to grasp the scope of these roles by noting how the interaction changes with the introduction of the images. The patient starts to respond to my question about how and what he is feeling in the light of his postoperative imaging with "First of all, I feel..." Then he is interrupted, the suggestion is made to "show him the scans," and we wait in silence while these are quickly fetched. Once the patient is presented with the images that he then shows and begins to explain to me, he tells me not about how or what he is feeling but, rather, about what the images depict. The images have shifted the course of his answer. Displaying them to me, the patient passes over a personal account of himself and his feelings in favor of an impersonal account of the images and what they reveal to him. He adopts a role not unlike that of a Gamma Knife physician in the process of pointing out to a patient what this or that means on a scan, and what has disappeared of "the" AVM. In so doing, the patient has also adopted the physician's impersonal and detached manner of speaking about his AVM and his condition.

In this situation and others that patients have told me about, images extend social discourse about a patient beyond the realms of personal emotion and feeling. That is, talk by and about a patient need no longer be limited to what he or she feels or thinks, a highly personal and unpredictable domain that close kin, such as the daughter described above, may not wish to have opened before them -- or before strangers. Instead, social discourse can be steered with images into a safer, more objective domain, in which the collective burden of the personal and the unpredictable is removed -- or lightened at least -- in favor

of the supposedly universal and the predictable, namely medical reason and fact. In short, images help medicalize social interaction. They carry over to settings and situations beyond the confines of Hillcrest Hospital a manner of speaking and seeing -- of *knowing* -- that approximates the narrow scope of the clinical gaze shared among Gamma Knife physicians in Hillcrest Hospital, around the Gamma Knife, in review conferences, in the company of patients, and, also, with other physicians (see for evidence of this last point, Foucault 1973; Good 1994:180-4). This narrow gaze, adopted via their images, relocates patients as objects of medical interest and shuts out from their encounters -- with others and themselves -- their embodied observations and feelings about themselves and their conditions, including those that they have cultivated over the last six-eight months.

Like other biomedical patients, a Gamma Knife patient learns, with help from medical images, to think of his or her illness "in technical terms and to assess [his or her] body and its improvement objectively" (see Becker and Kaufman 1995:181. Also see Young 1981). It is possible, even accurate, to construe this learning experience as beneficial. In their embrace, Gamma Knife patients feel connected once again to their former position as patients, that they possess a means with which to ward off embodied doubts and concerns, and that help them shape their social interactions around a source of clinical verification that most kin and friends view as objective and immutable. But there is also a downside to the fashion in which images lend themselves to these benefits. That is, the authority to which they lay claim also renders patients' embodied feelings and observations suspect, casting doubt on those aspects of experience that clinical reasoning and 'fact' do not readily accommodate. Images, in other words, divide (alleged) fact and feeling so that patients may

struggle experientially to reconcile what these biomedical artifacts tell them and what their bodies tell them. The next section explores this and other observations.

Latent No Longer: Onset and Experience of "Complications"

The ultimate catastrophe that can strike a Gamma Knife patient according to that category dryly tagged in medical circles, "postoperative complications," is hemorrhage. This does happen, but not frequently. Kondziolka and his colleagues report in their review of 348 patients treated for AVMs with the Gamma Knife, for example, that 18 (5.2 percent) experienced hemorrhaging "in the latency period prior to complete obliteration" (Kondziolka et al. 1993:142). One third of those who experienced hemorrhaging died as a result between six and 29 months after their Gamma Knife surgeries.[3] From a medical standpoint, these and similar statistics signal nothing less than a spectacular advance over the surgical resection or excision of deep-seated AVMs (the main kind of AVMs treated with the Gamma Knife), which may claim a postoperative mortality in excess of five percent (and up to ten percent in some cases) due to postoperative hemorrhaging and other, related complications (see for example, Guidetti and Delitala 1980; Parkinson and Bachers 1980. See for some reasons for mortality differences between Gamma Knife surgery and surgical resection or excision, Cunha e Sa 1996; Ganz 1993:7).

That a patient has a fair chance of being spared a hemorrhage following their Gamma Knife treatments (at least in the short term) does not mean, however, that they do not fear its occurrence, nor that they are spared other

[3] These findings are consistent with other clinical reports on hemorrhaging and death related to hemorrhaging after Gamma Knife surgery (see for example, Lunsford et al. 1989; Ganz 1993:105-6).

sorts of complications such as loss of hearing, declining vision, impaired motor control, epilepsy, and/or combinations of these problems. Though these sorts of problems are reportedly rare immediately following Gamma Knife surgery (probably due to the insidious nature of gamma radiation's effects), they do surface progressively as time goes by. Kondziolka et al. (1993:141-2) report, for example, that whereas 4.4 percent of 227 patients developed "new neurological deficits" between four and 18 months after their Gamma Knife treatments, 39 percent of 112 patients "presented with a fixed neurological deficit" two years after their Gamma Knife treatments.

This section examines the onset and experience of some of these "neurological deficits" and their impact on patients' and their families' lives in the postoperative context. It presents two extended case studies. The first again involves Mrs. Campbell, and highlights the impact of a neurological deficit that her physicians think of as relatively minor, but that has major personal and social implications for both Mrs. Campbell and her daughter, son-in-law, and grandson. This case study serves also to roughly characterize the period from six to 18 months after Gamma Knife treatment. The second case study involves a Mr. Farmer who developed a progressive loss of hearing and a hand-related tremor after his Gamma Knife treatment. Again considered in biomedical circles as relatively minor and as necessary "tradeoffs," the onset and course of these complications have had profound effects on Mr. Farmer and his relations with his wife, kin, and friends. This case study serves also to characterize the period from 18 months to two years after Gamma Knife treatment. The final part of this section interprets life in the postoperative context, one year following treatment and beyond, as an act of waiting that is split between the hope for a cure and the dread of harm. This split act, the section argues, undergoes a fundamental

shift with the onset of complications and the passing of time. From a kind of waiting that once involved expectation, it argues, patients move inexorably to a cynical, less finite, kind of waiting, one in which dread begins to replace hope, and in which notions of progression are replaced by a sense of stagnation and/or decline.

The Trembling Hand: Mrs. Campbell, Susan de Moe, and Kin

Dinner on March 17th, 1996, is almost over at the de Moe's when the phone rings. Henry de Moe, Susan's husband, answers. "It's your mother," he says to Susan, "she wants to talk to you." "Tell her I'll be right there," Susan calls from the kitchen, where she is stacking dishes into the dishwasher. "She says it's urgent," Henry calls out, "something about her hand." Susan stops what she's doing, rushes toward the phone, and snatches it from her husband. Patently unconcerned, Henry de Moe relinquishes the phone and disappears into the living room, having made up his mind long ago that he will not allow his mother-in-law to turn his life -- as he alleges she has his wife's -- into "a nightmare of concern" with what he perceives as her "constant, groundless complaining and bickering." He remains angry at his mother-in-law for this reason, and at his wife for "allowing herself" to be turned into "an emotional wreck" by her mother. Susan, on the other hand, maintains that she cannot emulate her husband's "unfeeling approach" to her mother. "She's my mother, for crying out aloud," she frequently says to him. Considerable tension has arisen between the de Moe's as a result of these conflicting viewpoints.

Meanwhile Susan is trying to soothe her mother, who is crying. "It's OK, Mom, calm down, tell me what happened." "It just started shaking, just like that,

and it hasn't stopped," Mrs. Campbell says between sobs. "What's shaking?" Susan asks. "My hand! My right hand, it's trembling like a leaf!" Mrs. Campbell responds. "How long's it been doing that?" "About two hours," Mrs. Campbell says, "I didn't want to call earlier because, you know, maybe it was because I was working in the garden...maybe I strained it. But it hasn't stopped!" "Does it hurt?" Susan continues. "No, it's just shaking, but bad, I can't even hold the phone with it." After several more questions and answers along these lines, Susan promises to drive over to her mother's home, "and take things from there." This she does, and is "shocked" to see that her mother's description of her trembling right hand is quite accurate -- "it really was shaking like a leaf."

That same evening Susan calls Dr. Platt, using a number that he gave her "in case anything comes up." Dr. Platt does not answer. Instead, a recorded message informs Susan that he is attending a conference abroad, and that callers should please direct their calls to a Dr. Hansen, a "colleague," whose number follows. Susan writes down the number and dials it. She reaches Dr. Hansen, and explains in detail who she is, who her mother is, and why she is calling. Dr. Hansen listens patiently, and then suggests that Susan "bring her mother in to see him" the next day. He adds that "what you've described to me sounds like a minor neurological complication." But he would like to "check it out" in person before "saying so emphatically." And possibly schedule Mrs. Campbell for an angiogram -- two months earlier than originally planned -- to get a "better idea of how she's progressing overall." Dr. Hansen advises that Susan should concentrate on keeping her mother "calm" in the meantime, and that they she herself shouldn't "get too worried." Susan says she "will try" to do as he says, requests details on where to meet Dr. Hansen and when, thanks Dr. Hansen for his advice and his willingness to see them "so soon," and hangs up.

She goes to her mother who is sitting at the kitchen table clasping her right wrist with her left hand, perhaps to steady it, and begins to tell her what Dr. Hansen said.

Mrs. Campbell and her daughter suffer a string of emotional setbacks over the next several days and weeks. The onset of Mrs. Campbell's tremors, first of all, shatters their hope and confidence, new-found in the wake of Mrs. Campbell's first postoperative round of imaging, that she has made "real" progress and that things for them both have changed for the better. Their meeting with Dr. Hansen, though positive in the sense that he assures them that her hand-tremors are not especially serious nor unusual, and that they do not necessarily auger further complications, leave Mrs. Campbell and Susan feeling as though they have reentered the preoperative phase of her ordeal by virtue of having to acquaint themselves with a new physician, and with a new physical condition. The angiogram that Mrs. Campbell undergoes -- on Dr. Hansen's recommendation -- heightens this sense of reentry. Laid out once more in the angiographic unit amid gloved surgeons, tubes, and sanitized sheets "it all came flooding back," she says, "everything I went through the first time. It was like someone set the clock back a year." Susan's relationship with Henry, her husband, also suffers. They have several "rows" over the next few weeks, centered on their conflicting positions on the level of obligation that Susan exercises toward her mother, and the emotional toll this obligation continues to take on Susan. "When is this all going to end?" he wants to know. Susan's and Henry's six-year-old son is witness to some of these rows; he privately wishes, so his mother reports, that "grandma would just go far away and leave us alone." Mrs. Campbell senses that she is vicariously generating tension. She tells her daughter that she feels "terribly guilty" because she's

"threatening" the welfare of her daughter's marriage and family. This perception in turn strains relations between Susan and Mrs. Campbell as Susan finds herself now also having to assure her mother, with a conviction that she does not feel, that her guilt is unfounded.

Dr. Platt returns from his conference abroad in time to take over the analysis and presentation of Mrs. Campbell's angiographic images from Dr. Hansen. The images reveal no patent reason for her shaking hand. But they do indicate, according to Dr. Platt (and several of his Gamma Knife colleagues who corroborate on their interpretation), further obliteration in her AVM. "This is good news," Dr. Platt informs Mrs. Campbell and Susan, engaging them once again in a discourse of hope. "It means that the risk of a rebleed continues to be lowered." Both Mrs. Campbell and Susan are grateful to hear this. Lurking at the back of both their minds, especially with the onset of Mrs. Campbell's hand tremors, which they suspected might spell a setback of still greater proportions, is fear of another hemorrhage or a rebleed. That the angiographic results indicate ongoing progress on the AVM front thus helps Mrs. Campbell and Susan to mentally defuse the emotional anxiety that her shaking hand has ignited.

Yet the angiographic results do not eliminate this anxiety. Indeed, it is even partially reignited by the fact that Dr. Platt cannot conclusively explain to Mrs. Campbell -- neither on the basis of her angiographic results nor his wider neuroanatomical training -- why her right hand has started behaving as it has. Subsequently Mrs. Campbell begins to suspect, with considerable foreboding, that there are limits to Dr. Platt's expertise and knowledge, areas in which she has so far had unquestioned faith and respect.

> It's making me think that there are things he and the other doctors don't know -- that he couldn't tell me why I have this shaking hand. Not exactly anyway. He said it could be because of the 'natural course' of my AVM, or because of the gamma radiation. Or some other, other 'factor.' 'The brain is a complicated place,' he said. That's making me wonder about... about how much they really know. I mean, they've always been so *sure* about everything up to now. That scares me -- that there are limits. I wonder where it leaves me, what else could happen.

Susan de Moe, with whom Mrs. Campbell has shared her suspicion, sees it as her task to reinspire her mother's faith in Dr. Platt's expertise and knowledge -- and that of biomedicine in general. She rallies to this task not because of unwavering faith and respect on her part -- she privately harbors, if anything, deeper suspicions about the limits of biomedical expertise and knowledge concerning her mother -- but because she feels strongly that it would be emotionally disastrous for her mother now to lose confidence in Dr. Platt and his profession and peers.

> I have my own ideas on the subject. I've thought for a long time that they're [her mother's physicians] in the dark about many things. They're dealing with the human brain, for God's sake. But how can I agree with my mother on this? Dr. [Platt] and what he and the others know -- that's all she has left to hang onto. If she goes on questioning them it could shatter her last ounce of confidence, her last source of hope.... [So] I've told her she shouldn't worry, that maybe there are limits as she thinks, but that they still know a heck of a lot. Enough to see her through this thing. Of course they can't be totally sure about everything, I told her. But who can? He [Dr. Platt] is a good doctor. They all are. I keep telling her this. To restore her confidence -- a confidence I don't really feel, but that I know, deep down, she must have.

For the second time following her attempts to allay Mrs. Campbell's guilt about raising tensions between her daughter and her son-in-law we see Susan telling her mother something that she herself has doubts about, that she does not entirely believe in. Such situations also develop among other patients' kin, several of whom report examples in which they similarly attempt to counter reasons that patients give for their flagging confidences, or feelings of guilt and uncertainty, with reassurances that privately they set little store by. In the postoperative context, in other words, especially as the onset of complications threatens to shatter what remains of hope and conviction, interactions between patients and kin enter psychological terrain that involves at its center a process one might accurately term "altruistic hypocrisy." Kin say things for the benefit of patients and their peace of mind that privately they perceive as untrue.

Though in one sense telling such untruths is not unique -- we all may find ourselves telling what are effectively lies to cheer others up, to comfort friends or loved ones, and expect at some level such lies in return -- this act may take on added significance in the context of serious illness and its social dimensions. In the postoperative context of Gamma Knife surgery, for example, given its highly charged social and interpersonal nature, small, altruistic lies may add up to what kin perceive as elaborate deceit in the long run, which may generate in them a sense of moral anguish and entrapment. Consider the position on this issue of Mr. Roland Cornell, husband and self-appointed emotional caregiver to a Gamma Knife patient:

> I'm being a hypocrite, there's really no other word for it. She's says one thing and I tell her no, don't worry, that's not how it is. When actually I'm thinking that she's right. That I believe what she believes. Like the time she said her best friend doesn't want to come and see her anymore because she gets depressed when

> she comes. I said no no, she's probably just very busy, what with her new grandson and all. But I know that's not the reason -- she isn't coming because she *does* get depressed around [his wife].... I think maybe I should be honest with her, that all these lies and half-lies are going to catch up with us. She might turn around one day, soon, and say, 'you've been lying to me, about how I am, and what's going on, and how can I forgive you for that.' Even though I did it with the best of intentions. And what about her? What's it going to do to her if this -- this big illusion which I'm helping her build comes crashing down? What then? God, it's just a nightmare, I tell you...so much bigger than you think.

Moral order, as well as physical order, may suffer in the postoperative context. This is perhaps especially the case as postoperative complications set in and shatter patients' remaining hope and confidence, which kin then attempt to piece together against the grain of their own beliefs.

Another kind of order, about the nature and scope of physical disorder, also suffers with the onset of complications in the postoperative context. That is, up to the emergence of complications, Gamma Knife patients have consistently viewed their brains, or small portions thereof, as the locus of their disorders, limited to that highly defined "target" on which their physicians concentrate their diagnostic, therapeutic, and prognostic efforts to the virtual exclusion of all other bodily regions. On the basis of what they have learned and retained before and during their treatments, in postoperative meetings, around the dinner or kitchen table, viewing copies of their MR scans, patients have adopted in ways meaningful to them, as we have seen, the clinical gaze that so narrowly defines the source of their suffering. The conceptual boundaries that this gaze imposes are rudely pushed back or erased for patients as other regions of their bodies are now implicated -- the hand that shakes, the ears that no longer function quite as well as once they did (see case study below). Recall Mrs. Campbell's

terrified outburst in her telephone conversation with Susan de Moe: "My hand! My right hand, it's trembling like a leaf!" Her terror, surely, stems here also from a sudden realization that there exist frontiers beyond the alleged locus of her disorder and her treatment that are not immune or extraneous to their influences. Under the brunt of postoperative complications the conceptual order of disorder, cemented with biomedical notions of pathological locus and limitation, may therefore crack and fissure and leave patients standing in the rubble of a central construct of meaning and perception.

So far I have discussed some psychological and social implications of the onset of a specific complication in the postoperative context. The next case study considers these and other implications with reference to the ongoing experience of a patient who suffers from two complications, hand tremors and loss of hearing. As we shall see, his experiences around these complications tug violently at the emotional moorings with which both he and his wife attempt to secure their hopes and prospects in the postoperative context. We shall also see how their frame of reference to the Gamma Knife and Gamma Knife treatment has changed so that it conflicts with previous surgical constructions and the intonations of expedience, progress, and repair that these contained.

Lending an Ear and a Hand: A Case Study of Life Beyond the First Postoperative Year

On the way to Tahoe one weekend I stop near Sacramento at the home of John and Jean Farmer, whom I had telephoned several days earlier to request an interview. Theirs turns out to be a stucco house in a suburban neighborhood, overlooking a tree-filled yard in which birds are twittering and

singing by the dozens. On the doorstep, after I meet both Mr. and Mrs. Farmer, I comment on the yard, and the symphony of bird songs. "HE SAYS HE LIKES THE YARD AND THE BIRD-SINGING," Mrs. Farmer yells into her husband's left ear. I am taken aback. Mr. Farmer, on the other hand, is not. "Oh," he says. "The bird-singing. Yeah...I remember that. You're from the city, eh?" I am invited in, and we go and sit down in a neat and modest sitting room; the only dust around seems to have settled on an old stereo system squatting in one corner. Over the next few minutes I learn the reason for Mrs. Farmer's yelling. Mr. Farmer's hearing has deteriorated so that even his hearing-aid, when he wears it, fails to bring to him clearly and without strain the sounds and utterances of the living world. This ongoing loss of hearing, Mrs. Farmer explains, is directly related to her husband's Gamma Knife treatment, which he underwent 24 months prior to our interview.

> They say that it's because there was some spill over -- that's what they call it, "spill over" -- into his auditory nerve, from the Gamma Knife surgery. That's why he's losing his hearing. Dr. [] told us this might happen before the procedure, yes, because his -- [her husband's] -- AVM is so close to the nerve. He said it would be a risk we'd have to consider, a "trade-off." But they didn't say how bad it would get -- he didn't say "deaf," which he [her husband] just about is. [Do you think you might not have chosen the treatment if you'd known before how badly his hearing would be affected?] I don't know, it's hard to say, but probably not. It was either that -- the Gamma Knife surgery -- or facing another hemorrhage, and we -- my husband -- definitely didn't want that.[4]

[4] Progressive loss of hearing is a complication that may follow from Gamma Knife treatment as a result of gamma radiation that "spills over" into the auditory nerve, a structure well known in neurosurgical circles for its "vulnerability" to both mechanical and radiation-related manipulation (Ganz 1993:88).

The deterioration of his hearing has affected Mr. Farmer's life beyond the acts of speaking and listening, both of which Mr. Farmer has difficulties with. Gradually it emerges that some of the things that Mr. Farmer has always routinely done -- "automatic, simple things" such as answering the telephone, watching television, carrying on a conversation -- now also pose in his mind a threat to his social being. "I feel so embarrassed about not being able to hear and talk properly, like I'm getting old and senile before my time." Mr. Farmer is 57 years old.

Mr. and Mrs. Farmer tell me also about the tremors in his right hand. "They started after his hemorrhage. We knew the Gamma Knife wouldn't make them go away -- they told us that -- but we didn't expect it to get worse, and it has. He can't even hold a pen anymore," reports Mrs. Farmer. The tremors too are a source of concern and embarrassment for Mr. Farmer:

> I wonder all the time how bad it's gonna get, if it will spread up my arm, or to my left hand. My wife has to do all the bills and stuff. And golf -- I used to play a good game of golf -- I can't play anymore. People look at me as if I've got that shaking disease or something. So I keep my hand stuck in my pocket most of the time...like this.

Alongside the decline in his hearing and hand, Mr. and Mrs. Farmer tell me also about their declining hopes and certainties, based in part on their belief that they were led astray in their expectations by latent promises of a speedy return to health for Mr. Farmer. "We thought after the surgery -- the Gamma Knife surgery -- that everything was taken care of, that his AVM was gone," Mrs. Farmer says, continuing:

> Then we find out from Dr. [] that only 25% was gone -- after eight months of waiting -- and that the 'treatment must still run its course'. When I heard that, I asked him [the doctor] why they call it surgery. '*Gamma Knife surgery*.' So he tells me that they actually don't, that they prefer to say Gamma Knife *Radio*surgery. I call that splitting hairs when it suits you, that's what I call it. Of course I didn't tell him that -- I should have though.

Mr. Farmer does not recall ever having had this distinction between Gamma Knife 'surgery' and 'radiosurgery' presented to him. Before his Gamma Knife treatment, he says, he was under the impression that Gamma Knife treatment was "a kind of new surgery," an impression he reportedly cultivated from sources that included newspaper articles, his physicians, and television. He shares his wife's opinion that, in the wake of all that has happened to him, the distinction is a moot one, and that "it's much to late." He says, "I'm still not better, so what's the difference?"

Mrs. Farmer takes care of her husband in a fashion similar to her care for him before his Gamma Knife treatment -- except that she now also figures into her care taking role his progressive loss in hearing and right-hand control.

> Not much has changed, no. I still do a lot of the things that I did before he went in for the Gamma Knife -- that he once did. The groceries, the car, the yard, fixing things around the house. Stuff that before -- and now, *still* -- he shouldn't do because of the exertion and the chance of another hemorrhage. And of course I do other things related to his hearing and his hand; answering the phone, the door, doing the finances, helping him dress etcetera, etcetera. *And* I do a lot of shouting -- because he doesn't wear the hearing aid because he says it makes him look like an old man. So I shout a lot. And sit at night with the television blaring.

Mr. Farmer feels embarrassed about his need for such care taking. Again, he sees himself cast through them into a "senile" role comparable to "my father, before he died, when he was 89. Only I'm having to rely on other people to do what we did for him long before that [age]." This embarrassment extends still further, into the realms of social contact with his family, relatives, and remaining friends. "I'm an old man to them, even the ones who are my age. They go off dancing, play golf, and all these things, and I don't go along.... They don't ask anymore." The reasons that Mr. Farmer no longer does "go along" are strongly linked to his loss of hearing, his hand tremors, and to medical advice, given to him after his Gamma Knife treatment, that he should "keep physical exercise to a minimum." Yet they are also strongly linked to a feeling that his peers have grown rightfully impatient with his inabilities and "tired" of his situation:

> It's not what they say, it's what they don't say. Like my brother -- who's my age... I can -- I can feel he's got impatient with me -- that he's kinda asking, 'well, dammit, aren't you better yet -- you had this amazing new surgery, and you're *still* not better?' He doesn't have to say it in words, but it's there. The funny thing is, I don't think I can really blame him -- I would feel like that too if the shoe was on the other foot. Hearing about this damn problem for months and months, having to do this and that, and there's no end to it. Sometimes I can even hear it in my wife's voice -- *when* I hear her -- this impatience. She says I'm imagining it. but I know sometimes I'm not. I'm making the people around me sick, sick of me.

Mr. Farmer is pointing here to something profound -- to the likelihood that sick roles, whereby patients "are excused from their usual role requirements" (Cassell 1991:40) are limited and circumscribed by social perception to the onset and treatment of their illnesses, after which their right to assume that role

is gradually retracted or withdrawn. Whether or not this is true is unimportant; the feeling among people like Mr. Farmer that it is true counts, however, because it influences their perceptions of how others perceive them, namely as malingerers for whose problems -- especially in the wake of "amazing new surgery" -- they no longer have time or patience. It is this feeling that also keeps Mr. Farmer from socializing as he once did with family members and friends, for such socializing -- in which "they do things [dance, play golf] I cannot do because of my hearing, my hand, and the AVM" -- would merely increase (in Mr. Farmer's mind) their impatience and make obvious to them the extent of his malingering. He senses himself trapped thus between a rock and hard place, between the twin perceptions that he is due to be embarrassed should he attempt to do what others do, and that he continues in the meantime to embarrass himself by not attempting to do so.

Cassell, speaking about chronic illness conditions, says the following:

> The sick person may develop reclusive behaviors that further exaggerate social loss when symptoms such as social abnormalities of speech, gait, or physical appearance make social intercourse painful. On occasion the sick person may unintentionally exaggerate some symptom -- such as a speech defect -- to have an excuse to avoid social relations. [Cassell 1991:51]

I have not observed this tendency among Gamma Knife patients, even though their conditions resemble those of the chronic sufferers that Cassell is talking about. On the contrary: Mr. Farmer and other Gamma Knife patients appear to avoid social relations not by exaggerating their symptoms or complications, but on the basis of their perception that these symptoms potentially stigmatize them.

Thus Gamma Knife patients attempt, if anything, to downplay or hide their symptoms and deficits rather than exaggerate them. This may explain why Mr. Farmer is often loath to wear his hearing aid (though he has inserted it for the benefit of our interview), and why he sits throughout the interview with his right hand either buried in his trouser pocket, or in his lap, covered with his left hand. Like younger people who suffer from urinary incontinence or other chronic conditions that are socially linked (in the United States at least) to old age, Gamma Knife patients see themselves as having aged prematurely under the brunt of their complications; theirs too is a "classic instance of the responsibility stigmatized people have to manage themselves so as not to offend 'normal' people" (Mitteness and Barker 1995:196. See also Oring 1979). Such management may involve a decline in social life and the reorganization of living, increasingly, in private rather than public domains (see Mitteness and Barker 1995:203).

But what of Mr. Farmer's medical interactions? Have these perhaps taken on added significance in the light of his declining social life? I ask Mr. Farmer about his last postoperative meeting. It took place three months before our interview (and 21 months after his Gamma Knife treatment).

> I don't really remember what he [Mr. Farmer's physician] said. Just that it looked good -- the AVM -- it was almost gone. Oh yeah, I told him that it felt like the rest of my brain was almost gone too. He didn't say anything about that. Just that it -- the AVM -- was almost gone. That's what they've been saying all along. It's going, going, it's almost gone. I don't know what to think about it anymore. They say that, and then they say but there's still some risk. You know, of hemorrhage. So take it easy. I don't know what they're saying anymore. I've been waiting forever and now I'm just gonna stop waiting.

Like Mrs. Campbell and other Gamma Knife patients, Mr. Farmer also says that great anticipation, anxiety, and then elation accompanied his first postoperative meeting, six months after his treatment. Those emotions no longer surface; they have been replaced, as his comment above indicates, by cynicism and bitter confusion. The issue is not that Mr. Farmer has started to challenge biomedical reason and authority, but that he now considers his biomedical interactions as rather meaningless encounters that consistently fail to address anything other than the pathological regression of his original disorder. This regression itself is now almost meaningless to Mr. Farmer in view of his regressed hearing and right-hand control, and in view of constant cautioning from his physician that he remains at risk for hemorrhage even though its potential source is now almost completely "gone."

Therefore, Mr. Farmer's recent medical interactions have taken on added significance in relation to his declining social life only insofar as they compound an even larger sense of decline, one that signals a descent into fatalism -- "I've been waiting forever and now I'm just gonna stop waiting" -- from the vantage point of hope and expectation. This descent is one that other Gamma Knife patients also experience, especially beyond the first postoperative year, when the various adverse physical, psychological, and social processes that I have discussed seem most likely to merge, and result in a key emotional transition. The sense of awareness among patients that they have been "waiting" too long and that, like Mr. Farmer, they will "stop" or "have stopped waiting" is crucial to this transition. What does this mean? We may get a good idea by turning once more to Hans-Jost Frey, the literary theorist whose work I used in Chapter Four to interpret the ritualized construction of Gamma Knife procedures as closed-ended, highly structured linear narratives.

There are in stories and in real life, writes Frey, two kinds of waiting. The first kind involves expectation. "One waits for something, which one supposes, fears or hopes will happen" (Frey 1996:57). This kind of waiting is something that "one has to put up with for the sake of purpose...a state of lack that one wants to overcome as fast as possible." When the expectation is fulfilled, he writes, order and balance are reestablished. The second kind of waiting is different because it involves no expectation, or, because it "sets in when one has waited for something so long, without seeing any signs of imminent fulfillment, that the object of expectation begins to fade [and] waiting has become empty, mere opening onto infinite lack." The outcome of this second kind of waiting is existentially profound:

> In it lasts a present that breaks off, does not stop breaking off, because no future moment is able to develop and change the present one. Every *now*, a breaking point inaccessible to completion, rises up into emptiness. [Frey 1996:58]

It is a transition from this first kind of waiting to the second kind that Mr. Farmer almost certainly points to with his comment, "I've been waiting forever and now I'm just gonna stop waiting." Yet, as both he and other patients conceivably would agree, this transition is one that involves less an end to waiting than an end to or loss of expectation, so that the act of waiting indeed becomes "empty, mere opening onto infinite lack." Mr. Farmer's emotional state in this context represents perhaps an advance over that in which patients like Mrs. Campbell find themselves earlier on. Even then, however, strong doubts and a sense of transition beyond hope and expectation may arise, as we saw with the onset of Mrs. Campbell's complications, as harbingers of still worse to

come. Patients' experiences then do become inaccessible to completion, and begin to rise up into emptiness.

Conclusion

To fully explore patients' experiences after Gamma Knife treatment would require a longitudinal study over a period far longer than that covered in this chapter. Nevertheless, its main argument has received considerable support with a focus on patients' experiences up to two years after their Gamma Knife treatments. That patients are adversely influenced in the postoperative context by the construction of their treatments as swift, expedient, surgical-like events has been demonstrated in several respects. Focus on their departures from Hillcrest Hospital and their journeys home illustrated, for one, how the intimate and exalted nature of Gamma Knife encounters prime patients for feelings of separation and abandonment. Experiences in this light are tantamount to that withdrawal of surgical attention and contact that follows major operating-room surgeries, except that they also represent in the Gamma Knife context a more emphatic withdrawal of interest and support from patients by virtue of their swift discharge from hospital. This withdrawal sharply contradicts the intense focus and expression of care and support that patients experience at the hands of the Gamma Knife team.

The first days and weeks home typically involve patients in experiences made difficult and unsettling by the attempts of kin and friends to symbolically mark the end of their suffering, and by the perception among patients that others now expect them to behave normally. Some experiences in this period point to the construction of two different healing trajectories: one a kin-based trajectory

that equates Gamma Knife surgery more generically with traditional surgeries and their assumed expedience, the other a patient-based trajectory that leads from disengagement, bathos, and a mounting sense of being unchanged to a perceived disjuncture between Gamma Knife surgery and other surgeries. The gap between these two trajectories may lead patients to feel misunderstood and their status misperceived. Thus one might reinterpret patients' attempts to signal to others that they are not yet healed (or out of the danger zone) as attempts to bridge this gap and establish their more open-ended trajectory as a common platform of perception and interaction. Other experiences in this period involve kin who share or come to share patients' sense of trajectory, having learned beforehand or along the way that Gamma Knife surgery is a form of treatment radically different in implication and outcome from surgery as most people know it. In this instance there is no need for patients to resort to behavior that others perceive as unconventional or erratic; patient and kin share an open-ended, more dynamic view of the postoperative context.

Discussion of the coming-home period also highlighted how traditional surgery enters into social perception and interaction around issues of credibility and authenticity. Associated in name, representation, and practice with surgery as most people know it, coming home from Gamma Knife treatment places patients in a position in which they feel expected to display some classic proof or piece of evidence to show that they have "had surgery." This they cannot do due to the noninvasive nature of Gamma Knife treatment. Explaining the reasons for this lack of visual or hard evidence may in turn lead social discourse away from a common understanding of surgeries and what they entail; patients may then be viewed as showoffs or blow-hards.

At six-eight months postoperative imaging takes place. Patients learn for

the first time about the status and condition of their disorders. Even in the best-case scenarios, this learning process may involve patients and their kin in great anticipation and fear, concerned as they are that the "news" may not be good. Emotional build-up to the postoperative meeting as well as its focus almost exclusively on images and their interpretation most strongly define interaction between patient and physician. Comparing "before and after" images visually establishes continuity between the preoperative and postoperative contexts, a continuity that may not be experientially supported in the long run. Requesting and receiving copies of images, in turn, introduces into social interaction a powerful biomedical medium for visualizing and localizing disorders. Patients may adopt in viewing and sharing these images with kin and friends a quasi-biomedical role, which disengages them from their embodied observations about their disorders, and the uncomfortable emotional dynamics these observations may lead to in a family or relationship. Images serve in this sense as a means with which patients and kin reduce or avoid the emotional strain that life in the postoperative context generates. This function, as I showed, is not all beneficial, as it psychologically creates a gulf between knowing one's disorder biomedically and experiencing it emotionally and physically.

The onset of "complications" illustrates how closely on the edge of this gulf patients live. Entering the second postoperative year, patients develop complications ranging in severity from recurring headaches and a gradual loss of hearing and motor control to hemorrhage and seizures. The former are most common, and the latter less so. The physical effects of such problems combine with psychological and social considerations to further compound the difficulties of life and living in the postoperative context. Former hopes, expectations, and confidences fade rapidly, and are replaced with doubt, cynicism, and bitterness.

This transition is based in part on the emotional dread that complications give rise to, and an attending breakdown of previously-held notions of progression and movement toward resolution. It is also based, as we saw most clearly in Mr. Farmer's case, on patients' interpretation of complications as premature signs of aging, which in turn invite social stigmatization. Seeing themselves thus as unfit for public life and "old" before their time, as unstable bodies facing an uncertain future, and no longer as subjects of medical interest, Gamma Knife patients may find that they are no longer waiting as once they did with hope and expectation.

In sum, life after Gamma Knife treatment involves experiences that differ radically in form and structure from the symbolic and ritualized construction of their treatments as conclusive linear narratives that begin when they enter Hillcrest Hospital and end when they leave. These narratives, as they extend beyond the hospital, change shape, grow fluid and open-ended, blur meanings and passages previously read and understood. Extended, they feature no clear beginning, middle, or end. Some patients and kin may manage this shift or transformation in the structure of their narratives and lives more successfully than others. We have seen that this is the case, for example, where kin and patient gain mutual support from recognizing early on the unfinished nature of Gamma Knife treatment. More common and realistic, however, is the scenario in which patients approach and enter into their individual stories like readers who have been promised a denouement, a blessed apogee, before abruptly finding the last pages missing.

Chapter Six

Conclusion

This dissertation set out to examine the Gamma Knife, a technology that has been hailed in the media and by physicians as an innovative newcomer to neurosurgical frontiers in the United States and elsewhere. My objectives were twofold: to investigate processes whereby "old" or established meanings and conventions shape the Gamma Knife's present identity and use, and to explore the impact on patients of these shaping processes. The technology's name, the Gamma Knife, and the obvious way in which it ties the innovation to that most commanding of classic surgical technologies, the scalpel, served as my mental starting point. Beyond this association prevail others that link the Gamma Knife to surgical relations, practices, and characteristics. These associations combine to seriously mystify patients and their social relations in the postoperative context. This chapter summarizes the nature and impact of these associations. It discusses the theoretical contribution that the dissertation makes to the study of medicine, science, and technology, and to our grasp of changes in the meaning and practice of biomedical "surgery." The chapter also provides several recommendations that realistically may help physicians and their institutions to ameliorate or reverse the impact of adverse associations on patients. It also considers the direction that technical advances in brain surgery may take over the next ten years, and problems these advances may pose for Gamma Knife physicians and patients. The final section briefly considers how I hope to pursue further research in the field of medicine, science, and technology.

Due in part to the breadth, speed, and complex nature of technological change in the late 20th century, and the ways in which these qualities challenge our existing frameworks and patterns of understanding, writes historian David Channell in his book, *The Vital Machine,* "[t]here will be no easy answers" to questions that researchers of science, medicine, and technology pose about contemporary technological change (Channell 1991:152). I also have found this observation to be true. Like other present-day technologies, from computers to space stations, the Gamma Knife is part of changing social and cultural milieux so complex in scope that it defies pat analysis or simple conclusion.

Having said that, I have also tried in this dissertation *not* to be daunted by the complexities that confront me in writing about the Gamma Knife, since there is conceivably a point beyond which one may be held up by such complexities, and even be overwhelmed by them. I have thus tried to introduce and maintain a theoretical framework that allows room for the many complex dimensions of the Gamma Knife and for a definitive grasp of how this technology is used and what it has come to symbolize. I have primarily based this theoretical framework on the idea that changes are mediated by older, preexisting attitudes and forms of thought and interaction. Beyond the raw power of technologies to carry out some new or unprecedented function, I have argued, an interplay of established relations, perceptions, and processes influences how people construe, use, and experience them.

Among the various theories that have advanced a perspective similar to mine resides the notion that there exists a "technological imperative" that acts as a mandate for the influx and continued use of new medical technologies (see

Banta 1983; Fox and Swazey 1978; Fuchs 1968; Koenig 1988). On this score, bioethicist and medical anthropologist Barbara Koenig has written what is still, due to her cross-cultural focus and her attention to ethnographic detail, a leading exegesis of a technological imperative in action. Setting out with the observation that innovations proceed from an experimental to a standardized status, Koenig examines the introduction into hospitals in the United States and Britain of a technology called Therapeutic Plasma Exchange, and the local decisions, rituals, and narratives that stimulated its adoption and continued use (see also Barley 1988). Her argument too hinges primarily on the idea that technologies are mediated and rendered meaningful by preexisting attitudes and forms of conduct -- rather than by their "newness" alone. Diana Forsythe (in press) follows a similar line of argument. Based on her involvement in a project that set out to develop a computer system to help migraine sufferers learn about their conditions, she shows how preexisting assumptions about patients, their gender, and their perceived status as naive sufferers are "embedded" in the system's design.

Like these and other accounts, my dissertation has tried to reveal how a new kind of medical technology is routinized on the basis of prevailing ideas, practices, and conventions. It too has tried to show that the identity and use of a new technology form and "crystallize[s] over time, from many sources" (Koenig 1988:486), including the historical, the micropolitical, the symbolic, and the discursive. It too has tried to depict technological change backstage, tinkering, anxious, and, in a manner of speaking, semi-dressed, in a state that seated before public stages on which "progress" stereotypically appears in full costume and with well-rehearsed lines, one is inclined to miss.

Yet with this theoretical focus the dissertation also fills in a gap that other

accounts have created due to their overarching concern with "meaning," and its ostensible valence in defining, shaping, and making technologies "meaningful." This gap is most evident (as I suggested in Chapter One) in the literature on modern medical technologies and metaphor, which widely depicts the role of metaphoric constructions as one that renders technologies and the messages that form around them orderly, understandable, and sensible. We recall, for example, van der Geest's and Whyte's definition of metaphor, in view of the cultural packaging that certain pharmaceuticals undergo, as a mechanism that helps shift experience and perception from the inchoate to the concrete, and from the ethereal to the palpable (van der Geest and Whyte 1989:353-354). I have focused in this dissertation on quite a different kind of metaphor, a kind that appears rational and meaningful to physicians and their practices and professional relations, but that confuses, contradicts, and mystifies patients and their experiences and social relations. In the final analysis, in other words, terms such as "Gamma Knife," "radiosurgery," and "operative" and "postoperative" are more accurately seen in the broader therapeutic context as mechanisms that fail to render experiences, beyond those of physicians, meaningful and palpable. Patients ultimately encounter these as mixed metaphors, a form of construction that researchers have yet to fully engage in their studies of science, medicine, and technology.

This dissertation has also focused on aspects of medical practice that lie beyond words and terminologies. Theoretically and empirically, it has examined 1. historical conditions on which are based the emergence of the Gamma Knife as a surgical/incisive technology, 2. micropolitical relations and contestations among Gamma Knife physicians, 3. aspects of spatial, symbolic, and discursive design of Gamma Knife procedures at Hillcrest Hospital. In doing so, I have tried

to illustrate that the association to surgery and surgical technologies contained at root level in the term, "Gamma Knife," exists also in practice, in the things that Gamma Knife physicians do, and where and how they do them. I have showed this to be the case, for example, with the respect to the historical attempt by Leksell to enroll or position the Gamma Knife as a neurosurgical instrument; the dynamics of present-day Gamma Knife teamwork and the renegotiation in review conferences of relations of disciplinary power, image, and control; the choice of "Pre-Op" as a site of preparation; the conceptual distance and compliance established between patient and (neuro)surgeon in the stereotactic framing procedure; the construction of Gamma Knife treatment as a surgical-like rite of passage.

One aim behind this focus was to suggest that there exist levels beyond verbal association on which the Gamma Knife is attributed an aesthetic kinship to traditional surgical notions and conventions. Another aim was to suggest that patients' experiences are embraced by this kinship, that it maps out, in a sense, the historical affiliation of their encounters in Hillcrest Hospital. Two points can be made in the wake of this focus. First, actions as well as words cultivate a surgical aesthetic around the Gamma Knife, and, second, patients symbolize their recoveries in relation to that aesthetic, which acts as a template for defining their Gamma Knife encounters. This focus has been central to the overall aim of the dissertation, which was to reveal processes that transfer "old" or established medical meanings and symbols to new innovations and practices. In a broader light, it contributes also to our understanding of how existing ideas and relations in biomedicine serve actively in defining therapeutic experiences, and that these experiences do not simply shift direction as a result of the introduction of a "new" technology or practice. "When we suffer disease," writes Byron J. Good,

"we confront the resistance of the real world as brute fact" (Good 1994: 177). We may also confront in having our suffering biomedically addressed, however, the resistance of a medical world and its practitioners to conceptual and symbolic change as brute fact.

The implications that follow from the construction of a surgical aesthetic around the Gamma Knife were discussed in Chapter Five. It examined the influence and impact on Gamma Knife patients of the construction of their treatments as a form of surgery, and the difficulties that this construction poses for them once they leave Hillcrest Hospital. These difficulties, I showed, stem in part from the fact that after leaving Hillcrest Hospital patients experience thoughts and feelings that fail to conform to the expectations latently impressed upon them before and during their Gamma Knife procedures. Bathos, for one, features strongly in their lives and emotions once patients leave the locus of their Gamma Knife procedures, no longer occupying the exalted position that surgical associations in Gamma Knife thought and practice help cultivate.

Against the backdrop of an interminable wait for clinical verification of their progress, for another, awareness dawns on patients that they have left Hillcrest Hospital neither sick nor better but as people suspended between these two states, as though once more they have been consigned to the liminal phase of their Gamma Knife procedures. Considerations of a social kind compound this awareness, such as the sense among patients that their kin and friends see them no longer as sufferers because they have undergone a kind of "surgery." Moreover, some patients feel that normal, reconstituted, conduct is now expected of them, and that they can no longer maintain claims to being sick in the wake of their perception that others now see them as having undergone "surgery." Emotional tensions mount both in patients and between patients and

those around them, which are in turn exacerbated in the long run by the onset of radiation-related "complications" such as loss of hearing and bodily tremors -- effects that challenge their biomedically rooted notions that "disorder" is limited to the locus of their AVMs.

Chapter Five also narrowly considered another key aspect of Gamma Knife practice -- the swift discharge of patients, typically on the morning after their procedures -- but did not consider its broader implications. Identifying these might begin with the observation that a fundamental change in the position of Hillcrest Hospital (and other Gamma Knife centers) toward a growing number of patients with deep-seated AVMs is currently underway. Typically treated before the advent of radiosurgery in operating theaters, after which they remained hospitalized for up to two weeks, AVM patients are more and more likely -- if the trend toward "noninvasive brain surgeries" continues -- to experience their treatments as outpatients. Radiosurgery makes this possible, ironically, by allowing specialists to swiftly administer a form of treatment that provides no immediate benefits or drawbacks, and that entails a long period of latency before its beneficial or harmful effects can be identified and assessed. Unlike operating-room surgeries for AVMs, therefore, there is no patent clinical reason to keep patients under close observation following radiosurgery. The fact that patients might desire such observation, given the grave nature of their illnesses and their assumptions regarding the nature and consequences of "surgery," does not enter into clinical assessment.

Swift discharge from Gamma Knife centers is hailed widely in the media and by physicians as a central benefit of radiosurgery. We have seen how newspapers and medical institutions consistently promote the Gamma Knife by claiming, for example, that "it not only successfully eliminates disorders, it does

so quickly," and that patients are "basically ready to go back to work the next day" (see Chapter Four). Media that report on the Gamma Knife in the United States assume, in other words, that most of their audiences place considerable value on convenience and independence, and a desire to return quickly to work and mainstream society. I have tried to show that this assumption is gravely misplaced. Swift discharge is in several respects tantamount to medical disengagement from the postoperative lives and interests of patients, a factor that overwhelms any cultural predilection -- true or otherwise -- toward minimal hospitalization and its alleged benefits. Of course there are disadvantages to prolonged hospitalization following any form of medical intervention, not least among them a lingering, historically rooted view that hospitals (and other kinds of medical centers) are places of dying and death, which combines with other factors that question the suitability of hospitals and other medical centers as sites of prolonged care and recovery. A flip-side scenario, however, in which hospitals and medical centers disengage themselves from the postoperative emotional and social welfare of patients, is no less questionable. And perhaps it is even more so, since it follows with Gamma Knife treatment in the wake of surgical handling that has historically emphasized the hospital and the clinic as central loci of care and attention, even though such care and attention have unfolded at the level of the patient as clinical object rather than subject. This form of disengagement may thus also signal the start of a new and disturbing era in the biomedical treatment of serious brain disorders such as AVMs, in which the relationship between medical centers and patients is increasingly retracted and instrumentalized, and at the same time justified in the name of cultural priorities and preferences.

One last theoretical and empirical contribution that I wish to mention here

involves the current status of anthropological and other social science literature on biomedical surgery and surgical practices. Much of this literature is limited by historical default to a notion that biomedical surgery is something that happens only in operating rooms and around physically opened, inert patient-bodies. The meaning and significance of biomedical surgery is said to follow from these and other characteristics, governed by the "nonsocial nature" of surgeon-patient interaction and the "ritual segmentation" of patient-bodies (Goffman 1961), the "dislodgement of the patient's person" through narcosis (Hirschauer 1991:313), the "religious fervor" and God-like status of surgeons (Selzer 1974), and by other features that surround the highly evocative business of surgically opening, entering, and repairing human bodies (for further examples see, Bosk 1979; Cassell 1986, 1987; Ferrari 1987; Fischer and Peterson 1993; Freidson 1970; Katz 1981; Pouchelle, 1990; Thorwald 1956; Wilson 1954).

From this focus has emerged a rather static view of surgery, surgeons, and surgical patients, one that to some extent remains rooted in a seemingly timeless mix of blades, opened bodies, and blood. Though undoubtedly accurate before the recent influx into surgical domains of such innovations as the Gamma Knife, lasers, ultrasonic dissectors, robotic systems, and endoscopic equipment, this view is now becoming outdated. "Surgery," once defined as *Cheirourgia*, meaning hand-related work or the application of medical knowledge through handiwork (see Morris 1969), is limited no longer to the conditions of thought and practice that have sustained this definition for many decades, even centuries. "Surgery," as we have seen in this dissertation, may now also include as a designation and a praxis highly technologized, intellectual, and professionally diverse relations, activities, and outcomes. As a gateway to understanding biomedicine more broadly -- the nature and quality of

its ideas, actions, and relations -- "surgery" now needs to be approached as a term and a set of practices no longer confined to their original boundaries and meanings.

Toward Some Reflexive Recommendations

When one identifies a problem or adverse condition through empirical investigation, one is invariably confronted at the end of the day with the question, "what should be done?" This is perhaps especially the case with problems that one identifies in a medical situation, for these usually pose serious moral and practical implications that drive to the center of personal and collective well being. All the more reason, therefore, that one should carefully consider what one means by the question, "what should be done?" in a medical situation before attempting an answer. This is because the question itself can invite many hidden assumptions about who should be doing, how things should be done, and whose interests are being represented. Consider, for example, James Ferguson's telling commentary on how this question is sometimes blithely formulated in the context of policies designed, ostensibly, to alleviate Third World poverty:

> Any question of the form "what is to be done" implies both a subject and a goal, both an aim and an actor who strategizes toward that aim.... But the question of the subject, the actor who is to do the "doing," [can] remain completely unspecified. A great deal of liberal policy science fills in the gap left by this lack of specificity in its own unacknowledged way, implicitly translating the real-world question of poverty into the all too familiar, utopian form of the question: given an all-powerful and all-benevolent policy-making apparatus, what should it do to advance the interests of its poor citizens? In this form, it seems to me that the

> question is worse than meaningless -- in practice, it acts to disguise what are in fact highly partial and interested interventions as universal, disinterested, and inherently benevolent. If the question "what is to be done" has any sense, it is as a real-world tactics, not a utopian ethics. "What is to be done?" demands first of all an answer to the question, "By whom?" [Ferguson 1994:279-80]

Let me therefore begin this section with the question, "by whom?" Who should be addressing problems that may arise in and around Gamma Knife practice? Members of the Gamma Knife team? Their institutions? Gamma Knife patients? Their families and kin? The anthropologist? Some larger policy-making apparatus? The answer, clearly, will depend in large measure on the nature and locus of the problems that one reveals. For example: at the outset of Chapter Four I showed that popular media (newspaper reports, television, advertisements) and consent documents (among other means) encourage association -- ultimately to the disappointment and even bitterness of patients -- between the Gamma Knife and traditional or classic surgery. To partly counter this association the consent documents that Gamma Knife patients are provided could be reworded to avoid terms like "operation" and "surgery"; they could even include a sentence or two stressing that, despite its name, the Gamma Knife provides a form of treatment quite different from surgery as most people conceive it. Gamma Knife physicians and their institutions could implement this measure relatively easily and inexpensively.[1]

[1] Ideally, the name "Gamma Knife" itself could be changed to help minimize the technology's association with scalpels and surgeries; realistically, however, such a recommendation needs to take into account 1. that other trademark names and titles, such as "Gamma Knife radiosurgery," "Gamma Knife Society," and "Gamma Knife team" would accordingly have to change, possibly at considerable financial and symbolic expense, and, 2. that the interests of those who manufacture, sell, and use the technology may be symbolically invested in its current name, and that this investment may latently work against the adoption of a new and different name.

Not so with associations cultivated in the wider media. Though they might exercise some remedial caution by emphasizing differences between Gamma Knife treatment and surgery in their statements to news reporters, for example, Gamma Knife physicians and their institutions may prove largely ineffectual in tempering the kinds of associations that popular media draw between Gamma Knife treatment and classic surgeries (see Chapter One and Chapter Four). Furthermore, one should perhaps not expect physicians and/or their institutions to be agents of change in this regard. Their measure of corrective influence on the wider media is questionable, for one, given that these media may have found a profitable angle in also constructing a surgical aesthetic -- e.g., "The Invisible Blade" -- around the Gamma Knife, and that this aesthetic conforms at some level to broader cultural themes or preferences. Thus we see how the scale of an ostensibly small problem -- that of changing several words, a few connotations -- may assume much larger proportions when the focus of address shifts, for example, from consent documents to popular media. The answer to the question "by whom?" now also changes, from Gamma Knife physicians and their institutions to the media, media proprietors, reporters, (and audiences?) as potential agents of redress.

Another recommendation -- problematic but potentially enlightening -- that can be made on the basis of my findings is that Gamma Knife specialists recognize and pay attention to the emotional and social difficulties that their patients face once they leave Hillcrest Hospital. This will mean that physicians need to recognize the impact of metaphoric and other constructions on patients in Hillcrest Hospital, as well as the disengagement that patients experience when they leave. They will also need to recognize and accept that biomedical knowledge plays a pivotal role in the postoperative context, one that due to its

encouragement of a disembodied perspective in a highly charged personal and social world may at times detrimentally influence patients and their hopes of recovery. Recognizing and accepting these roles and processes may not be a simple task. In some respects they rub up against notions of truth and scientific authority in biomedicine. Furthermore, it is even possible, given the narrow clinical gaze subscribed to by Gamma Knife and other biomedical physicians, that they lack the language to articulate recognition and acceptance of such roles and processes since these are socially and culturally constructed, a recognition that biomedical reasoning tenaciously opposes. Nevertheless, this should not hold physicians up from inquiring after the emotional and social welfare of their patients, and how their welfare is influenced by what physicians think, say, and do in the daily interactions.

Two potential avenues of medical-based assistance to patients might follow from such inquiry. First, Gamma Knife physicians, nurses, and their institutions might play a more active role in explaining to patients what they can expect from their Gamma Knife procedures. Such explanation needs to include but also go beyond an outline of the technical steps involved in Gamma Knife procedures. Patients should be made more aware of the curiously abstract nature of Gamma Knife "surgery," and that their disorders are after treatment far from having been removed, obliterated, or "cut out." Gamma Knife physicians and nurses need to be more aware that patients may vicariously attribute a greater measure of immediacy and realism to their upcoming procedures than is accurate when they hear or overhear personnel speaking, for example, about "shots," "target," and "obliteration." At the same time, Gamma Knife personnel should take seriously the comment made by many patients following their procedures that "it was like nothing happened," rather than support and exalt

this comment with "Ta-daa!" and other overtures to the noneventful nature of Gamma Knife treatment. They should recognize that this and other comments also auger a deep and disconcerting fear among patients, namely, that nothing *did* happen, a fear that can escalate profoundly in the postoperative context. Though communication and advice would perhaps be developed best in this context by Gamma Knife nurses, given their training and experience with patients, Gamma Knife physicians also should consider and respond carefully to the impact of their spoken and unspoken associations and exaltations.

The second avenue of medical-based assistance might involve closer and more sustained contact with patients in the postoperative context. Though time and geographic constraints may make this difficult and expensive, these might be partially overcome to the benefit of patients if a telephone, computer, and/or some other system for *sustained* communication were established that allowed for a greater degree of contact and interaction between Gamma Knife physicians and/or nurses and patients than presently appears to be the case. Once established, such a system would need to accommodate the emotional and social concerns that patients and their kin experience in the postoperative context. This form of address might include, though need not always require, the specialized input of a counselor, a therapist, psychologist, or some other professional who is considered better-suited to emotional and social problems than a Gamma Knife physician or nurse. By proving more open and amenable to listening to and talking about such problems the Gamma Knife physician and\or nurse might better serve patients than "outside" professionals, given the importance that patients reportedly attach to the Gamma Knife team as a locus of expertise, management, and intimate contact.

I further recommend that Gamma Knife physicians, neurosurgeons especially, give serious thought to their changing professional roles and statuses, and the implications these changes may have for the quality of their services. I recommend this on the basis of the observations made, at various points in this dissertation, that Gamma Knife work differs considerably from surgical work as neurosurgeons have traditionally carried it out. These differences include, as I have shown, the fact that neurosurgeons come into contact (in actual Gamma Knife practice) with patients who are not anaesthetized or "put under"; they are conscious, sensate, and perceptive individuals. Their traditional inclination to handle surgical patients as nameless objects on the operating table, in other words, is not suited to Gamma Knife practice. Though the neurosurgeons whom I observed in action displayed some recognition of this difference -- by talking to patients, joking with them, using their names -- they also occasionally slipped back into a perception of patients as mere objects to be manipulated, most notably during the stereotactic framing procedure. Neurosurgeons who work with the Gamma Knife while also continuing their work in operating theaters should therefore ask themselves, for the benefit of their professional relations with patients, to what extent they carry over or transfer perceptions and forms of interaction from one site of activity and role to another, and whether what they transfer is suited on a humanistic level to those sites and roles.

Finally, Gamma Knife physicians should carefully consider for the benefit of the quality of their own working lives the nature of their relations with the tools and technologies that they work with in Gamma Knife practice. Neurosurgeons especially should pay attention to their thoughts and comments about various aspects of Gamma Knife work as mediocre, "unrewarding," and as involving

"anti-climax." These thoughts and comments signal the disappearance in the Gamma Knife context of the conditions that have traditionally lent themselves to the thrill and Promethean aura of neurosurgical repair, and the onset perhaps of an era in which these hands-on qualities will be increasingly replaced by a more mundane, even banal, set of activities.

Currently neurosurgeons may fill in the gap left over by the diminished need in Gamma Knife (or noninvasive) practice of their traditional hand-and-eye related skills with new intellectual challenges. They may in the future become increasingly preoccupied and interested in the many complexities of radiation theory and physics, in algorithms, atomic models, and mathematical equations, in reading and interpreting an ever-increasing stock of images and brain scans. In fact, some neurosurgeons expect and welcome that they are already moving in this direction. In a piece recently published in the international journal *Neurosurgery*, for example, French neurosurgeon Alim L. Benabid speculates with obvious fascination on how a "routine" surgical procedure in his field might unfold in the near future. Over two-and-half pages he describes a scenario in which a neurosurgeon called "R.B." is having a dream. In this dream R.B. prepares and carries out brain surgery in the year 2003 -- without ever coming into contact with the patient. Instead, R.B. is preoccupied and entranced with the virtuosity of the technology available to him:

> R.B. was sitting in front of the stereotactic work station: surgery this morning was aimed at treating a complex epileptogenic lesion of the left hippocampus extending to the brain stem.... R.B. typed into the computer the name of the patient and looked at the long list of items that appeared on the main screen. In front of him were listed the examinations the patient had undergone the previous days -- a three dimensional (3D) computed tomographic (CT) scan....; high-field magnetic resonance imaging (MRI); a positron emission

> tomographic (PET) scan; and magnetoencephalography (MEG). The studies had reached such a high spatial resolution that...R.B. had felt that he was looking at the screen seeing the live brain of his patient, extracted from the skull and videotaped. [Benabid 1993:660]

R.B. then proceeds to prepare for surgery by touching his computer screen to highlight, enlarge, and reangle certain areas on the images, and by instructing the computer, which responds to voice-activated commands, to select, cut, paste, and synthesize his protocol. From there R.B. goes on to admire "the impressive skills" of the robotic hand that he uses from a distance to "operate" on the patient, and how "astounding" this invention is by permitting "surgery in the depth of the brain without direct visual control" (Benabid 1993:662). The piece ends with R.B. waking up in the surgeon's lounge from this, his dream, without once having spoken to or having come into physical contact with the patient.

Though this "insider" piece might tell us more about current than future perceptions, it nevertheless also realistically anticipates an ongoing shift toward techno-intellectual preoccupation and interest among neurosurgeons.[2] This shift may in the future continue to enhance the technical accuracy and precision of "surgeries" that are carried out with technologies such as the Gamma Knife. It may also, however, further remove the patient and his or her emotional and social welfare from the neurosurgeon's domain of preoccupation, interest, and contact. Moreover, it is questionable whether neurosurgeons will in the future be as fascinated or even content with a profession and a craft that is limited to manipulating computers and robotic hands, given that some neurosurgeons are

[2] I say "realistically" because, as Dr. Richard D. Penn notes in his foreword, Benabid's predictions are "all rooted in what is currently available or being developed" (see Penn in Benabid 1993:660). Also see in this context, Jolesz and Shtern 1992.

already implying that Gamma Knife treatment is a poor substitute for hands-on work. Even though such work alone by no means guarantees the patient's welfare, it has traditionally provided the neurosurgeon with a clear-cut identity and a highly revered role. Should the trend toward swift, noninvasive surgery using technologies such as the Gamma Knife continue, it may well behoove neurosurgeons to ask what impact this trend is having on their own lives. For neurosurgeons too may find that they are increasingly alienated from the meaning and outcome of their work should it grow more abstract and intellectual than it already is at present. To help counter such alienation to their benefit and their patients', neurosurgeons should now and in the future strive to improve and sustain the quality of their relations with patients, increase their social awareness of patients' perspectives, and respond with greater sensitivity and support to questions and concerns that patients have in the postoperative context, even if these questions and concerns do not bear down directly on pathophysiological processes and outcomes.

Future Research: The Complexity of Technological Change

Before becoming a thundering avatar of global change, Schivelbusch (1977) tells us in his book, *The Railway Journey: The Industrialization of Time and Space in the 19th Century,* the railroad served a minor and inauspicious role. It was used to haul coal from mine shafts in England, in crude buckets, over short distances, dependent on human energy -- mine workers -- to push and pull its sooty cargo. The invention of steam engines in the early 1800s helped expand this role dramatically, leading to the application of the railroad to settings and industries beyond coal fields, and soon beyond England itself. By

the end of the 1800s the role of the railroad was far-reaching. People in many places began traveling faster than ever before. Personal possessions and commercial goods rumbled rather than clip-clopped overland. News and communications became less dated; the distribution of information improved. Stations, shunting yards, fuel depots, warehouses, tunnels, bridges, and housing were constructed to support the railroad, reorganizing in the process the urban and rural landscapes in which these structures appeared. New job titles emerged: the railroad worker, the shuntsman, the tapper, the station master, the conductor -- workers whose incomes and efforts helped advance those of others: financiers and farmers, merchants and mine owners, labor recruiters and land barons, colonial rulers and generals.

Alongside these changes, Schivelbusch informs, the railroad also stimulated biological, perceptual, and ideological changes. On the biological side, train travel and its toll on passengers and on-board workers led to the classification and treatment of new kinds of maladies such as "train fatigue," "railway spine," "tremors," and "accident-shock." On the perceptual side, the railroad led to a new kind of aesthetic appreciation for rural and urban landscapes, based on the speed and direction of rail travel as qualities that blurred, cut through, and cognitively reorganized landscapes. And, on the ideological side, trains and railroads served variously as symbols of national progress and innovation, and as symbols of industrial decline and exploitation.

Despite its brevity, this synopsis of Shivelbusch's brilliantly holistic account gives us a good idea of how complex and varied technologically-based changes can be, and how on many different levels -- social, economic, geographic, political, aesthetic, biological, ideological -- these changes can unfold. My ethnographic account of the Gamma Knife has tried to understand

this technology and its role in biomedicine in a fashion similarly respectful of such complexity and variation, though on a scale far less ambitious than Schivelbush's. I have limited my analysis largely to an aesthetic level, and to the ways in which established relations, perceptions, and processes have shaped the Gamma Knife and how it is experienced. My aim in the future, whether further researching the Gamma Knife or beginning a project on a different medical technology and practice, is to focus on and synthesize more fully the many dimensions of technological innovation and change in medicine. I believe that only with such focus and synthesis can one grasp with clarity and depth of understanding how new kind of technologies change things in relation to that which already exists, and how this relationship will continue in the future to command aspects of our lives and destinies.

Bibliography

Anders, George

1994 High-Tech Health: Hospitals Rush to Buy a $3 Million Device Few Patients Can Use. *The Wall Street Journal*, Wednesday, April 20, 1994: A1, A6.

Appadurai, Arjun, ed.

1986 *The Social Life of Things: Commodities in Cultural Perspective*. Cambridge: Cambridge University Press.

Arnheim, Rudolph

1969 *Visual Thinking*. Berkeley: University of California Press.

Aronowitz, Stanley

1988 *Science as Power: Discourse and Ideology in Modern Society*. Minneapolis: University of Minnesota Press.

Banta, H. David

1983 Social Science Research on Medical Technology: Utility and Limitations. *Social Science and Medicine* 17: 931-935.

Barley, Stephen R.

1988 The Social Construction of a Machine: Ritual, Superstition, Magical Thinking and other Pragmatic Responses to Running a CT Scanner. In *Biomedicine Examined*. Lock, Margaret, and Deborah Gordon, eds. Dordrecht: Kluwer Academic Publishers.

Becker, Gay, and Sharon R. Kaufman

1995 Managing an Uncertain Illness Trajectory in Old Age: Patients' and Physicians' Views of Stroke. *Medical Anthropology Quarterly* 9:2: 165-187.

Bell, David, Howard Raiffa, and Amos Tversky

1988 Descriptive, Normative, and Prescriptive Interactions. In *Decision Making: Descriptive, Normative, and Prescriptive Interactions*. Bell, David, Howard Raiffa, and Amos Tversky, eds. Pp. 9-30. Cambridge: Cambridge University Press.

Benabid, Alim L.

1993 A Routine Stereotactic Procedure in 2003. *Neurosurgery* 33:4: 660-662.

Benjamin, Walter

1985 *Illuminations*. New York: Schocken Books.

Bijker, Wiebe E., and John Law, eds.

1992 *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge: Massachusetts Institute of Technology Press.

Bosk, Charles L.

1979 *Forgive and Remember: Managing Medical Failure*. Chicago: University of Chicago Press.

Brecher, R., and E. Brecher

1969 *The Rays: A History of Radiology in the U.S. and Canada*. Baltimore: Williams and Wilkins.

Brody, Jane E.

1995 Personal Health. *New York Times*, Wednesday July 5, 1995: B6.

Cañizal, José Manuel

1996 Stereotactic Radiosurgery. In *Manual of Neurosurgery, 1996*. Compiled by Palmer, James D. Pp. 179-184. New York: Churchill Livingstone.

Casper, Monica J., and Barbara A. Koenig

in press Reconfiguring Nature and Culture: Intersections of Medical Anthropology and Technoscience Studies. *Medical Anthropology Quarterly* 10:4.

Cassell, Eric J.

1991 *The Nature of Suffering.* New York and Oxford: Oxford University Press.

1985 *Talking with Patients. Vol 1: The Theory of Doctor-Patient Communication.* Cambridge, Mass.: MIT Press.

Cassell, Joan.

1986 Dismembering the Image of God: Surgeons, Heroes, Wimps, and Miracles. *Anthropology Today* 2: 13-15.

1987 On Control, Certitude, and the "Paranoia" of Surgeons. *Culture, Medicine and Psychiatry* 11: 229-49.

Caufield, Catherine

1989 *Multiple Exposures: Chronicles of the Radiation Age.* New York: Harper and Row Publishers.

Channell, David, F.

1991 *The Vital Machine: A Study of Technology and Organic Life.* New York and Oxford: Oxford University Press.

Clarke, Adele E., and Monica J. Casper

in press From Simple Technology to Complex Arena: Classification of Pap Smears, 1917-90. *Medical Anthropology Quarterly* 10:4.

Clarke, Adele E., and Joan H. Fujimura

1992 What Tools? Which Jobs? Why Right? In *The Right Tools for the Job: At Work in Twentieth-Century Life Sciences.* Clarke, Adele E., and

Joan H. Fujimura, eds. Princeton, NJ: Princeton University Press.

Codere, Helen

1950 *Fighting with Property.* New York: J.J. Augustin.

Coser, Rose L.

1972 Authority and Decision-Making in a Hospital: A Comparative Analysis. In *Medical Men and Their Work.* Freidson, E., and J. Lorber, eds. Pp. 175-184. Chicago and New York: Aldine-Atherton.

Crichton, Michael

1970 *Five Patients: The Hospital Explained.* New York: Ballantine Books.

Cunha e Sa, Manuel

1996 The Management of Cerebral Arteriovenous Malformations. In *Manual of Neurosurgery, 1996.* Compiled by Palmer, James D. Pp. 471-475. New York: Churchill Livingstone.

Dantendorfer, Karl, Daniela Wimberger, Heinz Katschnig, and Herwig Imhoff

1991 Claustrophobia in MRI Scanners. *The Lancet* 338, September: 761-2.

Douglas, Mary, ed.

1991 *Constructive Drinking: Perspectives on Drink from Anthropology.* Cambridge: Cambridge University Press.

Douglas, Mary

1966 *Purity and Danger: An Analysis of Concepts of Pollution and Taboo.* London: Routledge and Kegan Paul.

du Toit, B. M., and I.H. Abdalla, eds.

1985 *African Healing Strategies.* New York: Trado-Medic Books.

Duffy, John

1993 *From Humors to Medical Science: A History of American Medicine.* Urbana and Chicago: University of Illinois Press.

Elekta Annual Report

1991-92 Elekta Annual Report. Atlanta and Stockholm: Elekta Incorporated.

Escobar, Arturo

1994 Welcome to Cyberia: Notes on the Anthropology of Cyberculture. *Current Anthropology* 35:3: 211-231.

Ferguson, James

1994 *The Anti-Politics Machine: "Development," Depoliticization, and Bureaucratic Power in Lesotho.* Minneapolis and London: University of Minnesota Press.

Fernandez, James W.

1986 *Persuasions and Performances: The Play of Tropes in Culture.* Bloomington: Indiana University Press.

Ferrari, G.

1987 Public Anatomy Lessons and the Carnival: The Anatomy Theatre of Bologna. *Past and Present* 117: 50-106.

Fishbain, David A., Myron Golberg, Elise Labbé, Diane Zacher, Renee Steele-Rosomoff, and Hubert Rosomoff

1988 Long-Term Claustrophobia Following Magnetic Resonance Imaging. *American Journal of Psychiatry* 145:8: 1038-1039.

Fisher, Bradley J., and Constance Peterson

1993 She Won't Be Dancing Much Anyway: A Study of Surgeons, Surgical Nurses, and Elderly Patients. *Qualitative Health Research* 3:2:

165-183.

Fishman, Steve

1988 *A Bomb in My Brain: A Heroic Tale of Science, Surgery, and Survival.* New York: Charles Scribner's Sons.

Forsythe, Diana E.

in press New Bottles, Old Wine: Hidden Cultural Assumptions in a Computerized Explanation System for Migraine. *Medical Anthropology Quarterly* 10:4.

Foucault, Michel

1973 *The Birth of the Clinic. An Archeology of Medical Perception.* New York: Random House.

Fox, Renée C., and Judith P. Swazey

1978 *The Courage to Fail: A Social View of Organ Transplants and Dialysis.* 2nd edition. Chicago: University of Chicago Press.

Franklin, Sarah

1995 Science as Culture, Cultures of Science. *Annual Review of Anthropology* 24: 163-184.

Freidson, Eliot

1970 *Professional Dominance: The Social Structure of Medical Care.* New York: Atherton.

Freidson, Eliot, and Ruford Rhea

1972 Processes of Control in a Company of Equals. In *Medical Men and Their Work.* Freidson, Eliot, and J. Lorber, eds. Pp. 185-199. Chicago and New York: Aldine-Atherton.

Frey, Hans-Jost

1996 *Interruptions.* New York: State University of New York Press.

Fuchs, Victor R.

1968 The Growing Demand for Medical Care. *New England Journal of Medicine* 279: 190-195.

Funani, Lumka Sheila

1990 *Circumcision among the Ama-Xhosa*. Braamfontein, South Africa: Skotaville Publishers.

Gaines, Atwood D., and Robert A. Hahn

1982 Physicians of Western Medicine: Introduction. *Culture, Medicine and Psychiatry* 6: 215-218.

Ganz, Jeremy C.

1993 *Gamma Knife Surgery: A Guide for Referring Physicans*. Wien and New York: Springer-Verlag.

Garfield, John

1996 The Wessex Confessional: How to Get Into/Get out of/Stay out of Trouble in Aneurysm Surgery. *In Manual of Neurosurgery, 1996*. Compiled by James D. Palmer. New York: Churchill Livingstone.

Geertz, Clifford

1973 *The Interpretation of Cultures*. New York: Basic Books.

Ginsberg, Faye D., and Rayna Rapp, eds.

1995 *Conceiving the New World Order: The Global Politics of Reproduction*. Berkeley: University of California Press.

Glasser, Otto

1993 *Wilhelm Conrad Roentgen and the Early History of the Roentgen Rays*. San Francisco: Norman Publishing.

Goffman, Erving

1961 *Encounters: Two Studies in the Sociology of Interaction*.

Harmondsworth: Penguin.

Good, Byron J.

1994 *Medicine, Rationality, and Experience: An Anthropological Perspective.* Cambridge: Cambridge University Press.

Good, Mary-Jo Delvecchio

1995 Cultural Studies of Biomedicine: An Agenda for Research. *Social Science and Medicine* 41:6: 461-473.

Good, Mary-Jo Delvecchio, Byron J. Good, Cynthia Schaffer, and Stuart E. Lind

1990 American Oncology and the Discourse on Hope. *Culture, Medicine, and Psychiatry* 14: 59-79.

Gordon, Deborah R.

1988 Tenacious Assumptions in Western Medicine. In *Biomedicine Examined.* Lock, Margaret, and Deborah R. Gordon, eds. Dordrecht: Kluwer Academic Publishers.

Granet, Roger B., and Lawrence J. Gelber

1990 Claustrophobia During MR Imaging. *New Jersey Medicine* 6, June: 479-480.

Gray, Chris Hables, Heidi J. Figeuroa-Sarriera, and Steven Mentor, eds.

1995 *The Cyborg Handbook.* New York: Routledge.

Guidetti, B. and A. Delitala

1980 Intracranial Arteriovenous Malformations: Conservative and Surgical Treatment. *Journal of Neurosurgery* 53: 149-152.

Habermas, Jürgen

1971 *Toward a Rational Society.* London: Heinemann.

Haraway, Donna

1991 *Simians, Cyborgs, and Women: The Reinvention of Nature.* New

York: Routledge.

1989 *Primate Visions.* New York: Routledge.

Harrington, Anne

1987 *Medicine, Mind, and the Double Brain.* Princeton, N.J.: Princeton University Press.

Hauber, Carl H., and Chris A, Philips

1995 The Evolution of Organized Neurological Surgery in the United States. *Neurosurgery* 36:4: 814-826.

Heap, M.

1985 Health and Disease in Two Villages in South-Eastern Lesotho: A Social Anthropological Perspective. Unpuplished Masters Dissertation. University of Cape Town.

Hess, David J.

in press Technology and Alternative Cancer Therapies: An Analysis of Heterodoxy and Constructivism. *Medical Anthropology Quarterly* 10:4.

1995 *Science and Technology in a Multicultural World: The Cultural Politics of Facts and Artefacts.* New York: Columbia University Press.

Hess, David J., and Linda L. Layne, eds.

1992 *Knowledge and Society: The Anthropology of Science and Technology.* Greenwich, CT: JAI Press.

Hewlett, Richard G., and Jack M. Moll.

1989 *Atoms for Peace and War: Eisenhower and the Atomic Energy Commission: 1953-1961.* Berkeley: University of California Press.

Hirschauer, Stefan

1991 The Manufacture of Bodies in Surgery. *Social Studies of Science* 1: 279-319.

Jolesz, Ferenc A., and Faina Shtern

1992 The Operating Room of the Future. Report of the National Cancer Institute Workshop, "Image-Guided Stereotactic Tumor Diagnosis and Treatment." *Investigative Radiology* 27:4:326-328.

Josephson, Mathew

1961 *Thomas Edison.* London: Eyre and Spottiswoode.

Kathren, Ronald

1982 Historical Development of Radiation Protection and Measurement. In *Handbook of Radiation Protection and Measurement, Vol. III.* Brodsky, A. ed. Boca Raton: CRC Press.

Katz, P.

1981 Ritual in the Operating Room. *Ethnology* 20: 335-50.

Kayser-Jones, Jeanie

1995 Decision Making in the Treatment of Acute Illness in Nursing Homes: Framing the Decision Problem, Treatment Plan, and Outcome. *Medical Anthropology Quarterly* 9:2: 236-256.

Keller, A.

1983 *The Infancy of Atomic Physics: Hercules in his Cradle.* Oxford: Clarendon Press.

Kihlström, Lars

1986 Stereotactic Radiosurgery: Epidemiological Considerations. Atlanta: Elekta Inc.

Kirmayer, Laurence J.

1992 The Body's Insistence on Meaning: Metaphor as Presentation and Representation in Illness Experience. *Medical Anthropology Quarterly* 6:4: 323-346.

1988 Mind and Body as Metaphors: Hidden Values in Biomedicine. In *Biomedicine Examined.* Lock, Margaret, and Deborah Gordon, eds. Dordrecht: Kluwer Academic Publishers.

Kleinman, Arthur

1988 *The Illness Narratives: Suffering, Healing, and Human Condition.* New York: Basic Books.

Kleinman, Arthur, and Joan Kleinman

1991 Suffering and its Professional Transformation: Toward an Ethnography of Experience. *Culture, Medicine and Psychiatry* 15: 275-301.

Koenig, Barbara A.

1988 The Technological Imperative in Medical Practice: The Social Creation of a 'Routine" Treatment. In *Biomedicine Examined.* Lock, Margaret, and Deborah Gordon, eds. Dordrecht: Kluwer Academic Publishers.

Kopp, Richard R.

1995 *Metaphor Therapy: Using Client-Generated Metaphors in Psychotherapy.* New York: Brunner/Mazel Publishers.

Laderman, Carol, and Marina Roseman

1996 Introduction. In *The Performance of Healing.* Laderman, Carol, and Marina Roseman, eds. New York and London: Routledge.

Latour, Bruno

1987 *Science in Action.* Cambridge: Harvard University Press.

Latour, Bruno and Steve Woolgar

1979/1986 *Laboratory Life: The Construction of Scientific Facts.* Princeton, New Jersey: Princeton University Press.

Leksell, Dan

1992 Lars Leksell: An Historical Vignette. In *Radiosurgery: Baseline and Trends.* Steiner, L. et al., eds. New York: Raven Press.

Leksell, Lars G.

1992 Brain Fragments. In *Radiosurgery: Baseline and Trends.* Steiner, L. et al., eds. New York: Raven Press.

1971 *Stereotaxis and Radiosurgery: An Operative System.* Springfield, Illinois: Charles C. Thomas.

1949 The Stereotaxic Method and Radiosurgery of the Brain: Report of a Case. Kugliga Fysiografiska Sällskapeti i Lund. *Forhandlingar* 25:1.

Leksell Society Report

1994 Leksell Gamma Knife Indications Treated 1968-1994. Atlanta: Elekta Incorporated.

Lindenbaum, Shirley, and Margaret Lock, eds.

1993 *Knowledge, Power, and Practice: The Anthropology of Medicine and Everyday Life.* Berkeley: University of California Press.

Linquist, Christer

1996 The Gamma Knife in the Neurosurgical Armamentarium. In *Manual of Neurosurgery, 1996.* Compiled by Palmer, James D. New York: Churchill Livingstone.

Livingstone-Wheeler, Virginia, and Edmon Addeo

1984 *The Conquest of Cancer.* San Diego: Waterside Productions.

Lock, Margaret

1990 On Being Ethnic: The Politics of Identity Breaking and Making in Canada, or, *Nevra* on Sunday. *Culture, Medicine, and Psychiatry* 14: 237-254.

1988 Introduction. In *Biomedicine Examined.* Lock, Margaret, and Deborah Gordon, eds. Dordrecht: Kluwer Academic Publishers.

Lunsford, L. Dade

1993 The Future of Gamma Knife Stereotactic Radiosurgery. In *Stereotactic Radiosurgery.* Alexander III, Eben, Jay S. Loeffler, and L. Dade Lunsford, eds. New York: McGraw Hill, Inc.

Lunsford, L. Dade, Eben Alexander III, and Jay S. Loeffler

1993 General Introduction: History of Radiosurgery. In *Stereotactic Radiosurgery.* Alexander III, Eben, Jay S. Loeffler, and L. Dade Lunsford, eds. New York: McGraw Hill, Inc.

Malinowksi, Bronislaw

1922/1961 *Argonauts of the Western Pacific.* New York: E.P. Dutton and Co., Inc.

Martin, Emily

1990 Toward an Anthropology of Immunology: The Body as Nation State. *Medical Anthropology Quarterly* 4:4: 410-426.

Mathews, Holly

1987 Predicting Decision Outcomes: Have We Put the Cart Before the Horse in Anthropological Studies of Decision Making? *Human Organization* 46: 54-61.

Mauss, Marcel

1925 (English trans., 1954) *The Gift.* London.

McClain, Carol

1983 Reviews of 'The Cultural Context of Therapeutic Choice' and 'The Ethnography of Health Care Decisions.' *Social Science and Medicine* 16: 1451-1530.

McKay, Alwyn

1984 *The Making of the Atomic Age*. Oxford: Oxford University Press.

Miller, Alex J.

1994 Letter to the Editor. *The Wall Street Journal*, Tuesday, May 24, 1994.

Mintz, Sidney

1985 *Sweetness and Power: The Place of Sugar in Modern History*. New York: Viking Press.

Mitteness, Linda S., and Judith C. Barker

1985 Stigmatizing a "Normal" Condition: Urinary Incontinence in Late Life. *Medical Anthropology Quarterly* 9:2: 188-210.

Moerman, Daniel E.

1991 Physiology and Symbols: The Anthropological Implications of the Placebo Effect. In *The Anthropology of Medicine*. Romanucci-Ross, Lola, Daniel E. Moerman, and Laurence R. Tancredi, eds. New York: Bergin and Garvey.

Morris, William

1969 *The American Heritage Dictionary of the English Language*. Boston and New York: American Heritage Publishing.

Nader, Laura

1996 Anthropological Inquiry into Boundaries, Power, and Knowledge. In *Naked Science: Anthropological Inquiry into Boundaries, Power, and Knowledge*. Nader, Laura, ed. New York and London: Routledge.

Nardi, Bonnie

1983 Goals in Reproductive Decision Making. *American Ethnologist* 10:4: 697-714.

Neil-Dwyer, Glen

1996 The Operating Microscope in Neurosurgical Practice. In *Manual of Neurosurgery, 1996.* Compiled by Palmer, James D. New York: Churchill Livingstone.

Oakley, Kenneth P.

1949 *Man the Tool-Maker.* Chicago: The University of Chicago Press.

Ong, Aihwa

1988 The Production of Possession: Spirits and the Multinational Corporation in Malaysia. *American Ethnologist* 15: 28-42.

1987 *Spirits of Resistance and Capitalist Discipline: Factory Women in Malaysia.* Albany: State University of New York Press.

Oring, Elliot

1979 From Uretics to Uremics: A Contribution toward the Ethnography of Peeing. In *Culture, Curers and Contagion.* Norman Klein, ed. Pp. 15-21. Novato, CA: Chandler and Sharp.

Ortner, Sherry B.

1984 Theory in Anthropology since the Sixties. *Comparative Studies in Society and History* 26:1: 126-166.

Pait, T. Glenn, Michael W. Dennis, Edward R. Laws, Hugo V. Rizzoli, and Charles J. Azzam

1991 The History of the Neurosurgical Engine. *Neurosurgery* 28:1: 111-129.

Palmer, James D. (compiled by)

1996 *Manual of Neurosurgery, 1996.* New York: Churchill Livingstone.

Pareras, Luis G., and Jose G. Martin-Rodriguez

1996 Neurosurgery and the Internet: A Critical Analysis and a Review of

Available Resources. *Neurosurgery* 39:1: 216-233.

Parkinson, D. and G. Bachers

1980 Arteriovenous Malformations. *Journal of Neurosurgery* 53: 285-299.

Pellegrino, Edmund D.

1994 Words Can Hurt You: Some Reflections on the Metaphors of Managed Care. *Journal of the American Board of Family Practice* 7:6: 505-510.

Pfaffenberger, Bryan

1992 Social Anthropology of Technology. *Annual Review of Anthropology* 21: 491-516.

Phelps, Lynn A.

1990 MRI and Claustrophobia. *American Family Physician* 42:4: 930.

Pickering, Andrew

1995 *The Mangle of Practice: Time, Agency, and Science.* Chicago and London: Chicago University Press.

Pouchelle, Marie-Christine

1990 *The Body and Surgery in the Middle Ages.* New Brunswick, NJ: Rutgers University Press.

Price, Laurie

1992 A Medical Anthropologist's Ruminations on NIH Funding. *Medical Anthropology Quarterly* 6:2: 128-146.

Pringle, Peter, and James Spigelman

1981 *The Nuclear Barons.* New York: Avon Books.

Rabinow, Paul

1996 *Making PCR: A Story of Biotechnology.* Chicago: University of

Chicago Press.

Rhodes, Lorna Amarasingham

1990 Studying Biomedicine as a Cultural System. In *Medical Anthropology: Contemporary Theory and Method.* Johnson, Thomas M., and Carolyn F. Sargent, eds. New York: Praeger.

Sacks. Oliver

1973 *Awakenings.* New York: E.P. Dutton.

Sartre, Jean Paul

1939/1992 Intentionality. In *Incorporations.* Crary, Jonathan, and Sanford Kwinter, eds. New York: Zone Books.

Seymour-Smith, Charlotte

1986 *Macmillan Dictionary of Anthropology.* London and Basingstoke: Macmillan.

Scheper-Hughes, Nancy, and Margaret Lock

1991 The Message in the Bottle: Illness and the Micropolitics of Resistance. *Journal of Psychohistory* 19:4: 409-432.

Schivelbusch, Wolfgang

1977/1986 *The Railway Journey: The Industrialization of Time and Space in the 19th Century.* Berkeley: The University of California Press.

Schwimmer, Brian

1996 Anthropology on the Internet: A Review and Evaluation of Networked Resources. *Cultural Anthropology* 37:3: 561-567.

Selzer, Richard

1974 *Mortal Lessons: Notes on the Art of Surgery.* New York: Simon and Schuster.

Seremetakis, C. Nadia, ed

1994 *The Senses Still: Perception and Memory as Material Culture in Modernity.* Chicago and London: The University of Chicago Press.

Sharp, Lauriston

1952 Steel Axes for Stone Age Australians. In *Human Problems in Technological Change.* Spicer, Edward H., ed. New York: Russell Sage Foundation.

Shelton, Mark

1989 *Working in a Very Small Place: The Making of a Neurosurgeon.* New York: Vintage Books.

Sontag, Susan

1989 *AIDS and its Metaphors.* New York: Farrar, Straus and Giroux.

Spencer, Dawn M.

1994 Letter to the Editor. *The Wall Street Journal,* Tuesday, May 24, 1994.

Sperber, Dan

1985 *On Anthropological Knowledge.* Cambridge: Cambridge University Press.

Star, Susan L.

1989 *Regions of the Mind: Brain Research and the Quest for Scientific Certainty.* Stanford: Stanford University Press.

Starr, Paul

1982 *The Social Transformation of American Medicine: The Rise of a Sovereign Profession and the Making of a Vast Industry.* New York: Basic Books, Harper Collins Publishers.

Stein, Howard F.

1995 Metaphors of Power and the Power of Metaphor in American Biomedicine: A Tale of Voice, Voicelessness, and Giving Voice. *High Plains Applied Anthropologist* 15:2: 131-143.

Strathern, Andrew J.

1996 *Body Thoughts.* Ann Arbor: University of Michigan Press.

Tambiah, Stanley J.

1990 *Magic, Science, Religion, and the Scope of Rationality.* Cambridge: Cambridge University Press.

Taussig, Michael

1987 *Shamanism, Colonialism and the Wildman.* Chicago: Chicago University Press.

The Atomic Age (film)

1996 Screened on PBS, March 6, 1996. A PBS production

Thomas, Nicholas

1991 *Entangled Objects: Exchange, Material Culture, and Capitalism in the Pacific.* Cambridge, Mass.: Harvard University Press.

Thorwald, J.

1956 *Das Jahrhundert der Chirurgen.* Stuttgart: Steingruben.

Traweek, Sharon

1993 An Introduction to Cultural and Social Studies of Sciences and Technologies. *Culture, Medicine, and Psychiatry* 17:1: 2-19.

1988 *Beamtimes and Lifetimes: The World of High Energy Physics.* Cambridge, Mass.: Harvard University Press.

Turner, Victor W.

1985 *On the Edge of the Bush: Anthropology as Experience.* Tucson,

Arizona: The University of Arizona Press.

1975 *Revelation and Divination in Ndembu Ritual.* Ithaca and London: Cornell University Press.

1968 *The Drums of Affliction.* Oxford: Oxford University Press.

1967 *The Forest of Symbols: Aspects of Ndembu Ritual.* Ithaca, NY: Cornell University Press.

United States Government

1996 *The Human Radiation Experiments: Final Report of the President's Advisory Committee.* New York and Oxford: Oxford University Press.

van der Geest, Sjaak, and Susan Reynolds Whyte

1989 The Charm of Medicines: Metaphors and Metonyms. *Medical Anthropology Quarterly* 3:4: 345-385.

Van Gennep, Arnold

1960 *The Rites of Passage.* Chicago: The University of Chicago Press.

Vayda, Andrew P., ed.

1969 *Environment and Cultural Behavior: Ecological Studies in Cultural Anthropology.* Austin: University of Texas Press.

Weiner, Annette, and Jane Schneider, eds.

1989 *Cloth and Human Experience.* Washington: Smithsonian Institution Press.

Williams, Peter L., and Roger Warwick

1980 *Gray's Anatomy, 36th Edition.* Edinburgh, London, Melbourne, and New York: W.B. Saunders Company.

Wilson, R.

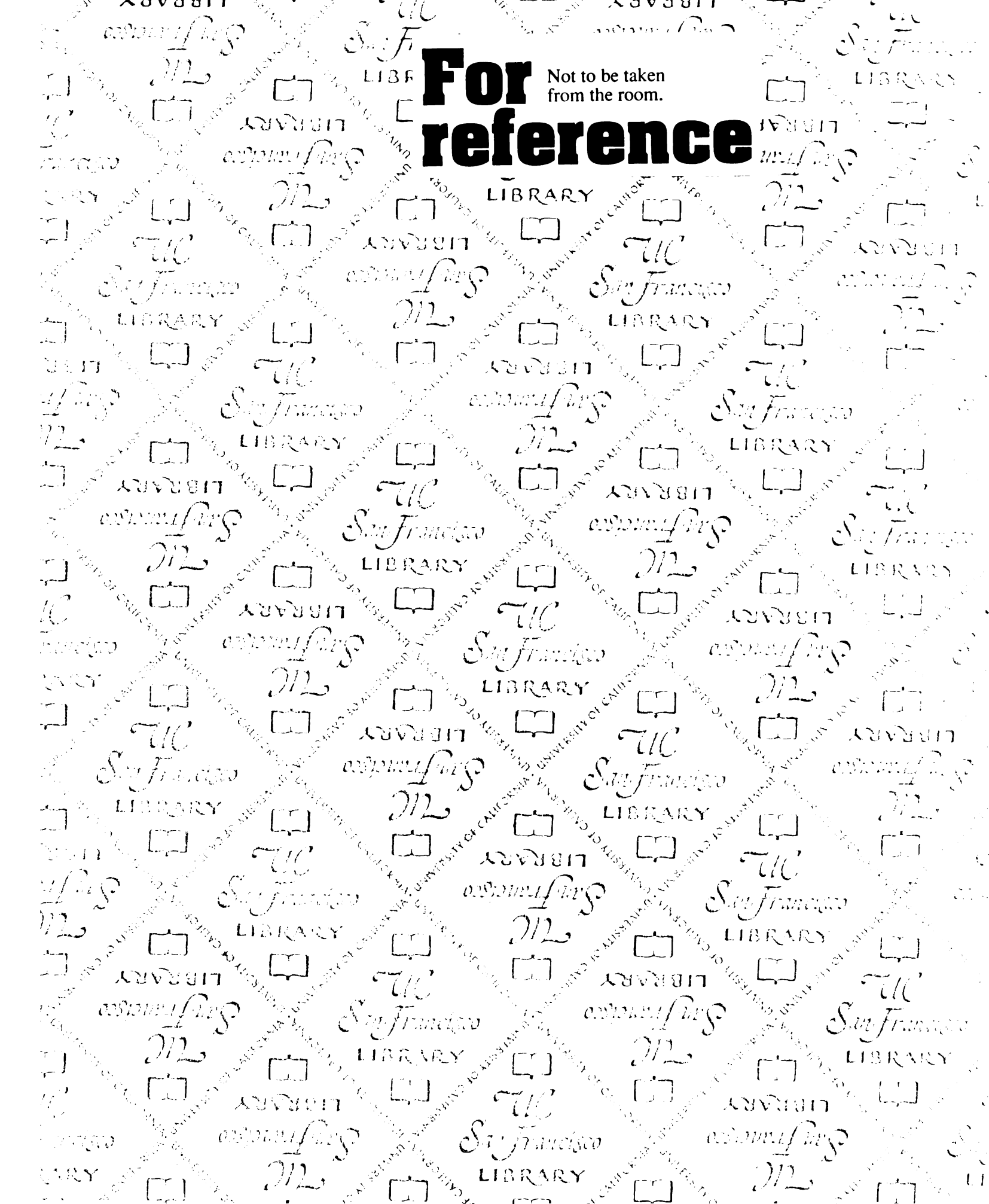
1954 Teamwork in the Operating Room. *Human Organization* 12: 9-14.

Winslow, Gerald R.

1994 Minding our Language: Metaphors and Biomedical Ethics. *Update* 10:4: 1-6.

Young, Allan

1981 The Creation of Medical Knowledge: Some Problems in Interpretation. *Social Science and Medicine* 15: 379-386.


For reference
Not to be taken from the room.
LIBRARY
UC San Francisco