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Publication Date

2021-03-01

DOI

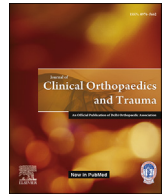
10.1016/j.jcot.2020.09.021

Peer reviewed



Contents lists available at ScienceDirect

Journal of Clinical Orthopaedics and Trauma

journal homepage: www.elsevier.com/locate/jcot

Do-Not-Resuscitate status is an independent risk factor for medical complications and mortality among geriatric patients sustaining hip fractures



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ARTICLE INFO

Article history:

Received 7 April 2020

Received in revised form

27 July 2020

Accepted 20 September 2020

Available online 22 September 2020

Keywords:

Code status

Do-not-resuscitate

DNR

Hip fracture

Mortality

ABSTRACT

Background: The purpose of this study was to compare outcomes after hip fracture surgery between DNR/DNI and full code cohorts to determine whether DNR/DNI status is an independent predictor of complications and mortality within one year. A significant number of geriatric hip fracture patients carry a code status designation of DNR/DNI (Do-Not-Resuscitate/Do-Not-Intubate). There is limited data addressing how this designation may influence prognosis.

Methods: A retrospective chart review of all geriatric hip fractures treated between 2002 and 2017 at a single level-I academic trauma center was performed. 434 patients were eligible for this study with 209 in the DNR/DNI cohort and 225 in the full code cohort. The independent variable was code-status and dependent variables included patient demographics, surgery performed, American Society of Anesthesiologists, score, Charlson Comorbidity Index, significant medical and surgical complications within one year of surgery, duration of follow-up by an orthopaedic surgeon, duration of follow-up by any physician, and mortality within 1 year of surgery. One-year complication rates were compared, and multiple logistic regression analyses were performed to analyze the relationship between independent and dependent variables.

Results: The DNR/DNI cohort experienced significantly more surgical complications compared to the full code cohort (14.8% vs 7.6%, $p = 0.024$). There was a significantly higher rate of medical complications and mortality in the DNR/DNI cohort (57.9% vs 36%, $p < 0.001$ and 19.1% vs 3.1%, $p = 0.037$, respectively). In the regression analysis, DNR/DNI status was an independent predictor of a medical complication (odds ratio 2.33, $p = 0.004$) and one-year mortality (odds ratio 9.69, $p < 0.001$), but was not for a surgical complication (OR 1.95, $p = 0.892$).

Conclusions: In our analysis, DNR/DNI code status was an independent risk factor for postoperative medical complications and mortality within one year following hip fracture surgery. The results of our study highlight the need to recognize the relationship between DNR/DNI designation and medical frailty when treating hip fractures in the elderly population.

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1. Introduction

A significant number of geriatric hip fracture patients carry a code status designation of “Do not resuscitate/Do not intubate” (DNR/DNI).^{1–3} DNR/DNI is an advanced directive meant to guide

end-of-life interventions by withholding invasive interventions such as chest compressions and mechanical ventilation in the event of cardiopulmonary decompensation, with the goals of increasing patient autonomy and improving quality of life.⁴ Patient factors associated with selection of DNR/DNI status include older age, female gender, white race, diagnosis of cancer, and greater dependency in activities of daily living. However, many factors influence this decision, including patient beliefs about life expectancy based on prognosis as well as spiritual and cultural

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influences.^{4–8} People who identify as religious are more likely to prefer resuscitation and be opposed to DNR/DNI status. Patients with a DNR/DNI status can derive significant benefit from certain surgical procedures which improve their quality of life during their remaining lifespan. However, surgery also raises practical and ethical dilemmas in patients with a DNR/DNI designation due to the inherent risks of cardiopulmonary complications as well as other medical and surgical complications. Surgery should proceed only after a detailed preoperative discussion to clarify patients' wishes.⁹

There are few studies addressing how a DNR/DNI designation may influence prognosis in hip fracture patients.¹⁰ However, one recent study evaluated more than 9000 patients using a national database and found that DNR was independently associated with mortality after surgical treatment of a hip fracture. Many risk factors of postoperative morbidity and mortality after hip fracture surgery are well documented, but almost all studies fail to evaluate or even mention DNR/DNI status.^{11–17} Identified and established risk factors include pre-existing cardiac conditions, dementia, male sex, higher ASA score, dependent functional status, presence of malignancy, and older age. Given the dearth of studies evaluating the significance of code status, additional inquiry is warranted.

The purpose of this study was to compare one year post-operative rates of medical and surgical complications as well as mortality among geriatric patients treated with surgery for hip fracture between DNR/DNI and Full Code cohorts. We hypothesized that DNR/DNI status would be an independent predictor of one-year medical complications and mortality without impacting surgical complication rates. The results of this study are valuable to patients as well as the medical community. This knowledge will help physicians be more aware of the implications of a DNR/DNI designation, which is common among patients sustaining geriatric hip fractures. It will also help patients by allowing surgeons to perform a more accurate informed consent as it relates to DNR/DNI designation.

2. Methods

This retrospective cohort study identified all geriatric hip fracture patients treated by multiple surgeons at a single academic level 1 trauma center between 2002 and 2017. Patients over the age of 65 with hip fractures resulting from low energy trauma were identified through a query of the hospital electronic medical record database using relevant CPT codes. The inclusion criterion was the presence of a unilateral hip fracture as an isolated injury in patients over the age of 65 years. Exclusion criteria included erroneous diagnosis of hip fracture, surgical fixation at an outside hospital, inadequate medical records, pathologic fractures, non-operative management, polytrauma, bilateral hip fractures, and severe traumatic brain injury (TBI). The control group was comprised of patients that were designated full code during the admission, while the experimental group was comprised of patients with a DNR/DNI code status on file during the admission. Patients with a DNR/DNI code status had this status temporarily reversed for the operating room after a discussion between the patient and the anesthesiology team. This study was conducted after approval by the hospital's Institutional Review Board.

A total of 898 patients over the age of 65 were diagnosed with a hip fracture during the study period. Of 434 patients included, there were 209 patients with a code status of DNR/DNI and 225 with a code status of full code.

Patient demographics, type of surgery performed, American Society of Anesthesiologists (ASA) score,¹⁸ Charlson Comorbidity Index (CCI),¹⁹ significant medical and surgical complications within one year of surgery, duration of follow-up by an orthopaedic surgeon, duration of follow-up by any physician, and mortality within

1 year of surgery were recorded. Medical complications considered in this study included acute kidney injury, new arrhythmias, venous thromboembolism and pulmonary embolism, pneumonia, cerebrovascular accident, gastrointestinal bleed, congestive heart failure exacerbation, sepsis, myocardial infarction, intubation longer than 48 h, cardiac arrest, readmission, and death. Surgical complications considered in this study included deep and superficial surgical site infection, fixation failure, prominent implants, avascular necrosis of the femoral head, peri-prosthetic fracture, and return to operating room. Mortality was determined through chart review.

Categorical data were compared using Pearson's chi-squared test, while continuous data were compared using student's T-test. Significance for all statistical testing was set at $p < 0.05$. Multiple logistic regression analyses were performed to analyze the relationship between independent (age, gender, ASA score, CCI score, and code status) and dependent (medical complications, surgical complications, and mortality within one year) variables.

3. Results

Gender demographics were similar, with the DNR/DNI cohort 33% male and 67% female vs full code cohort 32% and 68%, respectively. The DNR/DNI cohort was found to have a significantly higher mean age (88.0 ± 5.8 years vs 80.2 ± 7.7 years), mean ASA score (3.1 ± 0.5 vs 2.8 ± 0.5), and mean CCI score (6.2 ± 1.8 vs 5.2 ± 1.9) than the control group ($p < 0.001$ for mean age, mean ASA, and mean CCI). Additionally, the DNR/DNI group had shorter mean duration of orthopaedic follow-up compared to the control group (0.4 ± 0.4 vs 1.3 ± 1.2 years; $p < 0.001$) and shorter mean follow-up duration with any physician (2.3 ± 2.2 vs 3.4 ± 3.0 years; $p < 0.001$).

The fracture locations (femoral neck fracture, intertrochanteric fracture, subtrochanteric fracture) and treatment methods (cannulated screw, sliding hip screw, intramedullary nail, hemiarthroplasty, total hip arthroplasty) were similar between the groups with the exceptions of significantly more subtrochanteric fractures and total hip arthroplasty in the Full Code cohort (subtrochanteric 12.0% vs 5.7%, total hip arthroplasty 12.9% vs 5.3% $p < 0.05$).

The DNR/DNI cohort experienced significantly more surgical complications compared to the full code cohort (14.8% vs 7.6%, $p = 0.024$) (Table 1). However, in regression analysis DNR/DNI status was not independently associated with the occurrence of any surgical complication within one year (OR 0.973, 5–95% CI 0.48–1.94). There was a significantly higher rate of postoperative fall with periprosthetic fracture in the DNR/DNI group (8.6%) compared to the full code group (0.9%, $p < 0.001$). More DNR/DNI patients were required to return to the operating room (7.7%) than full code patients (4.4%), although this result also failed to reach statistical significance ($p = 0.228$).

There was a significantly higher overall rate of medical complications within 1 year in the DNR/DNI group versus the full code group (57.9% vs 36.0%, $p < 0.001$). DNR/DNI patients had increased rates of new arrhythmia, pneumonia requiring readmission, cerebrovascular accident, gastrointestinal bleed, exacerbation of congestive heart failure, intubation longer than 48 h, readmission, and death compared to full code patients (Table 2). Average time to death in the full code cohort was 3.05 ± 2.6 years compared to DNR/DNI cohort average 1.85 ± 2.3 years, which was significantly different ($p = 0.027$). One patient in the full code cohort died during the initial hospitalization compared to 18 patients in the DNR/DNI cohort ($p = 0.036$).

In the regression analysis, DNR/DNI code status, male gender, and an ASA score of 3 were independently associated with a

Table 1
Comparison of surgical complications within 1 year of surgery between full code and DNR/DNI patient cohorts.

Surgical Complication	Full Code Cohort	DNR/DNI Cohort	p-value
Deep surgical site infection requiring incision & drainage	0.9%	0.0%	0.432
Superficial surgical site infection	0.0%	1.9%	0.114
Fixation failure	3.1%	4.3%	0.685
Prominent implants	1.3%	0.5%	0.668
Avascular necrosis of femoral head	0.4%	1.0%	0.949
Fall with post-operative periprosthetic fracture	0.9%	8.6%	<0.001*
Return to operating room	4.4%	7.7%	0.228
Patients with any surgical complication	7.6%	14.8%	0.024*

* indicates significance at $\alpha = 0.05$ with Pearson’s chi-square test.

Table 2
Comparison of medical complications within 1 year of surgery between full code and DNR/DNI patient cohorts.

Complication	Full Code Cohort	DNR/DNI Cohort	p-value
Acute kidney injury	7.1%	12.0%	0.118
New arrhythmia	5.3%	14.8%	0.002*
Venous thromboembolism/Pulmonary embolism	3.6%	4.8%	0.689
Pneumonia (requiring readmission)	1.8%	12.9%	<0.001*
Cerebrovascular accident	1.8%	5.7%	0.029*
Gastrointestinal bleed	0.4%	5.7%	0.003*
Congestive heart failure exacerbation	0.9%	10.1%	<0.001*
Sepsis	2.2%	4.3%	0.330
Myocardial infarction	1.8%	3.4%	0.462
Intubation longer than 48 h	0.9%	4.8%	0.029*
Cardiac arrest	0.9%	3.4%	0.144
Readmission	22.7%	32.1%	0.031*
Death	3.1%	19.1%	0.037*
Patients with any medical complication	36.0%	57.9%	<0.001*

* indicates significance at $\alpha = 0.05$ with Pearson’s chi-square test.

Table 3
Multiple logistic regression for independent variables listed, with likelihood of patient having a medical complication within 1 year as the dependent variable.

Independent Variable	Response	Odds Ratio (5–95% CI)	p-value
Gender	Female	Referent	Referent
	Male	1.84 (1.18–2.87)	0.024*
Age	65–84 years	Referent	Referent
	85–100 years	1.09 (0.69–1.72)	0.755
Code Status	Full Code	Referent	Referent
	DNR/DNI	2.33 (1.45–3.77)	0.004*
CCI Score	Below 6	Referent	Referent
	6 and above	1.07 (0.69–1.65)	0.809
ASA Score	1 or 2	Referent	Referent
	3	2.26 (1.23–4.32)	0.031*
	4	2.70 (1.10–6.71)	0.070

CI = confidence interval, ASA = American Society of Anaesthesiologists, CCI = Charlson Comorbidity Index.

* indicates significance at $\alpha = 0.05$.

patient’s likelihood of having a medical complication within 1 year of surgery (Table 3). A separate multiple regression analysis found DNR/DNI code status was an independent predictor of 1-year-mortality (OR = 9.69) (Table 4). None of the independent variables tested (gender, age, code status, CCI score, and ASA score) were found to be independent predictors of a surgical complication.

4. Discussion

The purpose of this study was to evaluate the impact of DNR/DNI code status on medical and surgical postoperative complications within one year of hip fracture surgery. In this retrospective review of 434 patients from a single center, we found that mortality rates were six times greater in the DNR/DNI group, and DNR/DNI status was an independent risk factor for mortality. Additionally, medical

Table 4
Multiple logistic regression for independent variables listed, with mortality within 1 year as the dependent variable.

Independent Variable	Response	Odds Ratio (5–95% CI)	p-value
Gender	Female	Referent	Referent
	Male	1.45 (0.76–2.92)	0.324
Age	65–84 years	Referent	Referent
	85–100 years	2.06 (0.93–4.98)	0.151
Code Status	Full Code	Referent	Referent
	DNR/DNI	9.69 (4.02–27.80)	<0.001*
CCI Score	Below 6	Referent	Referent
	6 and above	1.21 (0.62–2.41)	0.647

CI = confidence interval, CCI = Charlson Comorbidity Index.

* indicates significance at $\alpha = 0.05$.

complications were more prevalent in the DNR/DNI group, and DNR/DNI status was identified as an independent risk factor for the occurrence of a medical complication. DNR/DNI code status was not independently associated with increased risk for surgical complication.

Hip fracture surgery is well known to be associated with high rates of postoperative complications, including mortality.^{11–17} A previous study titled “Do-Not-Resuscitate status is an independent risk factor for patients undergoing surgery for hip fracture” evaluated code status as a risk factor using the American College of Surgeons’ National Surgical Quality Improvement Project (ACS NSQIP) database. This prior study also found increased 30-day mortality and post-operative complications among DNR patients after hip fracture surgery.¹⁰ Our study is unique and important as we extracted data from a large retrospective cohort and therefore were able to identify late complications and control for comorbidities with information not available in database research.²⁰ Although it seems intuitive that DNR/DNI status would portend poor outcomes, the specific reasons for this association are unclear.

Our DNR/DNI cohort was significantly older and had a significantly increased ASA and CCI scores, which is to be expected in a cohort of patients who have elected to become DNR/DNI. However, neither of these parameters were independently associated with morbidity or mortality in our study.

Though DNR/DNI status has been infrequently evaluated within the orthopaedic literature, some guidance can be obtained from publications within other specialties such as vascular surgery. In one study comparing DNR and non-DNR cohorts undergoing common major vascular procedures, DNR status was found to be an independent risk factor for 30 day mortality (21% vs 3.4%, $p < 0.001$), in spite of the two cohorts having no difference in demographics or comorbidities.²¹ The authors suggest that DNR status may increase the risk of “failure to rescue” (FTR), which is defined as death after a major complication. This has been attributed to inadvertent provider bias leading to “inadequate or insufficient care” beyond withholding cardiopulmonary resuscitation or mechanical ventilation.¹⁰ By way of example, DNR patients may be less likely to be offered aggressive therapy for major postoperative complications such as an emergent operation. This theory is difficult to quantify as we are unaware of available data existing for proper analysis of its veracity.

There were several limitations to our study. First was the retrospective nature of our data analysis. This data was generated over the course of more than a decade and there were numerous treating surgeons. Additionally, there was variability in length of follow up. This is likely a function of our institution’s role as a tertiary referral center with a large catchment area, as well as a function of expected follow up rates previously described in trauma patients.^{22,23} Given our institution’s designation as a level I trauma center, the number of operative geriatric hip fractures recorded per year in our study is likely an underestimate of the actual number treated. Our review depended on accurate coding within our electronic medical record, and not all cases were captured by our CPT code query. Many patients treated prior to initiation of the electronic medical record had incomplete records and were excluded. The treatment setting of an academic tertiary care medical center could potentially impact generalizability of our findings. However, our findings have been corroborated by other studies with different study designs and in other subspecialties, suggesting that they are more broadly applicable.^{10,21}

The results of our study highlight the need to recognize the relationship between DNR/DNI designation and medical frailty when treating hip fractures in the elderly population. This information is also important for surgeons when counseling patients and their families about outcomes of hip fracture surgery. In conclusion, we found that DNR/DNI code status was an independent risk factor for postoperative medical complications and mortality within one year following hip fracture surgery.

Author contribution

Each author warrants authorship as SC, MG and JB participated in conception of the project; LB, KN, LL and SC participated in data collection; LB, KN and LL participated in data analysis; LB and KN prepared the manuscript; and all authors participated in manuscript review.

CRediT authorship contribution statement

Liam C. Bosch: Data curation, Formal analysis, Writing - original draft, Writing - review & editing. **Karthik Nathan:** Data curation, Formal analysis, Writing - original draft, Writing - review & editing. **Laura Y. Lu:** Data curation, Formal analysis, Writing - review &

editing. **Sean T. Campbell:** Conceptualization, Data curation, Writing - review & editing, Supervision. **Michael J. Gardner:** Conceptualization, Writing - review & editing, Supervision. **Julius A. Bishop:** Conceptualization, Writing - review & editing, Supervision.

Declaration of competing interest

The authors have no relevant conflicts of interest to report. This research received no grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements

None.

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