

UCSF

UC San Francisco Previously Published Works

Title

Longitudinal evaluation of the surgical workforce experience during the Covid-19 pandemic.

Permalink

<https://escholarship.org/uc/item/7fc590tn>

Journal

American Journal of Surgery, 224(5)

Authors

Landau, Sarah
Mavroudis, Catherine
Brooks, Ezra
[et al.](#)

Publication Date

2022-11-01

DOI

10.1016/j.amjsurg.2022.04.015

Peer reviewed



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Original Research Article

Longitudinal evaluation of the surgical workforce experience during the Covid-19 pandemic



Sarah I. Landau^a, Catherine Mavroudis^b, Ezra Brooks^a, Regan Bergmark^c, Nicholas L. Berlin^d, Elizabeth Lancaster^e, Jennifer Waljee^d, Elizabeth Wick^e, Heather Yeo^f, Christopher Wirtalla^b, Rachel R. Kelz^{b,*}

^a University of Pennsylvania, Perelman School of Medicine, USA

^b University of Pennsylvania, Department of Surgery, USA

^c Harvard Medical School and Brigham and Women's Hospital, USA

^d University of Michigan, USA

^e University of California, San Francisco, USA

^f Weill Cornell Medical College, USA

ARTICLE INFO

Keywords:
Covid-19
Longitudinal
Stress
Surgical workforce
Qualitative

ABSTRACT

Background: An updated examination of the surgeon experience during the Covid-19 pandemic is lacking. This study sought to describe how surgeon stress levels and sources of stress evolved over the pandemic.

Methods: An electronic survey was administered to surgeons at four academic hospitals at 6-months and 12-months following an initial telephone survey. The primary outcome was stress level and secondary outcomes were the individual stressors. Thematic analysis was applied to free text responses.

Results: A total of 103 and 53 responses were received at 6-months and 12-months, respectively. The mean overall stress level was 5.35 (SD 1.89) at 6-months and 4.83 (SD 2.19) at 12-months. Mean number of stressors declined from 3.77 (SD 2.39) to 2.06 (SD 1.60, $P < 0.001$), though the “finances” stressor increased frequency (27.2% to 34.0%). Similar qualitative themes were identified, however codes for financial and capacity challenges were more prominent at 12-months.

Conclusions: The surgical workforce continues to report elevated levels of stress, though the sources of this stress have changed. Targeted interventions are imperative to protect surgeons from long-term psychological and financial harm.

1. Introduction

In March of 2020, widespread cancellation or deferral of elective surgical procedures led to rapid and sharp declines in operative volume.^{1,2} Acutely, surgical providers saw their clinical practices threatened and academic advancement stalled^{3,4} and trainees struggled to find enough cases to further their operative education and meet mandatory case requirements.^{3,5} Over the next few months, as the acute shock subsided and elective surgery resumed, the Covid-19 pandemic evolved into a more sub-acute threat with residual impact on surgical care delivery and training.

During the first months of Covid-19, there was also concern about a “parallel pandemic” resulting from the virus’ threat to clinician physical and mental health.⁶ Appropriately, there was intense focus on how to

best protect healthcare workers.⁷ Several early studies looking specifically at the surgical workforce found that surgeons were experiencing high levels of stress, anxiety, and depression.^{3,5,8,9} Since this research was performed, we have witnessed substantial changes in the nature of Covid-19 itself, and the healthcare landscape more broadly. For example, institutions have implemented new infection control policies and expanded telehealth and remote work options. Elective surgeries resumed, with many surgical providers now focused on working through the backlog of cases.^{10,11} Most recently, we have seen the introduction of large-scale vaccination, which has altered the epidemiology of the pandemic. To date, it is unknown how these changes have impacted the experience of the surgical workforce.¹²

We conducted a multi-institutional, longitudinal study to describe how surgeon stress levels and sources of stress evolved over the course of

* Corresponding author. 3400 Spruce Street Philadelphia, PA, 19104, USA.

E-mail address: Rachel.kelz@pennmedicine.upenn.edu (R.R. Kelz).

<https://doi.org/10.1016/j.amjsurg.2022.04.015>

Received 20 December 2021; Received in revised form 20 March 2022; Accepted 14 April 2022

Available online 25 April 2022

0002-9610/© 2022 Elsevier Inc. All rights reserved.

the pandemic. We aimed to update our understanding of the surgical workforce experience and provide information to develop effective interventions to support surgeons in the chronic phase of the Covid-19 pandemic.

2. Methods

2.1. Study design

We conducted a longitudinal, multi-institutional, cross-sectional survey study of the surgical workforce at the Brigham and Women's Hospital (BWH), the University of Michigan (UM), the Hospital of the University of Pennsylvania (HUP), and the University of California, San Francisco (UCSF). New York Presbyterian-Weill Cornell Medicine (WCM) participated in the initial study but did not participate in any of the follow-up surveys. The Institutional Review Board (IRB) at the University of Pennsylvania approved the study protocol and agreed to additionally be the IRB of record using the Streamlined, Multisite, Accelerated Resources for Trials (SMART) IRB Reliance Platform for BWH, UM, and UCSF (IRB Protocol #8943009).

2.2. Study population

The initial study consisted of phone interviews of surgical house staff and faculty practicing in the Department of Surgery at each of the five sponsor institutions between May 15 and June 1, 2020, as previously described.⁹ At the conclusion of the phone interview, participants were asked if they would be willing to provide an email address to participate in follow-up surveys. All initial survey respondents from BWH, UM, HUP, and UCSF who provided an email address were eligible for participation in the follow-up surveys. All eligible participants were sent an electronic follow-up survey at 6-months (December 14, 2020–January 14, 2021) and 12-months (June 14, 2021–July 14, 2021). Like the initial phone survey, the follow-up surveys included items on basic demographics, training status, domestic status and support, workplace and personal experiences specific to the Covid-19 pandemic. Stress levels were assessed in the same manner, using the validated self-reported stress measure, the stress numerical rating scale-11 (Stress NRS-11).¹³ In addition to the 9 stressors included in the initial survey, the follow-up surveys included four additional stressors that reflected the prolonged and changing nature of the Covid-19 pandemic. Four open-ended questions were also added to capture greater nuance and depth of the surgical workforce experience in the later months of the pandemic. The same survey was used for both follow-up time points. Survey results were collected using REDCap, an encrypted web-based database, hosted at the University of Pennsylvania.¹⁴ See Supplement A for the survey instruments.

2.3. Exposures & outcomes

Our primary outcome measure was self-reported stress level at each of the follow-up time points. Secondary outcomes were the individual stressors. Descriptive statistics and univariate analyses with T-tests, Chi-Square Tests and ANOVA were performed as appropriate. A post-hoc stratified analysis by training status was performed to compare the experiences of surgical housestaff and faculty. All statistical analyses were performed using Stata v16.1 (StataCorp, College Station, TX).¹⁵

2.4. Qualitative analysis

Follow-up surveys included four open ended questions to add greater depth to our understanding of the surgical workforce experience in the later months of the pandemic. A thematic analysis within a realist framework was performed as described by Braun and Clarke.^{16,17} Data coding and candidate theme development was performed by SL who had no role in the development of the survey tool. Candidate themes were

subsequently reviewed by RRK and SL at the level of the coded data and in relation to the entire data set, and iteratively revised until the final list of themes captured the scope of respondent experiences.

3. Results

3.1. Population characteristics

The initial phone survey had 335 respondents across all five sponsor institutions with a 63.7% response rate.^{8,9} 274 surgeons from BWH, UM, HUP, and UCSF participated in the initial survey and 256 of these surgeons agreed to participate in a follow-up survey. Of those who agreed to participate in a follow up survey, 103 completed the 6-month follow-up survey (response rate = 40.2%) and 53 completed the 12-month follow-up survey (response rate = 20.7%). Of those who responded the 6-month survey (N = 103), 43 responded to the 12-month survey, resulting in a 41.7% response rate. There were no significant differences between characteristics of the responders and non-responders across the study time frame. See [Supplemental Table 1](#).

[Table 1](#) shows the basic demographics, training status, domestic status and support, and workplace experiences specific to the Covid-19 pandemic, for each of the survey cohorts based on responses to the initial survey. Of the 103 respondents to the 6-month survey, 45 (43.7%) were female with an average age of 38.3 years. 80.6% of respondents to the 6-months survey were partnered (includes married or domestic partnership), and 64.1% reported dependents with 43.7% having children ≤ 18 years of age. Of the 53 respondents to the 12-month survey, 28 (52.8%) were female with an average age of 38.0 years. 71.7% of respondents to the 12-month survey were partnered, with 56.6% reporting dependents and 41.5% having children ≤ 18 years of age. A similar distribution of surgical specialties was observed among respondents at 6-months and 12-months.

Changes in workplace experience due to Covid-19 were reported by respondents to both follow-up surveys. 86.4% and 94.3% of the respondents at 6-months and 12-months, respectively, had experienced a decrease in operative caseload during the pandemic. A substantial majority at 6-months (89.0%) and 12-months (81.0%) had been notified of potential redeployment at some point during the pandemic, though only a fraction had worked or were currently working outside their typical scope of practice (6-months = 20.4%, 12-months = 20.8%).

When stratified by training status, significant differences were observed in the age, relationship status, and dependent status of respondents. Specifically, faculty were older and more commonly married with dependents. Across all time points, most of the faculty and housestaff reported decreased operative caseload. Similar numbers of faculty and housestaff had been notified of the possibility of redeployment though few reported the need to work outside of their typical scope of practice. See [Supplemental Table 2](#).

3.1.1. Self-reported surgeon stress

[Fig. 1](#) shows the distribution of surgeon stress levels across the survey time points. During the initial survey, both current and peak stress were reported. The mean peak stress was 7.04 (SD 1.95), while mean current stress at the time of the initial survey was 4.37 (SD 2.03).^{8,9} At 6-months, overall mean stress level was 5.35 (SD 1.89). At 12-months, the overall mean stress level was 4.83 (SD 2.19). Though faculty reported significantly higher current stress levels at the time of the initial survey, no significant differences were observed in the mean reported stress levels of faculty and housestaff at 6-months or 12-months. See [Supplemental Table 3](#).

3.1.1.1. Stressors. The mean number of stressors decreased across the time points. Of the 9 potential stressors included in all three surveys, the mean number of stressors reported was 3.43 (SD 2.02) in the initial survey, 2.62 (SD 1.66) in the 6-month survey, and 1.30 (SD 1.22) in the

Table 1
Respondent characteristics and work experience.

	Initial Survey w/Phase 2 Consent	Initial Survey + 6-month Follow-Up	Initial Survey + 12-month Follow-Up
Number of Respondents	256	103	53
What is your age?, mean (SD)	39.6 (10.6)	38.3 (9.8)	38.0 (10.3)
Occupational Status, n (%)			
Housestaff, n (%)	120 (46.9)	54 (52.4)	29 (54.7)
Faculty, n (%)	136 (53.1)	49 (47.6)	24 (45.3)
Housestaff: What is your PGY Level? n (%)			
1, n (%)	28 (23.3)	11 (20.4)	5 (17.2)
2, n (%)	25 (20.8)	8 (14.8)	5 (17.2)
3, n (%)	17 (14.2)	12 (22.2)	8 (27.6)
4, n (%)	11 (9.2)	6 (11.1)	4 (13.8)
5, n (%)	15 (12.5)	6 (11.1)	0 (0.0)
6, n (%)	13 (10.8)	5 (9.3)	3 (10.3)
7, n (%)	7 (5.8)	4 (7.4)	2 (6.9)
8, n (%)	4 (3.3)	2 (3.7)	2 (6.9)
Faculty: # of years since transition to practice, mean (SD)	13.2 (9.3)	12.0 (8.5)	12.2 (8.7)
What is your gender? (Female), n (%)	103 (40.2)	45 (43.7)	28 (52.8)
What is your relationship status?, n (%)			
Married, n (%)	181 (70.7)	74 (71.8)	33 (62.3)
Domestic Partnership, n (%)	16 (6.3)	9 (8.7)	5 (9.4)
Monogamous Relationship, NOS, n (%)	17 (6.6)	9 (8.7)	5 (9.4)
Single, n (%)	33 (12.9)	9 (8.7)	9 (17.0)
Divorced, n (%)	4 (1.6)	0 (0.0)	0 (0.0)
Other, n (%)	5 (2.0)	2 (1.9)	1 (1.9)
Relationship Status, n (%)			
Partnered, n (%)	197 (78.2)	83 (80.6)	38 (71.7)
Monogamous Relationship, n (%)	17 (6.7)	9 (8.7)	5 (9.4)
Single/Divorced, n (%)	33 (13.1)	9 (8.7)	9 (17.0)
Other, n (%)	5 (2.0)	2 (1.9)	1 (1.9)
(if "Partnered"): Partner Employed? (Yes), n (%)	160 (81.2)	67 (80.7)	30 (78.9)
(if "Partnered"): What is your partners occupation?, n (%)			
Physician, n (%)	71 (44.4)	27 (40.3)	12 (40.0)
Business Person, n (%)	30 (18.8)	14 (20.9)	7 (23.3)
Other, n (%)	52 (32.5)	24 (35.8)	10 (33.3)
Other Healthcare Worker, n (%)	7 (4.4)	2 (3.0)	1 (3.3)
(if "Partnered" and "Physician"): Is your partner employed by the same health system?, n (%)			
No, n (%)	36 (46.2)	11 (37.9)	4 (30.8)
Yes, n (%)	42 (53.8)	18 (62.1)	9 (69.2)
Dependents, n (%)			
No, n (%)	91 (35.5)	37 (35.9)	23 (43.4)
Yes, n (%)	165 (64.5)	66 (64.1)	30 (56.6)
Dependents: Pets Only, n (%)			
No, n (%)	223 (87.1)	87 (84.5)	48 (90.6)
Yes, n (%)	33 (12.9)	16 (15.5)	5 (9.4)
Number of Dependents (non-pets), mean (SD)	1.1 (1.3)	1.0 (1.3)	1.0 (1.3)
Dependents aged ≤18, n (%)	118 (46.1)	45 (43.7)	22 (41.5)
Dependents aged 19–59, n (%)	19 (7.4)	7 (6.8)	6 (11.3)
Dependents aged 60+, n (%)	6 (2.3)	1 (1.0)	0 (.)
Is anyone pregnant in the household?, n (%)			
No, n (%)	244 (95.3)	99 (96.1)	51 (96.2)
Yes, n (%)	12 (4.7)	4 (3.9)	2 (3.8)
Specialty, n (%)			
General Surgery, n (%)	100 (39.1)	42 (40.8)	21 (39.6)
Plastic and Reconstructive Surgery, n (%)	27 (10.5)	12 (11.7)	7 (13.2)
Colorectal Surgery, n (%)	16 (6.3)	7 (6.8)	2 (3.8)
Trauma, Acute Care, and Surgical Critical Care, n (%)	14 (5.5)	5 (4.9)	4 (7.5)
Surgical Oncology, n (%)	11 (4.3)	4 (3.9)	3 (5.7)
Other Specialty, n (%)	88 (34.4)	33 (32.0)	16 (30.2)
Operative Caseload, n (%)			
Increased, n (%)	1 (0.4)	0 (0.0)	0 (0.0)
Decreased, n (%)	227 (88.7)	89 (86.4)	50 (94.3)
Stayed the same, n (%)	28 (10.9)	14 (13.6)	3 (5.7)
	163 (80.3)	73 (89.0)	34 (81.0)

Table 1 (continued)

	Initial Survey w/Phase 2 Consent	Initial Survey + 6-month Follow-Up	Initial Survey + 12-month Follow-Up
At any time during the pandemic, were you notified that you could be redeployed (Yes), n (%)			
Are you working, or have you worked, outside of your typical scope of practice (Yes), n (%)	53 (20.7)	21 (20.4)	11 (20.8)

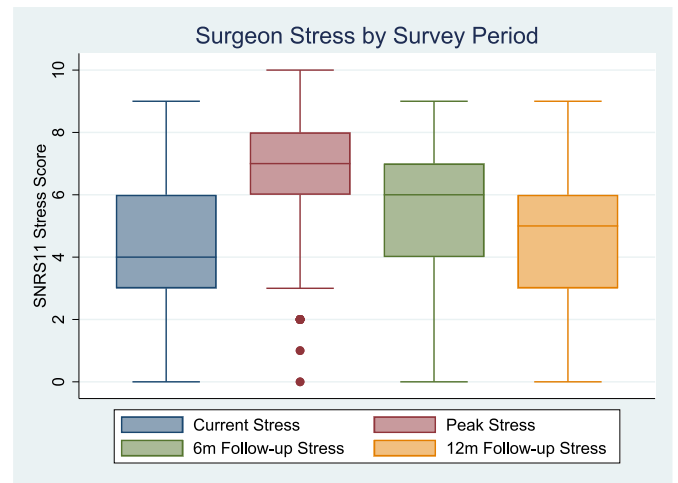


Fig. 1. Surgeon Stress by Survey Period. Self-reported surgeon stress level using the stress numerical rating scale-11 (range from 0 lowest to 10 highest). Distribution of current and peak stress levels from the initial phone survey are depicted along with current stress levels from 6-month and 12-month follow-up surveys.

12-month survey ($P < 0.001$). When looking at all 13 potential stressors included in the 6-month and 12-month surveys, we observed the mean number of reported stressors decline from 3.77 (SD 2.39) at 6-months to 2.06 (SD 1.60) at 12-months ($P < 0.001$).

Table 2 shows the change in the reported frequency of the individual

Table 2
Stressors by survey period.

Columns by: Cohort Category	Initial Survey	6-month Survey	12-month Survey
n (%)	256 (62.1)	103 (25.0)	53 (12.9)
Financial concerns	68 (26.6)	28 (27.2)	18 (34.0)
Rebuilding surgical practice	0 (0.0)	11 (10.7)	5 (9.4)
Recurring concerns regarding difficult clinical decisions during the pandemic	0 (0.0)	24 (23.3)	6 (11.3)
Possibility of a second wave	0 (0.0)	51 (49.5)	17 (32.1)
Adverse events (advanced disease due to treatment delays for patients during the pandemic)	0 (0.0)	32 (31.1)	12 (22.6)
Becoming seriously ill	120 (46.9)	42 (40.8)	14 (26.4)
Infecting my children	91 (35.5)	29 (28.2)	8 (15.1)
Infecting elderly family members	118 (46.1)	51 (49.5)	6 (11.3)
Infecting my partner	173 (67.6)	57 (55.3)	6 (11.3)
Practicing outside of my specialty	51 (19.9)	11 (10.7)	1 (1.9)
Facing ethical concerns due to limited healthcare resources	109 (42.6)	22 (21.4)	4 (7.5)
Orphaning my children	49 (19.1)	11 (10.7)	3 (5.7)
Other	98 (38.3)	19 (18.4)	9 (17.0)

stressors across the survey time points. In the initial and 6-month surveys, the most commonly reported stressor was infecting their partner (67.6% and 55.3%, respectively), but by 12-months this stressor was only reported by 11.3% of respondents. Similar decline overtime was seen in the reported frequency of stressors related to becoming seriously ill with Covid-19 and infecting their children, with the greatest decline seen between the 6-month and 12-month surveys. Stress related to infecting elderly family members increased from 46.1% at initial survey to 49.5% at 6-months, before falling to 11.3% at 12-months. Consistent decreases were observed in the reported frequency of the stressors of orphaning their children, practicing outside of specialty, and facing ethical concerns due to limited healthcare resources. The only stressor that consistently increased frequency over the study period was financial concerns, which increased from 26.6% at the initial survey to 27.2% at 6-months and 34.0% at 12-months.

The four stressors added to the follow-up surveys included: rebuilding surgical practice, recurring concerns about difficult clinical decisions, possibility of “second” wave, and adverse events (advanced disease due to treatment delays for patients during the pandemic). Rates of all of the four additional stressors decreased from 6-months to 12-months with the greatest decline seen for possibility a “second” wave (49.5% at 6-months vs. 32.1% at 12-months). See [Table 2](#).

When stratified by training status, the faculty and housestaff reported similar total numbers of stressors at 6-months and 12-months. The faculty and housestaff also reported similar experiences with individual stressors with one exception. A greater proportion of faculty endorsed stress related to infecting children at the initial survey (faculty: 51.5%, housestaff: 17.5%; $P < 0.001$) and 6-month survey (faculty: 40.8%, housestaff: 16.7%; $P = 0.006$). At 12-months, there was no statistically significant difference in the proportion of faculty and housestaff experiencing stress related to infecting children (faculty: 8.3%; housestaff: 20.7%; $P = 0.211$). Notably, the proportion of faculty experiencing this stressor declined between 6- and 12-months while the proportion of housestaff experiencing this source of stress remained constant across the study time frame. See [Supplemental Table 4](#).

3.2. Themes from personal and professional experiences of surgical workforce

The open-ended questions included in the 6-month and 12-month surveys assessed for the presence of major life events as a result of the Covid-19 pandemic, biggest fears during the pandemic, new practices adopted during the pandemic, and perceptions on how to improve workplace support.

[Table 3](#) displays the observed themes for each question, along with the codes used to construct each theme and representative quotes from the 6-month and 12-month surveys. All of the same themes were identified in responses to both follow-up surveys with the exception of “protect physical safety”, which was identified in the 6-month responses about workplace support.

Although the overall themes were similar across time points, the specific codes and/or relative contribution of the codes used to construct many of these themes differed subtly. For example, one of the themes observed in respondent’s biggest fears was “inability to care for patients.” At 6-months, codes for this theme reflected concerns about resources, redeployment, and residency training opportunities, while at 12-months, the codes were mainly focused on redeployment. Similarly, “support for personal needs and wellness” at both time points included nearly all the same specific codes, however, at 6-months, codes related to childcare and mental health contributed more to this theme, while at 12-months, codes about professional development were the major contributors.

The themes of “increase financial support” and “address volume and capacity challenges” were more prominently represented in the responses at 12-months. Specifically, 9/103 (8.7%) responses at 6-months contributed to the theme of “increase financial support,” while 10/53

(18.9%) of responses at 12-months contributed to this theme. For “address volume and capacity challenges”, 3/103 (2.9%) responses at 6-months contributed to this theme in comparison to 10/53 (18.9%) of responses at 12-months.

4. Discussion

This is the first longitudinal study to explore and document surgeon stress across multiple institutions over the course of the Covid-19 pandemic. We demonstrate that surgeons continued to report increased levels of stress at 6-month and 12-month follow-up time points, however, the source of this stress changed. Both the mean number of stressors and the frequency of reported stressors decreased over the study period, particularly for those stressors directly related to Covid-19 infection. By 12-months, financial concerns were identified as a dominant source of stress in both our quantitative and qualitative data.

While the frequency of reported stressors about infection risk declined over the study period, they did not reach zero, and overall surgeon stress levels remained elevated. This trend was observed for faculty and housestaff alike. The reality that there are still surgeons who perceive that their own health and/or the health of their family members is at risk and, more generally express persistently elevated levels of stress, has important implications for the psychological safety of the surgical workforce. After the Severe Acute Respiratory Distress (SARS) outbreak, a longer duration of perceived risk among healthcare workers correlated with higher rates of adverse outcomes, including burnout, posttraumatic stress, problematic substance use, and missed work.¹⁸ Moreover, years after the risk of infection was eradicated, healthcare workers who treated SARS patients were found to have elevated levels of stress, depression, anxiety, and posttraumatic stress.^{18–20} Our data similarly demonstrate that more than one year into the Covid-19 pandemic, even with the availability of an effective vaccine that greatly reduces the risk of morbidity and mortality from the virus,²¹ surgeons continue to express substantial levels of stress and concerns about mental health. Failure to address the long term psychologic sequelae of the Covid-19 pandemic may exacerbate pre-existing anxiety, stress, and burnout among surgeons²² and worsen outcomes for providers and patients.^{22–25}

Our findings also provide information on the changing drivers of surgeon stress. The observed shift in the dominant source of stress, from concerns about infection, to concerns about finances and surgical capacity, aligns with the broader challenges facing healthcare. Cancellation of elective surgical cases early in the pandemic resulted in significant financial losses and backlog of cases.^{4,10,26} With declining rates of Covid-19, hospitals are now attempting to recover these losses by increasing surgical volume.^{27,28} At the same time, many clinical support staff were furloughed or terminated during the early pandemic, while others, particularly nurses, chose to leave the clinical workforce, resulting in critical staffing shortages.^{29,30} Consequently, many hospitals are constrained in their ability to provide the resources necessary to support surgeons as they tackle both the backlog and higher acuity of surgical cases.²⁸ Our data suggest that institutional pressure on surgeons to increase clinical productivity in the absence of adequate resources or monetary compensation is contributing to surgeon stress, and interventions aimed at addressing financial and capacity challenges may alleviate an important source of surgeon stress. Based on our qualitative findings, increased financial compensation and clinical support for surgeons would most directly address a significant source of stress and should be pursued wherever possible. Investing in internal quality improvement may allow hospitals to enhance surgical efficiency and offload some of the non-clinical burden placed on surgeons.^{31,32} This can function to increase both institutional and provider capacity without increasing provider stress.

Mitigating the consequences of pandemic-related stress will also require deliberate efforts to promote surgeon wellbeing and resiliency. Our data demonstrate that, while the pandemic has introduced novel

Table 3
Themes, codes, and representative quotes from 6-month and 12-month follow-up surveys.

Have you experienced any major life events as a result of the COVID-19 pandemic?				
THEMES	6-MONTH CODES	6-MONTH QUOTES	12-MONTH CODES	12-MONTH QUOTES
Disruptions to personal life, directly and indirectly related to Covid-19	<ul style="list-style-type: none"> - Cancelled honeymoon - Change in wedding plans - Cancelled travel - Missed seeing family 	<p><i>“Postponed wedding”</i></p> <p><i>“Mostly just the chance to see our families. We did miss one family wedding this past summer.”</i></p>	<ul style="list-style-type: none"> - Change in wedding plans - Cancelled travel - Missed seeing family 	<p><i>“Change in wedding plans (still were able to get married just much smaller)”</i></p> <p><i>“Cancellation of family events and travel for those events”</i></p>
Disruptions to professional life, directly and indirectly related to Covid-19	<ul style="list-style-type: none"> - School disrupted - Fellowship changed - Cancelled residency graduation - Missed professional opportunities 	<p><i>“Resident graduation cancelled. Fellowship changed.”</i></p>	<ul style="list-style-type: none"> - Cancelled residency graduation - Missed professional opportunities 	<p><i>“Entire year of planned medical professional society travel cancelled.”</i></p>
Illness or death of loved ones, directly or indirectly related to Covid-19	<ul style="list-style-type: none"> - Serious illness family - Serious illness friend - Death of family member 	<p><i>“Grandfather died”</i></p> <p><i>“Serious illness of family and friends”</i></p>	<ul style="list-style-type: none"> - Serious illness family - Serious illness friend - Death of family member 	<p><i>“Serious illness of loved one”</i></p> <p><i>“Death of three family members”</i></p>
What has been your biggest fear during this pandemic?				
THEMES	6-MONTH CODES	6-MONTH QUOTES	12-MONTH CODES	12-MONTH QUOTES
Illness and/or death of loved ones	<ul style="list-style-type: none"> - Illness of loved one - Death of loved one 	<p><i>“Parent becoming ill/dying alone”</i></p>	<ul style="list-style-type: none"> - Illness of loved one - Death of loved one 	<p><i>“Illness of family members”</i></p> <p><i>“Losing family members”</i></p>
Infection of self and causing harm to others	<ul style="list-style-type: none"> - Getting Covid - Infecting loved ones - Dying from Covid - Orphaning children - Unable to provide for family 	<p><i>“Becoming infected or infecting others”</i></p> <p><i>“Becoming infected with COVID and then debilitated (e.g. from CVA) or dead, thereby leaving my wife and unborn child unable to financially care for themselves and emotionally devastated.”</i></p>	<ul style="list-style-type: none"> - Getting Covid - Infecting loved ones - Infecting patients - Orphaning children 	<p><i>“Getting Covid and giving to family”</i></p> <p><i>“My husband getting critically ill due to me infecting him from my exposures at work”</i></p>
Inability to care for patients	<ul style="list-style-type: none"> - Lack of resources for patient care - Redeployment outside typical scope of practice - Unable to care for patients - Decreased residency training opportunities 	<p><i>“Hospital staffing, lack of beds/staff/resources for our patients”</i></p> <p><i>“Having to quarantine and related workforce availability issues for coverage of patients”</i></p> <p><i>“Being inadequate at taking care of patients if outside of my specialty”</i></p>	<ul style="list-style-type: none"> - Redeployment outside typical scope of practice - Unable to care for patients 	<p><i>“Being redeployed and not able to care for patients well”</i></p>
Financial Concerns	<ul style="list-style-type: none"> - Financial impact on patients - Financial impact on family 	<p><i>“Financial concerns for our patients and people losing jobs and health insurance”</i></p> <p><i>“Leaving my family in a difficult financial situation or leaving my son without a mother.”</i></p>	<ul style="list-style-type: none"> - Financial concerns 	<p><i>“Financial concerns over lost income”</i></p> <p><i>“Financial distress”</i></p>
Societal unrest and future uncertainty	<ul style="list-style-type: none"> - Damage to society - Inadequate leadership - Politics - Unknown end 	<p><i>“My prevailing emotions are anxiety about the uncertainty of the future and depression/loneliness related to loss of social interaction and activities.”</i></p> <p><i>“Unclear end of pandemic, political games nationally and internationally”</i></p>	<ul style="list-style-type: none"> - Vaccine concerns - Unknown end 	<p><i>“Time to return to ‘new normal’ and what that will look like”</i></p> <p><i>“That it will never end!”</i></p>
Are there any specific new practices or lifestyle behaviors you have engaged in?				
THEME	6-MONTH CODES	6-MONTH QUOTES	12-MONTH CODES	12-MONTH QUOTES
Wellness activities	<ul style="list-style-type: none"> - Change in exercise routine - Sleep - Cooking - Hobbies - Mental health - Outdoors 	<p><i>“I cook a lot more and I work out at home.”</i></p> <p><i>“Meditation”</i></p> <p><i>“Spending more time outdoors”</i></p> <p><i>“I’m more open about my feelings”</i></p>	<ul style="list-style-type: none"> - Change in exercise routine - Cooking - Mental health - Outdoors 	<p><i>“Exercise”</i></p> <p><i>“Mindfulness”</i></p> <p><i>“Home workouts”</i></p> <p><i>“We adopted a dog and spend more time outdoors and in the park.”</i></p>
More time for relationships	<ul style="list-style-type: none"> - More time with family - Connect with remote friends - Pets 	<p><i>“Reading out loud to my kids for 1 h every night”</i></p> <p><i>“Spending more time with my partner at home and adopting a dog”</i></p>	<ul style="list-style-type: none"> - More time with family - Connect with remote friends 	<p><i>“We’ve enjoyed time as a nuclear family together, which I think has been very beneficial for us. We’ve also worked out in the house or outside of it together as a family, which has been nice.”</i></p> <p><i>“Paying attention to and actively spending more dedicated time with my family”</i></p>
Remote work	<ul style="list-style-type: none"> - More time at home - Zoom meetings - Remote conferences 	<p><i>“More socially acceptable to work from home, which is a huge help with 4 kids”</i></p> <p><i>“Not going to the hospital if I don’t have clinical duties”</i></p> <p><i>“Not traveling for work”</i></p>	<ul style="list-style-type: none"> - More time at home - Zoom meetings - Remote conferences 	<p><i>“Remote clinics and conferences”</i></p> <p><i>“Increased time at home working remotely”</i></p>
Infection control behaviors	<ul style="list-style-type: none"> - Self-disinfection practices 	<p><i>“Mask wearing. More handwashing”</i></p> <p><i>“Use of PPE”</i></p> <p><i>“Routine handwashing”</i></p>	<ul style="list-style-type: none"> - Self-disinfection practices - Social distancing 	<p><i>“Social distancing”</i></p> <p><i>“Take a shower when I get home from work”</i></p>

(continued on next page)

Table 3 (continued)

Have you experienced any major life events as a result of the COVID-19 pandemic?				
THEMES	6-MONTH CODES	6-MONTH QUOTES	12-MONTH CODES	12-MONTH QUOTES
	<ul style="list-style-type: none"> - Decontaminate surfaces/objects - Personal Protective Equipment 		<ul style="list-style-type: none"> - Personal Protective Equipment 	
What could your workplace do to better support you during this time?				
THEME	6-MONTH CODES	6-MONTH QUOTES	12-MONTH CODES	12-MONTH QUOTES
Protect physical safety	<ul style="list-style-type: none"> - Access to testing - Access to vaccines - Coverage plan in case of staff exposure - Safe spaces in workplace 	<p>“Access to vaccination”</p> <p>“Enforce mask policy”</p> <p>“Better access to safe transportation resources”</p> <p>“Provide more spaces for us to work in socially distanced way”</p> <p>“Having flexibility in the schedule or staffing in the event that a colleague or myself becomes exposed or ill”</p>	N/A	N/A
Improve Communication	<ul style="list-style-type: none"> - Better communication - Accessibility of leadership/administration - Recognition 	<p>“Clear communication at all times. Department leadership is generally very good at this, but divisional leadership is lacking in this regard.”</p> <p>“I feel that administrators are not as accessible when they work from home. More responsiveness is needed-step up communication.”</p>	<ul style="list-style-type: none"> - Better communication - Recognition 	<p>“Training location: better communication, more support of staff. Practice location: help with adjusting volume expectations. Communication on what is expected.”</p>
Support for personal and professional needs	<ul style="list-style-type: none"> - Childcare - Support professional development - Support mental health and wellness - More time off 	<p>“Backup childcare”</p> <p>“Expanded access to mental health resources”</p> <p>“I think my workplace could offer more personal days off than they do. Because of the pandemic and all the associated stressors, my mental health has been strained while at work and I think one day off per month or every other month would help significantly.”</p> <p>“More research support to not have our academic careers suffer while we are taking added administrative/childcare responsibilities”</p>	<ul style="list-style-type: none"> - Childcare - Support professional development support - Support mental health and wellness - F020 More time off- Support for remote work 	<p>“Counseling in regards to all the delays in academic advancement and how that will effect promotion and tenure”</p> <p>“Support with professional development/ opportunities”</p> <p>“Continue to offer remote options for meetings, allow for flexible work, provide financial and schedule support for mental health and wellness”</p> <p>“Ask me what I need instead of deciding what they are willing to offer”</p> <p>“More time off”</p>
Increase financial support	<ul style="list-style-type: none"> - Retirement matching - Hazard pay - Maintain salary - Better insurance options 	<p>“Hazard pay”</p> <p>“Reduce RVUs required for certain pay grades or redeploy me to ensure pay stays the same”</p> <p>“Would be nice to not take a pay cut”</p>	<ul style="list-style-type: none"> - Retirement matching - Hazard pay - Increase salary - Financial compensation 	<p>“The biggest issues arise from the lack of institutional leadership support including expectations for more clinical care with less resources. The institution also stopped retirement support for all of its staff in the health system, yet continued support for everyone else in the University. This is finally starting to change, but we’ll never get back to the level of support that we had before as the institution used COVID as an excuse for a huge cost-cutting exercise.”</p> <p>“Compensate those who worked even more than normal during the last 15 months”</p> <p>“Hazard pay and equal financial incentives”</p> <p>“Increase salary”</p>
Address Volume and Capacity Challenges	<ul style="list-style-type: none"> - Resource policies - Work volume expectations 	<p>“Less expectations for increased work capacity to meet medical centers financial goals”</p> <p>“There is too much focus on surgical volume, office volume and outperforming ourselves.”</p>	<ul style="list-style-type: none"> - More clinical support - Work volume expectations - Capacity challenges 	<p>“More clinical support”</p> <p>“Place less emphasis on RVUs, surgical volume”</p> <p>“Training location: better communication, more support of staff. Practice location: help with adjusting volume expectations. Communication on what is expected.”</p> <p>“Support with volume and capacity challenges”</p>

stressors (i.e., fears related to Covid-19 morbidity and mortality), it has also exacerbated the major factors known to contribute to burnout: lack of autonomy or control, work overload, insufficient reward, feelings of isolation, lack of fairness, and misalignment of individual and organizational values.^{22,33,34} Thus, the pandemic presents a critical opportunity to pause, reflect, and implement both individual-level and organizational-level approaches to combat surgeon burnout. Specific individual-focused approaches may include stress management training, professional coaching, and facilitated small group discussion. Examples of organizational-level approaches include: maximizing flexibility over work schedules, providing opportunities for team building and social engagement, and allowing surgeons to dedicate 20% of their professional effort to what they find most meaningful.^{33–35} Additionally, by

adopting the Mayo Clinic’s 9 organizational strategies to promote physician engagement,³⁶ institutions can develop more targeted interventions to better support the wellbeing and resiliency of their surgical workforce during the ongoing Covid-19 pandemic.

4.1. Limitations

This study has several limitations. First, the decreased survey response rate for the follow-up surveys, particularly the 12-month survey, may introduce nonresponse bias. However, no significant differences were found when comparing follow-up survey respondents and non-respondents.

Second, although significant, the pandemic was not the only

disruption in the personal and professional lives of respondents during the study period, and thus stress levels might not be solely attributable to the effects of Covid-19 alone. Baseline stress levels for respondents were unable to be assessed due to the ongoing nature of the pandemic at the start of the initial study. Since our research question focused on the change in surgeon stress over the pandemic, and all follow-up survey respondents contributed to the initial survey, current stress levels from the initial survey were able to function as a quasi-baseline stress level in the context of the present study.

Third, we are unable to comment on the impact of vaccination on surgeon stress. Emergency Use Authorization for Pfizer, BioNTech and Moderna vaccines was granted on December 11 and 18, 2020, respectively,³⁷ and vaccination data was not publicly available for the entire study period. Notably, the 6-month follow-up survey was administered around the time of vaccine approval (December 14, 2020 – January 14, 2021) and by the 12-month follow-up survey (June 14 – July 14, 2021) nearly 50% of the eligible US population was fully vaccinated.³⁸ While the change in the types of the stressors observed at 6-months and 12-months suggests an association between widespread adult vaccination and surgeon stress, further studies are needed to quantitatively assess this relationship.

Fourth, the 12-month study was likely underpowered to detect statistically significant differences in the stratified analysis by training status. However, it is interesting to note that the housestaff, who likely have younger children who may not have been eligible for vaccination at the time of the 12-month survey, expressed similar levels of stress related to infecting their children across the entire study time-frame. This contrasted with the trend in reported stress of infecting children by faculty where we saw a smaller proportion who reported stress of infecting children at the 12-month time point, which occurred after approval of vaccination of children 12 years of age and older.³⁹

Finally, this study was conducted at academic medical centers in metropolitan areas, which may limit the generalizability of our findings. Given that community and rural medical centers may have fewer financial and clinical resources,⁴⁰ it is possible that our findings underestimate surgeon stress at these institutions.

4.2. Conclusions

As the United States approaches the 3rd year of the Covid-19 pandemic, we must recognize that like the virus itself, the experience of the surgical workforce has evolved. Our data suggest that both the acute and chronic forms of the pandemic cause stress, but the drivers of this stress are different. To continue to adequately support the entire surgical workforce, regardless of training status, healthcare institutions should address surgeon concerns related to finances and surgical capacity. In the face of financial and resource constraints, implementing value-based strategies can help to optimize system efficiency and capacity,^{28,41} though careful attention must be paid to the effects of these strategies on individual surgeon workload. Further support of surgeons should also address the ongoing non-financial stressors. Interventions can be informed by the evidence-based strategies to mitigate physician burnout, and should specifically consider providing continued workplace flexibility, protected time for mental health and wellness, and dedicated faculty development time to address delays in professional development and academic advancement. As Covid-19 transitions from pandemic to endemic, we must continue to critically examine and deliberately support the surgical workforce in order to protect against long-term psychological and financial harm.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements

This study would not have been possible without the research team members at each institution, particularly Chloe Warinner, BA, Amanda Reich, PhD, Masami Kelly, MA, Claudia Orlas Bolanos, MD, and Manuel Castillo Angeles, MD, MPH, from Brigham and Women's Hospital; Jenny Broering, RN, PhD, MPH, and Lillian Lai, MD, from the University of California, San Francisco; Alex Sobczak, BS, Merissa Maccani, BS, Alex Highet, BA, Sara Jafri, BS, Michael Broderick, BS, Lia Delaney, BS, Brandon Ellsworth, BA, and Christopher Breuler, BS from the University of Michigan.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amjsurg.2022.04.015>.

References

1. CMS adult elective surgery and procedures recommendations. <https://www.cms.gov/files/document/cms-non-emergent-elective-medical-recommendations.pdf>. Accessed November 9, 2021.
2. COVID-19: Recommendations for management of elective surgical procedures. March. 2020;13. <https://www.facs.org/covid-19/clinical-guidance/elective-surgery>. Accessed November 9, 2021.
3. Coleman JR, Abdelsattar JM, Glocker RJ, et al. COVID-19 pandemic and the lived experience of surgical residents, fellows, and early-career surgeons in the American College of Surgeons. *J Am Coll Surg*. 2021;232(2):119–135. e120.
4. Satiani B, Davis CA. The financial and employment effects of coronavirus disease 2019 on physicians in the United States. *J Vasc Surg*. 2020;72(6):1856–1863.
5. Collins C, Mahuron K, Bongiovanni T, Lancaster E, Sosa JA, Wick E. Stress and the surgical resident in the COVID-19 pandemic. *J Surg Educ*. 2021;78(2):422–430.
6. Dzau VJ, Kirch D, Nasca T. Preventing a parallel pandemic—a national strategy to protect clinicians' well-being. *N Engl J Med*. 2020;383(6):513–515.
7. Shanafelt T, Ripp J, Trockel M. Understanding and addressing sources of anxiety among health care professionals during the COVID-19 pandemic. *JAMA*. 2020;323(21):2133–2134.
8. Mavroudis CL, Landau S, Brooks E, et al. The relationship between surgeon gender and stress during the Covid-19 pandemic. *Ann Surg*. 2021;273(4):625.
9. Mavroudis CL, Landau S, Brooks E, et al. Exploring the experience of the surgical workforce during the Covid-19 pandemic. *Ann Surg*. 2021;273(3):e91.
10. Berlin G, Bueno David, Gibler Kyle, Schulz John. Cutting through the COVID-19 surgical backlog. October 2, 2020 <https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/cutting-through-the-covid-19-surgical-backlog>. Accessed November 9, 2021.
11. Jain A, Dai TBK, Myers C. Covid-19 created an elective surgery backlog: how can hospitals get back on track. *Harv Bus Rev* August. 2020;10.
12. Cobianchi L, Pugliese L, Peloso A, Dal Mas F, Angelos P. To a new normal: surgery and COVID-19 during the transition phase. *Ann Surg*. 2020;272(2):e49.
13. Karvounides D, Simpson PM, Davies WH, Khan KA, Weisman SJ, Hainsworth KR. Three studies supporting the initial validation of the stress numerical rating scale-11 (Stress NRS-11): a single item measure of momentary stress for adolescents and adults. *Pediatric Dimensions*. 2016;1(4):105–109.
14. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inf*. 2009;42(2):377–381.
15. *StataCorp. Stata Statistical Software: Release 15*. College Station, TX: StatCorp LLC; 2017.
16. Braun V, Clarke V. *What Can "Thematic Analysis" Offer Health and Wellbeing Researchers?* Taylor & Francis; 2014.
17. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol*. 2006;3(2):77–101.
18. Maunder RG, Lancee WJ, Balderson KE, et al. Long-term psychological and occupational effects of providing hospital healthcare during SARS outbreak. *Emerg Infect Dis*. 2006;12(12):1924.
19. Lee AM, Wong JG, McAlonan GM, et al. Stress and psychological distress among SARS survivors 1 year after the outbreak. *Can J Psychiatr*. 2007;52(4):233–240.
20. McAlonan GM, Lee AM, Cheung V, et al. Immediate and sustained psychological impact of an emerging infectious disease outbreak on health care workers. *Can J Psychiatr*. 2007;52(4):241–247.
21. Scobie HM, Johnson AG, Suthar AB, et al. Monitoring incidence of COVID-19 cases, hospitalizations, and deaths, by vaccination status—13 US jurisdictions, April 4–July 17, 2021. *MMWR (Morb Mortal Wkly Rep)*. 2021;70(37):1284.
22. Balch CM, Freischlag JA, Shanafelt TD. Stress and burnout among surgeons: understanding and managing the syndrome and avoiding the adverse consequences. *Arch Surg*. 2009;144(4):371–376.
23. Restauri N, Sheridan AD. Burnout and posttraumatic stress disorder in the coronavirus disease 2019 (COVID-19) pandemic: intersection, impact, and interventions. *J Am Coll Radiol*. 2020;17(7):921–926.

24. Panagioti M, Geraghty K, Johnson J, et al. Association between physician burnout and patient safety, professionalism, and patient satisfaction: a systematic review and meta-analysis. *JAMA Intern Med.* 2018;178(10):1317–1331.
25. Shanafelt TD, Balch CM, Bechamps G, et al. Burnout and medical errors among American surgeons. *Ann Surg.* 2010;251(6):995–1000.
26. *Hospitals and Health Systems Face Unprecedented Financial Pressures Due to COVID-19.* American Hospital Association; May 2020.
27. Billig JI, Sears ED. The compounding access problem for surgical care: innovations in the post-COVID era. *Ann Surg.* 2020;272(2):e47.
28. Berlin NL, Dimick JB, Kerr EA, Skolarus TA, Dossett LA. Demand for surgical procedures following COVID-19: the need for operational strategies that optimize resource utilization and value. *Ann Surg.* 2020;272(4):e272–e274.
29. Jacobs A. 'Nursing is in crisis': staff shortages put patients at risk. *N Y Times.* August 21, 2021.
30. Boyle P. Hospitals innovate amid dire nursing shortages. September 7, 2021 <https://www.aamc.org/news-insights/hospitals-innovate-amid-dire-nursing-shortages>. Accessed November 9, 2021.
31. Sammann A, Chehab LZ, Patel D, Liao J, Callcut R, Knudson MM. Improving efficiency and meeting expectations without compromising care on trauma surgical rounds. *J Surg Res.* 2020;247:163–171.
32. Baccei SJ, Henderson SR, Lo HS, Reynolds K. Using quality improvement methodology to reduce costs while improving efficiency and provider satisfaction in a busy, academic musculoskeletal radiology division. *J Med Syst.* 2020;44(6):1–7.
33. Rothenberger DA. Physician burnout and well-being: a systematic review and framework for action. *Dis Colon Rectum.* 2017;60(6):567–576.
34. Carrau D, Janis JE. Physician burnout: solutions for individuals and organizations. *Plast Reconstr Surg Glob Open.* 2021;9(2).
35. Mahmoud NN, Rothenberger D. From burnout to well-being: a focus on resilience. *Clin Colon Rectal Surg.* 2019;32:415–423, 06.
36. Shanafelt TD, Noseworthy JH. Executive leadership and physician well-being: nine organizational strategies to promote engagement and reduce burnout. Paper presented at: Mayo Clin Proc.
37. AJMC. A Timeline of COVID-19 Developments in 2020. American Journal of Managed Care. (January 1, 2021). <https://www.ajmc.com/view/a-timeline-of-covid19-developments-in-2020>. Accessed November 9, 2021.
38. US Coronavirus vaccine tracker. USA Facts. <https://usafacts.org/visualizations/covid-vaccine-tracker-states>. Accessed December 6, 2021.
39. Coronavirus (COVID-19) update: FDA authorizes Pfizer-BioNTech COVID-19 vaccine for emergency use in adolescents in another important action in fight against pandemic. U.S. Food and Drug Administration <https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-pfizer-bio-ntech-covid-19-vaccine-emergency-use>. Accessed March 6, 2022.
40. Khullar D, Bond AM, Schpero WL. COVID-19 and the financial health of US hospitals. *JAMA.* 2020;323(21):2127–2128.
41. Kadakia KT, Fleisher LA, Stimson C, Aloia TA, Offodile AC. Charting a roadmap for value-based surgery in the post-pandemic era. *Ann Surg.* 2020;272(2):e43.