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Original Research Article

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

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A R T I C L E   I N F O

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A B S T R A C T

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.\(^4,5\) 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...
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, Multi-site, 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. 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). 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. 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).

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. 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. 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 partner), 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 1.75), while mean current stress at the time of the initial survey was 4.37 (SD 2.03). 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 2.29). 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.

| Number of Respondents | 256 | 103 | 53 |
|------------------------|-----|-----|----|
| What is your age?, mean (SD) | 38.6 (10.6) | 38.3 (9.8) | 38.0 (10.3) |
| Occupational Status, n (%) | 120 (46.9) | 54 (52.4) | 29 (54.7) |
| Housestaff, n (%) | 136 (53.1) | 49 (47.6) | 24 (45.3) |
| Faculty, n (%) | 28 (23.3) | 11 (20.4) | 5 (17.2) |
| Housestaff: What is your PGY Level? n (%) | 1, n (%) | 2, n (%) | 3, n (%) |
| 1, n (%) | 25 (20.8) | 8 (14.8) | 5 (17.2) |
| 2, n (%) | 17 (14.2) | 12 (22.2) | 8 (27.6) |
| 3, n (%) | 11 (9.2) | 6 (11.1) | 4 (13.8) |
| Dependents aged 60+, n (%) | 15 (12.5) | 6 (11.1) | 0 (0.0) |
| Dependents aged ≤18, n (%) | 13 (10.8) | 5 (9.3) | 3 (10.3) |
| Dependents aged 19+, n (%) | 7 (5.8) | 4 (7.4) | 2 (6.9) |
| Dependents aged 19+ (if Yes), 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 (%) | 181 (70.7) | 74 (71.8) | 33 (62.3) |
| Married, n (%) | 16 (6.3) | 9 (8.7) | 5 (9.4) |
| Domestic Partnership, n (%) | 17 (6.6) | 9 (8.7) | 5 (9.4) |
| Monogamous Relationship, NOS, n (%) | 33 (12.9) | 9 (8.7) | 9 (17.0) |
| Single, n (%) | 4 (1.6) | 0 (0.0) | 0 (0.0) |
| Divorced, n (%) | 5 (2.0) | 2 (1.9) | 1 (1.9) |
| Other, n (%) | 197 (78.2) | 83 (80.6) | 38 (71.7) |
| Relationship Status, n (%) | 17 (6.7) | 9 (8.7) | 5 (9.4) |
| Partnered, n (%) | 33 (13.1) | 9 (8.7) | 9 (17.0) |
| Single/Divorced, n (%) | 5 (2.0) | 2 (1.9) | 1 (1.9) |
| Other, n (%) | 16 (6.3) | 67 (60.7) | 30 (78.9) |
| Occupational Status, n (%) | 103 (40.2) | 45 (43.7) | 28 (52.8) |
| Business Person, n (%) | 30 (12.9) | 14 (20.9) | 7 (14.3) |
| Other, n (%) | 7 (4.4) | 2 (3.0) | 1 (3.3) |
| Physician, n (%) | 71 (44.4) | 27 (40.3) | 12 (40.0) |
| Other Healthcare Worker, n (%) | 36 (46.2) | 11 (37.9) | 4 (30.8) |
| No, n (%) | 42 (53.8) | 18 (62.1) | 9 (69.2) |
| Yes, n (%) | 91 (35.5) | 37 (35.9) | 23 (43.4) |
| Dependent status (if “Partnered”): Partner Employed? (Yes), n (%) | 165 (64.5) | 66 (64.1) | 30 (56.6) |
| No, n (%) | 223 (87.1) | 87 (84.5) | 48 (90.6) |
| Yes, n (%) | 7 (4.4) | 2 (3.0) | 1 (3.3) |
| Dependents, n (%) | 33 (12.9) | 16 (15.5) | 5 (9.4) |
| No, n (%) | 118 (46.1) | 45 (43.7) | 22 (41.5) |
| Yes, n (%) | 19 (7.4) | 7 (6.8) | 6 (11.3) |
| Dependents aged 19–59, n (%) | 6 (2.3) | 1 (1.0) | 0 (0.0) |
| Number of Dependents (non-pets), mean (SD) | 1.1 (1.3) | 1.0 (1.3) | 1.0 (1.3) |
| Is anyone pregnant in the household?, n (%) | 244 (95.3) | 99 (96.1) | 51 (96.2) |
| No, n (%) | 12 (4.7) | 4 (3.9) | 3 (4.8) |
| Yes, n (%) | 100 (39.1) | 42 (40.8) | 21 (39.6) |
| General Surgery, n (%) | 27 (10.5) | 12 (11.7) | 7 (13.2) |
| Plastic and Reconstructive Surgery, n (%) | 16 (6.3) | 7 (6.8) | 2 (3.8) |
| Colorectal Surgery, n (%) | 14 (5.5) | 5 (4.9) | 4 (7.5) |
| Trauma, Acute Care, and Surgical Critical Care, n (%) | 11 (4.3) | 4 (3.9) | 3 (5.7) |
| Surgical Oncology, n (%) | 88 (34.4) | 33 (32.0) | 16 (30.2) |
| Other Specialty, n (%) | 227 (88.7) | 89 (86.4) | 50 (94.3) |
| Operative Case load, n (%) | 28 (10.9) | 14 (13.6) | 3 (5.7) |
| Increased, n (%) | 163 (80.3) | 73 (89.0) | 34 (81.0) |

Table 2
Stressors by survey period.

| Stressor | Initial Survey | Initial Survey + 6-month Follow-Up | Initial Survey + 12-month Follow-Up |
|----------|----------------|-----------------------------------|-----------------------------------|
| n (%)    | 256 | 103 (25.0) | 53 (12.9) |
| Financial concerns | 68 (26.6) | 28 (27.2) | 18 (34.0) |
| Rebuilding surgical practice | 42 (16.7) | 11 (10.7) | 5 (9.4) |
| Recurring concerns regarding difficult clinical decisions during the pandemic | 24 (23.3) | 6 (11.3) |
| Possibility of a second wave | 51 (49.5) | 17 (32.1) |
| Adverse events (advanced disease due to treatment delays for patients during the pandemic) | 32 (31.1) | 12 (22.6) |

At any time during the pandemic, were you notified that you could be redeployed? (Yes), n (%) | 53 (20.7) | 21 (20.4) | 11 (20.8) |

Are you working, or have you worked, outside of your typical scope of practice (Yes), n (%) | 163 (80.3) | 73 (89.0) | 34 (81.0) |

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 stressors.
stresses across the survey time points. In the initial and 6-month sur-
veys, 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 finan-
cial 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 of 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 re-
ported similar total numbers of stressors at 6-months and 12-months.
The faculty and housestaff also reported similar experiences with indi-
vidual 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 sta-
tistically significant difference in the proportion of faculty and house-
staff 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 iden-
tified 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 pa-
tients.” At 6-months, codes for this theme reflected concerns about re-
sources, redeployment, and residency training opportunities, while at
12-months, the codes were mainly focused on redeployment. Simi-
larly, “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 re-
spones 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 mem-
bers 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.19,20 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 pro-
viders 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 ca-
pacity, aligns with the broader challenges facing healthcare. Cancell-
a tion of elective surgical cases early in the pandemic resulted in
significant financial losses and backlog of cases.22,10,28 With declining
dates 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.24,30 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.26 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 in-
terventions 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.22,31,32 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

S.I. Landau et al.
The American Journal of Surgery 224 (2022) 1199–1206
1202

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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** | • Cancelled honeymoon | • Change in wedding plans | • Change in wedding plans (still were able to get married just much smaller) | |
| | • Change in wedding plans | • Cancelled travel | • Cancellation of family events and travel for those events | |
| | • Cancelled travel | • Missed seeing family | | |
| | • Missed seeing family | | | |
| **Disruptions to professional life, directly and indirectly related to Covid-19** | • School disrupted | • Resident graduation cancelled. Fellowship changed. | • Entire year of planned medical professional society travel cancelled. | |
| | • Fellowship changed | • Canceled residency graduation | • Missed professional opportunities | |
| | • Canceled residency graduation | • Missed professional opportunities | | |
| | • Missed professional opportunities | | | |
| **Illness or death of loved ones, directly or indirectly related to Covid-19** | • Serious illness family | • Serious illness family | • Serious illness of loved one | |
| | • Serious illness friend | • Serious illness friend | • Death of family member | |
| | • Death of family member | | | |

| 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** | • Illness of loved one | • Parent becoming ill/dying alone | • Illness of loved one | • Illness of loved one | |
| | • Death of loved one | | • Death of loved one | • Losing family members | |
| **Infection of self and causing harm to others** | • Getting Covid | • Becoming infected or infecting others | • Getting Covid | • Getting Covid and giving to family | |
| | • Infecting loved ones | • 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. | • Infecting patients | • My husband getting critically ill due to me infecting him from my exposures at work | |
| | • Dying from Covid | • Unable to provide for family | • Orphaning children | | |
| | • Orphaning children | | | | |
| **Inability to care for patients** | • Lack of resources for patient care | • Hospital staffing, lack of beds/staff/resources for our patients | • Redeployment outside typical scope of practice | • Being redeployed and not able to care for patients well | |
| | • Redeployment outside typical scope of practice | • Having to quarantine and related workforce availability issues for coverage of patients | • Unable to care for patients | | |
| | • Unable to care for patients | • Being inadequate at taking care of patients if outside of my specialty | | | |
| | • Decreased residency training opportunities | | | | |
| **Financial Concerns** | • Financial impact on patients | • Financial concerns for our patients and people losing jobs and health insurance | • Financial concerns | • Financial concerns over lost income | |
| | • Financial impact on family | • Leaving my family in a difficult financial situation or leaving my son without a mother. | | • Financial distress | |
| **Societal unrest and future uncertainty** | • Damage to society | • My prevailing emotions are anxiety about the uncertainty of the future and depression/loneliness related to loss of social interaction and activities. | • Vaccine concerns | • Time to return to ‘new normal’ and what that will look like | |
| | • Inadequate leadership | | • Unknown end | • That it will never end” | |
| | • Politics | • “Unclear end of pandemic, political games nationally and internationally” | | | |

| 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** | • Change in exercise routine | • I cook a lot more and I work out at home.” | • Change in exercise routine | • Exercise” | |
| | • Sleep | • ‘Mediation’ | • Cooking | • Mindfulness” | |
| | • Cooking | • ‘Spending more time outdoors’ | • Mental health | • ‘Home workouts” | |
| | • Hobbies | • ‘I’m more open about my feelings” | • Outdoors | • ‘We adopted a dog and spend more time outdoors and in the park.” | |
| | • Mental health | | | | |
| | • Outdoors | | | | |
| **More time for relationships** | • More time with family | • ‘Reading out loud to my kids for 1 h every night” | • More time with family | • ‘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.” | |
| | • Connect with remote friends | • ‘Spending more time with my partner at home and adopting a dog” | • Connect with remote friends | • ‘Paying attention to and actively spending more dedicated time with my family” | |
| | • Pets | | | | |
| **Remote work** | • More time at home | • ‘More socially acceptable to work from home, which is a huge help with 4 kids” | • More time at home | • ‘Remote clinics and conferences” | |
| | • Zoom meetings | • ‘Not going to the hospital if I don’t have clinical duties” | • Zoom meetings | • ‘Increased time at home working remotely” | |
| | • Remote conferences | • ‘Not traveling for work” | • Remote conferences | | |
| **Infection control behaviors** | • Self-disinfection practices | • ‘Mask wearing. More handwashing” | • Self-disinfection practices | • ‘Social distancing” | |
| | • ‘Use of PPE” | • ‘Routine handwashing” | | | |

(continued on next page)
isolation, lack of fairness, and misalignment of individual and organizational values. 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. Additionally, by adopting the Mayo Clinic’s 9 organizational strategies to promote physician engagement, 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, 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. 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.

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, 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, 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.

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Appendix A. Supplementary data

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

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