Critical care medicine training in the age of COVID-19

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Abstract

Context: The COVID-19 pandemic caused the largest disruption to graduate medical education in modern history. The danger associated with SARS-CoV-2 necessitated a paradigm shift regarding the fundamental approach to the education of medical residents and fellows. Whereas prior work has examined the effect of the pandemic on residents’ experiences during training, the effect of the pandemic on academic performance of critical care medicine (CCM) fellows is not well understood.

Objectives: This study examined the relationship between CCM fellow’s lived experiences during the COVID-19 pandemic and performance on in-training examinations.

Methods: This mixed-methods study consisted of a quantitative retrospective analysis of critical care fellows’ in-training examination scores and a qualitative, interview-based phenomenological examination of fellows’ experiences during the pandemic while training in a single large academic hospital in the American Midwest. Quantitative: Prepandemic (2019 and 2020) and intrapandemic (2021 and 2022) in-training examination scores were analyzed utilizing an independent samples t test to determine whether a significant change occurred during the pandemic. Qualitative: Individual semi-structured interviews were conducted with CCM fellows exploring their lived experiences during the pandemic and their perception of the effect on their academic performance. Transcribed interviews were analyzed for thematic patterns. These themes were coded and categorized, and subcategories were developed as indicated during the analysis. The identified codes were then analyzed for thematic connections and apparent patterns. Relationships between themes and categories were analyzed. This process was continued until a coherent picture could be assembled from the data to answer the research questions. Analysis was performed from a phenomenological perspective with an emphasis on interpretation of the data from the participants’ perspectives.

Results: Quantitative: Fifty-one in-training examination scores from 2019 to 2022 were obtained for analysis. Scores from 2019 to 2020 were grouped as prepandemic scores, while scores from 2021 to 2022 were grouped as intrapandemic scores. Twenty-four prepandemic and 27 intrapandemic scores were included in the final analysis. A significant difference was found between mean total prepandemic and intrapandemic in-service examination scores ($t_{49}=2.64$, $p=0.01$), with mean intrapandemic scores being 4.5 points lower than prepandemic scores (95% CI, 1.08–7.92). Qualitative: Interviews were conducted with eight CCM fellows. Thematic analysis of the qualitative interviews revealed three main themes: psychosocial/emotional effects, effects on training, and effects on health. The factors that most affected participants’ perceptions of their training were burnout, isolation, increased workload, decreased bedside teaching, decreased formal academic training opportunities, decreased procedural experience, a lack of an external reference point for normal training in CCM, fear of spreading COVID-19, and neglect of personal health during the pandemic.

Conclusions: In-training examination scores decreased significantly during the COVID-19 pandemic for CCM fellows in this study. The fellows in this study reported perceived effects of the pandemic on their psychosocial/emotional well-being, medical training, and health.

Keywords: academic performance; COVID-19; critical care medicine; graduate medical education; in-training exam; mental health.

On March 11, 2020, the World Health Organization (WHO) declared the newly emerged SARS-CoV-2–related COVID-19 disease to be a pandemic [1]. The virus rapidly spread throughout the United States, and there were over 104,698,931 cases and 1,131,819 deaths as of May 7, 2023 [2]. Healthcare workers found themselves in an unprecedented situation as hospitals became overwhelmed [3] and had no well-defined plans for crisis standards of care in place [4]. The COVID-19 pandemic caused the largest disruption to graduate medical education in modern history [5], and the associated danger
necessitated a paradigm shift regarding the fundamental approach to the education of residents and fellows.

Lockdowns and distancing measures aimed at mitigating the risk of acquiring COVID-19 [6–8] resulted in disruptions in experiential learning opportunities for graduate medical trainees [9–11]. Experiential learning relies on the learner to reflect on, modify, and construct knowledge based on direct experience [12]. Trainees deprived of direct learning experiences have reported increased concern about missed educational opportunities [10]. In contrast, trainees participating in experiential learning programs have reported better perceptions of learning [9] and demonstrate better mastery of material [13].

Trainees in general surgery, cardiac surgery, otolaryngology, cardiac electrophysiology, and critical care medicine (CCM) have experienced variable levels of patient contact, decreased procedural volume, and decreased in-person learning opportunities [14–19]. Training in CCM is of particular concern because this specialty relies not only on direct patient contact, but also on procedure volume to ensure adequate training.

The COVID-19 pandemic has affected the mental health of residents [20, 21]. Trainees have expressed fear of contracting COVID-19 or bringing the disease home to family members as their most pressing concerns [20, 21]. Stress, anxiety, depression, posttraumatic stress disorder (PTSD), and burnout have increased in residents during the pandemic, with concern for personal health, family health, and inadequate access to personal protective equipment (PPE) most cited as the source of the increase [22, 23]. Additionally, trainees have expressed concern that training received during the pandemic may be inadequate preparation for the independent practice of medicine [16–19]. The uniformity of the effects of the COVID-19 pandemic on residents’ mental health remain uncertain; however, some authors have suggested that rates of trainee burnout have not changed during the pandemic [24, 25].

CCM fellows potentially have an increased risk of suffering academic setbacks due to their experiences during the pandemic. CCM clinicians have experienced both the psychological [8, 22] and educational [26] effects of the COVID-19 pandemic. Although prior studies have examined graduate medical trainees’ perceptions of the academic disruption associated with the COVID-19 pandemic [27, 28], the effect of these experiences on the academic performance of CCM fellows is not yet known.

**Hypotheses**

1. In-training examination scores of CCM fellows obtained during the first 2 years (2021 and 2022) of the pandemic will be lower than those obtained in the 2 years immediately prior to the pandemic (2019 and 2020).
2. Compared to prepandemic scores, intrapandemic scores will be higher for subjects directly related to the care of acute respiratory distress syndrome and the treatment of severe pulmonary diseases, and lower for those subjects that are not related to these topics.
3. CCM fellows will perceive concerns regarding personal health, family health, and inadequate access to PPE as having the greatest effect on their academic performance during the first and second years of the pandemic.

**Methods**

**Ethical approval**

A mixed-methods, observational study design was chosen to allow for greater understanding of the potential relationship of the variables involved. A before and after observational study design was utilized for the quantitative portion of the study. The study was deemed exempt by the A.T. Still Research Institute (IRB# WM20220601-001) and underwent expedited review and approval from the primary research site (IRB# 1.917.047) 22–084).

**Sample**

The qualitative portion of this study utilized a convenience sample of CCM fellows within a large academic hospital located in a major metropolitan area within the midwestern United States. The researcher adhered to a strict policy of nondiscrimination based on race, color, ethnicity, religion, sex, age, national origin, sexual orientation, gender identity or expression, disability, veteran status, marital status, or any other protected status.

**Recruitment**

All CCM fellows at the research site were given equal chance to participate in the study. A brief introduction was provided at the hospital during an established monthly fellowship meeting, after which each fellow was sent an email inviting them to participate in the qualitative portion of the study. A follow-up email was sent 1 week after the original email invitation.

Informed consent was obtained from all participants in person by the primary researcher, which included a thorough explanation of the purpose, risks, and benefits of the study. Participation was voluntary and participants were informed of their right to withdraw from the study at any time, that there was no penalty for withdrawal from the study, and that participation vs. nonparticipation had no effect on their academic assessments. No incentives were offered for participation.

**Instrumentation**

Scores from the Multidisciplinary Critical Care Knowledge Assessment Program (MCKAP) were utilized to assess academic performance. The
internal reliability coefficient for this examination is 0.89, indicating good internal consistency [29]. In-training examinations also have a strong positive predictive value for a trainee’s likelihood of passing their specialty board examination [30], making them valuable tools to assess a trainee’s progress during training.

Semi-structured interviews utilized a set of questions/prompts to stimulate a discussion regarding the trainees' experiences during the pandemic, their perception and experience of being in training during the pandemic, and their perceptions of the effect of the pandemic on their academic performance. Each of the questions was meant to stimulate conversation and could be followed up with unstructured questions. Face validity of the qualitative interview questions was assessed utilizing by a group of experts who were unaffiliated with the research. Construct and content validity were assessed continuously through the study by examining the answers elicited by the questions within the phenomenological framework of the research, as suggested by Hayashi et al. [31].

Data collection

Quantitative: Data for the quantitative portion of the study were collected from fellows’ score reports from the MCCKAP in-training examination [32] taken from 2019 to 2022.

To allow for consistent data analysis across all 4 years of tests, subtopics reported from 2019 to 2021 were combined into the appropriate topics. The subtopic scores from 2019, 2020, and 2021 were each recorded, sorted into the appropriate topic based on those reported in 2022, and the mean for the combined subtopics was reported as the topic score. This process resulted in scores for the following 24 topics: renal, electrolytes, acid-base disorders, endocrine, cardiovascular disorders, pulmonary disease, infectious disease, gastrointestinal disorders, liver, neurologic disorders, hematologic disorders, oncology, surgery and trauma, transplantation, environmental injury and disaster management, pharmacology and toxicology, obstetrics, research/administration and ethics, critical care ultrasound, autoimmune disorders, dermatologic/integument, immunology, epidemiology/outcomes, and anestheisia.

Qualitative: Interviews were conducted by the primary researcher. Interviews followed the outline provided in the qualitative research questions, but both the researcher and the participant were free to pursue any other lines of discussion that they felt were relevant. Following the completion of all interviews, the audio was transcribed verbatim, assigned a numerical identifier with no link to the participants identity, and entered into the qualitative coding software. The original interview recordings were permanently deleted.

Data analysis

Total scores and scores from each of the 24 individual subsections from the in-service examinations for the prepandemic and intrapandemic test groups were analyzed utilizing a 2-tailed independent samples t test.

Interviews were analyzed for thematic patterns. Themes were coded and categorized, and subcategories were developed as indicated during the analysis. The identified codes were then analyzed for thematic connections and apparent patterns. Relationships between themes and categories were analyzed. This process was continued until a coherent picture could be assembled from the data to answer the research questions. Analysis was performed from a phenomenological perspective with an emphasis on interpretation of the data from the participants’ perspectives.

Results

Sample

Quantitative

Fifty-one in-training examination scores from 2019 to 2022 were obtained for analysis. Scores from 2019 to 2020 were grouped as prepandemic scores, whereas scores from 2021 to 2022 were grouped as intrapandemic scores. Twenty-four prepandemic and 27 intrapandemic scores were included in the final analysis. Mean scores and standard deviations are presented in Table 1.

Qualitative

Invitations to participate in the study were sent to 13 fellows. Eight fellows were screened for eligibility, and all were enrolled in the study. Eight interviews were completed. The interviews were transcribed verbatim. Transcriptions and the researcher’s field notes and observations were entered into ATLAS.ti for analysis.

An initial codebook was developed with codes corresponding to each section and subsection of the interview guide. Further codes were developed as themes emerged and were identified during the qualitative analysis process. Codes were then grouped by theme, and redundant codes were eliminated.

Findings

Quantitative

Mean scores for the prepandemic and intrapandemic groups, along with scores from the 24 subsection scores were found to be approximately normally distributed by visual inspection of Normal Q-Q Plots and assessment of skewness and kurtosis. Homogeneity of variances was tested by Levene’s test, and results from an independent samples t test for each pre- and intrapandemic score group were interpreted accordingly.

Table 1: Mean in-training examination scores for 2019–2022.

<table>
<thead>
<tr>
<th>Year</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>12</td>
<td>67.2</td>
<td>5.6</td>
</tr>
<tr>
<td>2020</td>
<td>12</td>
<td>73.8</td>
<td>4</td>
</tr>
<tr>
<td>2021</td>
<td>13</td>
<td>64.9</td>
<td>7.4</td>
</tr>
<tr>
<td>2022</td>
<td>14</td>
<td>68.0</td>
<td>5</td>
</tr>
</tbody>
</table>

SD, standard deviation.
A significant difference was found between mean total pre-pandemic and intrapandemic in-service examination scores \((t_{49}=2.64, p=0.01)\), with mean intrapandemic scores being 4.5 points lower than pre-pandemic scores (95% CI, 1.08 to 7.92). Significant decreases in scores were found for 7 of the 24 subsections and are presented in Table 2.

No subsections demonstrated a significant increase in scores. The predicted increase in pulmonary subsection scores was not seen when comparing grouped pre- and intrapandemic scores \((t_{49}=-1.41, p=0.17)\). A significant difference in pulmonary subsection scores was found when comparing scores from 2019 to 2022 \((t_{49}=-2.86, p=0.01)\). Mean pulmonary subsection scores increased 9.96 points from 2019 to 2022 (95% CI, −17.15 to −2.76).

### Qualitative

Thematic analysis of the qualitative interviews revealed three main groups into which the effects of the pandemic could be sorted: psychosocial/emotional effects, effects on training, and effects on health.

#### Psychosocial/emotional effects

Participants reported feelings of isolation, particularly during surges of COVID-19 cases, and increased burnout. Social isolation and isolation from family were most often reported as significant. Quotes representative of the perceptions of isolation expressed by participants are presented in Table 3.

Negative effects of social isolation included perceptions of increased depression, burnout, and worse physical health. Isolation from family was primarily associated with fear of spreading the infection, fear of the unknown regarding COVID-19, and loss of primary psychological support structure.

### Participants expressed attempts to balance between fear of accidentally infecting family members, the unknowns surrounding COVID-19, and the need for a sound psychological and emotional support structure during these experiences. Participants commonly reported their families to be their primary support system, yet they were forced to remain isolated from their families during an extremely stressful time. The forced separation from this support structure contributed to feelings of helplessness and a perception of increased difficulty in coping with the challenges of the pandemic.

An increase in burnout was also reported by most participants, which manifested as compassion fatigue and feelings of helplessness. Feelings of grief associated with increased patient deaths, frustration with unvaccinated patients, and the loss of public trust in healthcare workers contributed to compassion fatigue. A perceived loss of agency and inability to change patient outcomes, along with feelings of practicing "war-time" medicine, contributed to feelings of helplessness. Quotes representative of the perceptions of burnout expressed by participants are presented in Table 4.

### Effects on training

Increased workload, a decrease in bedside teaching, a loss of formal academic training opportunities, and a loss of procedural experience were the most reported direct effects on training. As one participant stated:
Table 4: Quotes related to burnout.

<table>
<thead>
<tr>
<th>Thematic group</th>
<th>Example quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practicing “war-time” medicine</td>
<td>“(Being forced to) prioritize, like a combat situation where you have to prioritize green, red, who is going to benefit from this right now more, and they need your attention because there’s no one else to attend to these patients.”</td>
</tr>
<tr>
<td></td>
<td>“(Being forced to) allocate resources and (realizing) resources are limited. We ran out of so many things when it first started. We ran out of propofol, simple things like certain tube feeds. Everyone was on a Dilaudid PCA because we ran out of fentanyl of all things.”</td>
</tr>
<tr>
<td>Frustration with unvaccinated patients</td>
<td>“I remember one patient was 40 years old. When I came on service, she had already been intubated for 2 weeks. She was even one time extubated, and then she was reintubated and developed profound hypoxia and bradycardia, but because of the timeframe, they didn’t consider her for ECMO. I remember how we coded her, you know, for 2 and a half hours and how her family, her father, her husband, her young kids, they were in the room. We coded her, we did everything, but we all knew that there was no chance for her to survive. The thought that she could prevent that with two shots, that was really devastating.”</td>
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<tr>
<td></td>
<td>“The most frustrating part was the difference between the beginning of the pandemic before vaccines were available and the middle of the pandemic when we had vaccines. We had a tool to prevent (severe illness and death) and still had patients who didn’t want to do that. And they died.”</td>
</tr>
<tr>
<td>Loss of agency and inability to change patient outcomes</td>
<td>“I thought, you know, people are not leaving (the ICU), and there was a sense, sense of hopelessness with me personally. And I was like, oh, am I even doing anything?”</td>
</tr>
</tbody>
</table>

In the past, I feel like there was a lot more bedside examinations you’re doing with the attending and things you’re looking at on the monitor. For example, pulse pressure variation, ventilator waveforms, examination patterns, we don’t go to bedside like we did before.

Participants also discussed the lack of an external reference point to understand what to expect from fellowship training. Coupled with the increased workload, this led to the perception that fellowship training during the pandemic was representative of normal training. One participant, in reference to the increased workload experienced by the fellows during the pandemic in relation to the lack of an external reference point, stated:

During the biggest surge, we had an extra ICU open, and we would have an 80-patient census with 15 admissions a night. It was crazy, and we were first-year fellows, just a few months in (training), just managing everything. I just thought that this is how fellowship is because everyone told us that it’s going to be intense. I just thought that’s how night float is supposed to be.

Effects on health

Two major themes related to the effects of the pandemic on participants’ health emerged; concerns directly related to COVID-19 and neglect of personal health during the pandemic. Participants reported significant concerns regarding their own risk of contracting or spreading COVID-19 during the early pandemic. Quotes representative of the concerns of contracting or spreading COVID-19 expressed by participants are presented in Table 5.

Participants also reported neglecting their personal health during the pandemic. Multiple factors contributed to this neglect, including lockdowns during the pandemic, fear of contracting or spreading the COVID-19 virus, and the increased workload and stress in training. Participants reported forgoing regular medical checkups and routine dental work, not following up on known medical issues, decreased levels of activity, and poor dietary choices as

Table 5: Quotes related to concerns of contracting or spreading COVID-19.

<table>
<thead>
<tr>
<th>Thematic group</th>
<th>Example quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fear of contracting COVID-19</td>
<td>“The beginning of the pandemic was pretty hard, because we didn’t know how much it will affect our health. It was really scary at the beginning.”</td>
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<td></td>
<td>“I probably sweat through so many pairs of scrubs just from being so nervous about what could happen. And I know that I at least felt that I was a pretty healthy or am a pretty healthy person. So, I would try to keep it together and be like, okay, I think that I’m not going to be this sliver of the population (that had a bad outcome from COVID-19), but you never know, especially in the early days. So that was in the back of my mind quite a bit.”</td>
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<tr>
<td>Fear of spreading COVID-19</td>
<td>“(I was afraid of infecting) my kids and my husband. They don’t have any major risk factors, but at the beginning when we didn’t know what we were dealing with and when there was a lot of data from Europe, especially from Italy, about young, healthy people who got it and died. It was really scary.”</td>
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<td>“I was afraid of coming home with a wife who recently delivered a young baby at home. We didn’t know how (the virus) was behaving with young kids and babies. There was no information. It’s not like we all had immunity and that immunity was passed down to babies to give some protection. For 6 months, I was living separately in a different guest room in the basement to keep from infecting them.”</td>
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</table>
major contributing factors to a perceived negative effect of the pandemic on their own health. Despite all participants reporting having experienced a shortage of PPE at some point during the pandemic, none felt that this contributed to their own health concerns.

Discussion

Trainees perceived a disruption to the normal education provided during CCM fellowship training associated with the COVID-19 pandemic, which is supported by significantly decreased in-training examination scores found in this study. While the hypothesized improvement in scores for subjects directly related to the care of acute respiratory distress syndrome and the treatment of severe pulmonary diseases was not found, the decreased scores found for seven subjects unrelated to pulmonary diseases may reflect a relative neglect of these subjects due to the overwhelming focus on COVID-19 during the intrapandemic period reported by participants in this study.

Many of the effects of the pandemic reported by the participants in this study were related to a disruption in experiential learning, which relies on the learner reflecting on, modifying, and constructing knowledge based on direct experience [12]. The decreases in bedside teaching, loss of formal academic training opportunities, and loss of procedural experiences reported in this study are in line with previous literature [14, 15, 19]. In contrast to the decreased patient contact reported in the literature [27], participants in this study reported an increase in workload and patient volumes. This may be due to the severity of illness associated with COVID-19 and the subsequent increased ICU resource utilization during the pandemic and may be unique to training in CCM. A substantial disruption to the experiential learning process occurred despite the reported increase in patient contact due to a change in the nature of the interactions between attending physicians and participants. Participants reported fewer quality interactions with attending physicians, less time spent at bedside with the attendings, and fewer opportunities for discussing cases and reflecting on their performance and decision-making processes. This disruption to the normal experiential learning processes typically encountered during fellowship training may have contributed to the decreased in-training examination scores found in this study.

The frequency with which isolation, separation from family, and a loss of normal support structures was reported is of particular concern because each of these factors have been previously linked to resilience [33–36], which is inversely correlated with the severity of pandemic-related mental health effects [37–40]. Although not directly assessed in this study, these findings may indicate an increased risk for adverse pandemic-related mental health effects within this population.

Lack of access to adequate PPE has commonly been reported as a contributing factor to adverse mental health effects of the pandemic [41–43]. Notably, all participants in this study reported having experienced inadequate access to PPE at some point during the pandemic, but none felt that this had contributed to concerns regarding their own health or education. This may be due to the timing of the participants’ entry into fellowship training, because all participants in this study began training after the onset of the pandemic and may have experienced the worst of the PPE shortages before beginning fellowship training. This finding may also be explained by an institutional focus on prioritizing PPE for CCM physicians and trainees, mitigating the effects of the shortages on the ICU teams.

Limitations

The primary limitations to this study were the small sample size and the inability to directly compare prepandemic and intrapandemic in-training examination scores for individual participants. A direct comparison of prepandemic and intrapandemic scores for individual participants would have allowed for a more in-depth investigation into potential nonpandemic related causes of score changes at the individual participant level. Additionally, the entire sample was taken from a single institution, limiting the generalizability of the study findings. The effects of the pandemic were also geographically variable, further limiting the generalizability of findings from a single institution.

Conclusions

The COVID-19 pandemic caused an unprecedented disruption to the education of CCM fellows, with intrapandemic in-training test scores in this study falling from prepandemic levels. Trainees in this study experienced a loss of formal academic training opportunities, decreased bedside teaching by attending physicians, and loss of procedural experiences while simultaneously bearing the weight of a substantial increase in patient contact. During the pandemic, the fellows in this study experienced increased isolation from family and support structure, increased patient deaths, loss of public trust in healthcare workers, and a perceived loss of agency. The departure from the standards of training, coupled with the increased physical and emotional stressors,
interrupted the vital experiential learning processes typical of education in CCM.

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Conflicts of interests: None reported.

Informed consent: All participants provided written informed consent prior to participation in the study.

Ethical approval: The study was deemed exempt by the A.T. Still Research Institute (IRB# WM20220601-001) and underwent expedited review and approval from Mercy Institutional Review Board (IRB# 1917047 22-084).

References


