A Global Survey of the Effect of COVID-19 on Critical Care Training

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The coronavirus disease (COVID-19) pandemic has disrupted numerous facets of graduate medical education. Training programs have adapted by restructuring trainee schedules, teaching activities, and rounding structures to balance clinical demands and educational efforts with the safety and well-being of trainees (1–3). Intensive care units (ICUs) have been disproportionately affected by the pandemic (4). In this global survey, we aimed to assess perceptions of medical trainees and attending physicians caring for critically ill patients with COVID-19 regarding the pandemic's impact on clinical education and identify factors associated with a negative impact.

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METHODS

We distributed a 33-question electronic questionnaire between April 23 and May 7, 2020 (in English, worldwide), and June 10 and June 24, 2020 (in Portuguese, Brazil), to critical care providers across the globe. The overall aim of the survey was to assess the pandemic's impact on critical care resource use and provider well-being (the full survey is provided in the data supplement), and results regarding resource use and provider burnout have been published previously (5, 6). The present analysis focuses on portions of the survey assessing the pandemic's perceived impact on education, collected as a response to the following question: "Overall, at my hospital, the effect of the COVID-19 pandemic on clinical education and training of residents and fellows is: positive/no change/negative." Based on feedback from multidisciplinary providers during the survey pilot, questions regarding clinical education were limited to physicians (trainees and attendings).

Our target populations were physician trainees (residents and fellows) and attending physicians who self-attested to caring for patients with COVID-19 requiring intensive care. The survey was disseminated in collaboration with 15 critical care societies and relevant research networks and shared via emails to their respective memberships, posts on their websites, and/or social media outlets. Details regarding survey design, pilot testing, and distribution are described in prior publications (5, 6). Data were collected using REDCap electronic data capture (Institute of Translational Health Sciences) (7). The study was approved by the University of Washington Institutional Review Board and followed STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

Descriptive statistics were used to report respondent characteristics and variables hypothesized to affect clinical education, including training experience, and ICU resource availability. We used a log-binomial regression model (using R Software) (8) to characterize associations between perceived negative impact on clinical education (outcome) and variables of interest. Variables that were statistically significant in univariate regression analyses were considered for inclusion in the multivariate model. We excluded variables that were not significantly associated with the outcomes and did not improve the model fit as assessed by the likelihood ratio test (9). Chi-squared tests were used to evaluate differences in dichotomous variables, specifically to assess differences in perceptions between trainees and attendings.

RESULTS

We included 1,106 respondents (253 trainees and 853 attendings) from 37 countries in the analysis (*see* Table E1 in the data supplement). Figure E1 outlines reasons for exclusion. Most respondents were from the United States (32%, $n = 349$) and Brazil (29%, $n = 320$), with the remainder from Europe/Central Asia (25%, $n = 280$ from 24 countries) and East Asia/Pacific (14%, $n = 157$ from 11 countries) (Table 1). Overall, 42% of respondents were female, and 23% reported having cared for at least 50 critically ill patients with COVID-19. Most trainees (74%) and attendings (88%) listed critical care as one of their subspecialties.

Training Experience

Most respondents (58% of trainees and 53% of attendings) reported that COVID-19 had negatively impacted clinical education and training, and one-third (31% of

Table 1. Respondent characteristics and direct impact on clinical training

Physicians' Characteristics and Responses* (Trainees)	East Asia and Pacific (*n = 17*)	Europe and Central Asia (*n = 45*)	Brazil (*n = 106*)	United States (*n = 85*)	Total (*n = 253*)
Sex (female)	11 (65%)	21 (47%)	57 (54%)	47 (55%)	136 (54%)
Subspecialty					
Critical Care	15 (88%)	31 (69%)	77 (73%)	65 (76%)	188 (74%)
Pulmonology	0 (0%)	0 (0%)	7 (7%)	46 (54%)	53 (21%)
Anesthesiology	3 (18%)	26 (58%)	2 (2%)	5 (6%)	36 (14%)
Internal Medicine	0 (0%)	7 (16%)	22 (21%)	19 (22%)	48 (19%)
Emergency Medicine	4 (24%)	7 (16%)	2 (2%)	5 (6%)	18 (7%)
Cardiology	0 (0%)	4 (9%)	14 (13%)	1 (1%)	19 (8%)
Neurology	0 (0%)	0 (0%)	1 (1%)	11 (13%)	12 (5%)
Other	4 (24%)	1 (2%)	17 (16%)	10 (12%)	32 (13%)
Years in practice (mean, standard deviation)	7.06 (3.00)	4.89 (2.87)	7.46 (4.22)	5.14 (1.95)	6.08 (3.38)
Number of patients with COVID-19 cared for					
<10	15 (88%)	6 (13%)	17 (16%)	19 (22%)	57 (23%)
10–50	2 (12%)	32 (71%)	35 (33%)	45 (53%)	114 (45%)
>50	0 (0%)	7 (16%)	54 (51%)	21 (25%)	82 (32%)
Pandemic overall effect on clinical training					
Worse training compared to before COVID-19	10 (59%)	23 (51%)	55 (52%)	60 (71%)	148 (58%)
Same training compared to before COVID-19	3 (18%)	4 (9%)	15 (14%)	5 (6%)	27 (11%)
Better training compared to before COVID-19	4 (24%)	18 (40%)	36 (34%)	20 (24%)	78 (31%)
Trainees can opt out of caring for patients with COVID-19	6 (35%)	17 (38%)	56 (53%)	30 (35%)	109 (43%)

Table 1. *Continued.*

Physicians' Characteristics and Responses* (Trainees)	East Asia and Pacific (*n* = 17)	Europe and Central Asia (*n* = 45)	Brazil (*n* = 106)	United States (*n* = 85)	Total (*n* = 253)
Less formal teaching	11 (69%)	30 (71%)	55 (60%)	62 (74%)	158 (68%)
Fewer opportunities for trainees to perform procedures	3 (18%)	7 (16%)	20 (20%)	47 (56%)	77 (31%)
Trainee reassignments to subspecialties outside scope of training	9 (53%)	28 (64%)	50 (49%)	46 (55%)	133 (54%)
Less direct supervision from attendings	2 (12%)	16 (36%)	39 (38%)	23 (27%)	80 (32%)
Trainees make decisions that exceed level of competence	1 (6%)	15 (34%)	35 (34%)	18 (21%)	69 (28%)

Physicians' Characteristics and Responses* (Attendings)	East Asia and Pacific (*n* = 140)	Europe and Central Asia (*n* = 235)	Brazil (*n* = 214)	United States (*n* = 264)	Total (*n* = 853)
Sex (female)	29 (21%)	88 (37%)	94 (44%)	112 (42%)	323 (38%)
Subspecialty					
Critical Care	128 (91%)	204 (87%)	179 (84%)	236 (89%)	747 (88%)
Pulmonology	9 (6%)	7 (3%)	10 (5%)	164 (62%)	190 (22%)
Anesthesiology	32 (23%)	142 (60%)	6 (3%)	11 (4%)	191 (22%)
Internal Medicine	11 (8%)	18 (8%)	45 (21%)	43 (16%)	117 (14%)
Emergency Medicine	15 (11%)	33 (14%)	7 (3%)	13 (5%)	68 (8%)
Cardiology	2 (1%)	6 (3%)	27 (13%)	0 (0%)	35 (4%)
Neurology	3 (2%)	4 (2%)	4 (2%)	30 (11%)	41 (5%)
Other	11 (8%)	11 (5%)	41 (19%)	22 (8%)	85 (10%)
Years in practice (mean, standard deviation)	18.5 (5.60)	16.7 (7.01)	14.8 (7.25)	14.0 (5.70)	15.6 (6.65)

Table 1. *Continued.*

Physicians' Characteristics and Responses* (Attendings)	East Asia and Pacific (*n* = 17)	Europe and Central Asia (*n* = 45)	Brazil (*n* = 106)	United States (*n* = 85)	Total (*n* = 253)
Number of patients with COVID-19 cared for					
<10	127 (91%)	65 (28%)	41 (19%)	87 (33%)	320 (38%)
10–50	13 (9%)	125 (53%)	86 (40%)	133 (50%)	357 (42%)
>50	0 (0%)	45 (19%)	87 (41%)	44 (17%)	176 (21%)
Pandemic overall effect on clinical training					
Worse training compared with before COVID-19	92 (66%)	117 (50%)	94 (44%)	149 (56%)	452 (53%)
Same training compared with before COVID-19	15 (11%)	11 (5%)	19 (9%)	36 (14%)	81 (9%)
Better training compared with before COVID-19	33 (24%)	107 (46%)	101 (47%)	79 (30%)	320 (38%)
Trainees can opt out of caring for patients with COVID-19	63 (45%)	103 (44%)	85 (45%)	106 (40%)	357 (42%)
Less formal teaching	92 (66%)	117 (50%)	94 (44%)	149 (56%)	452 (53%)
Fewer opportunities for trainees to perform procedures	34 (24%)	56 (24%)	47 (35%)	122 (46%)	259 (30%)
Trainee reassignments to subspecialties outside scope of training	74 (53%)	148 (63%)	96 (45%)	182 (69%)	500 (59%)
Less direct supervision from attendings	6 (4%)	34 (14%)	52 (24%)	30 (11%)	122 (14%)
Trainees make decisions that exceed level of competence	3 (2%)	15 (6%)	31 (14%)	12 (5%)	61 (7%)

Definition of abbreviation: COVID-19 = coronavirus disease.
Data are *n* (%) unless otherwise stated.
*Participants can choose more than one subspecialty.

trainees and 38% of attendings) reported a positive impact; the remainder reported no change (Table 1). Trainees from the United States were most likely to report that COVID-19 had a negative impact on education (71% vs. 51–59% in other regions), whereas 40% of trainees from Europe/Central Asia and 34% of Brazilian trainees (vs. 24% in the United States and East Asia/Pacific) reported a positive impact. Trainees were more likely than attendings to report reductions in formal didactics (68% vs. 53%, $P < 0.001$) as well as less supervision from attendings (32% vs. 14%, $P < 0.001$) and perceptions that trainees were making decisions exceeding their level of competence (28% vs. 7%, $P < 0.001$). Among trainees who perceived a negative impact on education, 83% reported a reduction in formal didactics (vs. 37% of trainees reporting a positive impact, $P < 0.001$), 39% (vs. 18%, $P = 0.003$) reported less direct trainee involvement in procedures, 61% (vs. 45%, $P < 0.001$) reported increased trainee reassignments, and 44% (vs. 18%, $P < 0.001$) reported less supervision by attendings. Among attendings who perceived a negative impact on education, 73% reported a reduction in formal didactics (vs. 48% of attendings reporting a positive impact, $P < 0.001$), 54% (vs. 29%, $P < 0.001$) reported less direct trainee involvement in procedures, 47% (vs. 36%, $P = 0.279$) reported increased trainee reassignments, and 27% (vs. 12%, $P < 0.001$) reported less supervision by attendings (Table E2, Figure E2).

Critical Care Resource Availability

Participants reported substantial shortages of intensivists (30%), ICU nurses (41%), and ICU beds (22%) (Table E3), with respondents from Brazil reporting the highest shortages across all three domains (45%, 54%, and 38%, respectively). A lack of N95 masks and powered air purified respirators (PAPRs) were reported by 32% and 40% of all respondents, respectively. One in 10 respondents reported limited supply of ventilators, and restricted use of ultrasound and bronchoscopy in patients with COVID-19 was reported by 40% and 26% of respondents, respectively.

Multivariate Analysis

In multivariate regressions restricted to trainees, perceived negative impact of the pandemic on clinical education was associated with reporting reduction in formal didactics (absolute risk reduction [aRR], 2.2; 95% confidence interval [CI], 1.59–3.13), increased trainee reassignments (aRR, 2.22; 95% CI, 1.23–3.99), and less supervision by attendings (aRR, 1.34; 95% CI, 1.04–1.71) (Table 2). Among attendings, a perceived negative impact of the pandemic on clinical education was associated with reporting reductions in formal didactics (aRR, 1.44; 95% CI, 1.19–1.74), fewer trainee procedures (aRR, 1.43; 95% CI, 1.21–1.69), less supervision for trainees (aRR, 1.36; 95% CI, 1.11–1.64), insufficient ICU beds (aRR, 1.24; 95% CI, 1.00–1.52), lack of PAPRs (aRR, 1.4; 95% CI, 1.08–1.81), and restricted use of bronchoscopy (aRR, 1.31; 95% CI, 1.02–1.69) (Table 2).

Negative impact on training was not associated with years in practice, specializing in critical care, personal stressors, being able to opt out of caring for patients with COVID-19, or number of patients with COVID-19 cared for (Table 2, Table E4).

Table 2. Univariate and multivariate analyses of associations with negative impact on clinical education and training

Associations With Worsening Clinical Education (Trainees)	RR (95% CI)	*P* Value	aRR (95% CI)	*P* Value
Sex, male	0.93 (0.73–1.19)	0.401	0.93 (0.73–1.19)	0.572
Region				
Brazil	Ref.	—	Ref.	—
East Asia and Pacific	1.08 (0.66–1.78)	0.751	0.88 (0.61–1.26)	0.810
Europe and Central Asia	1.01 (0.71–1.42)	0.966	0.96 (0.52–1.76)	0.871
North America	1.35 (1.04–1.76)	0.022	1.24 (0.71–2.17)	0.451
COVID-19 impacts on training				
Less supervision from physicians	2.65 (1.91–3.68)	<0.001	1.34 (1.04–1.71)	0.024
Fewer opportunities for trainees to perform invasive procedures	1.35 (1.06–1.71)	0.016	—	—
Trainees reassigned to areas outside their primary field	2.91 (1.63–5.19)	<0.001	2.22 (1.23–3.99)	0.007
Fewer formal teaching and lectures	2.65 (1.91–3.68)	<0.001	2.23 (1.59–3.14)	<0.001
Trainees asked to make decisions that exceed their level of competence	1.32 (0.89–1.95)	0.171	—	—
Shortages reported				
Limited availability of PAPR	1.48 (1.04–2.09)	0.028	—	—
Lack of intensivists	1.16 (0.91–1.47)	0.241	—	—

Table 2. *Continued.*

Associations With Worsening Clinical Education (Trainees)	RR (95% CI)	*P* Value	aRR (95% CI)	*P* Value
Lack of nurses	1.44 (1.15–1.81)	<0.001	—	—
Lack of ICU beds	1.16 (0.89–1.51)	0.272	—	—
Bronchoscopy restricted	0.99 (0.70–1.41)	0.963	—	—
Ultrasound testing restricted	1.46 (1.15–1.85)	<0.001	—	—
Number of patients with COVID-19 cared for				
<10	Ref.		—	—
10–50	0.89 (0.66–1.19)	0.421	—	—
⩾50	1.01 (0.75–1.37)	0.929	—	—
Associations with Worsening Clinical Education (Attendings)				
Sex, male	1.01 (0.88–1.15)	0.905	1.06 (0.90–1.25)	0.483
Region				
Brazil	Ref.	—	Ref.	—
East Asia and Pacific	1.50 (1.22–1.83)	0.007	1.29 (0.96–1.72)	0.088
Europe and Central Asia	1.13 (0.94–1.37)	0.202	1.09 (0.85–1.39)	0.511
North America	1.28 (1.07–1.54)	0.014	1.07 (0.84–1.37)	0.575
COVID-19 impacts on training				
Less supervision from physicians	1.50 (1.27–1.78)	<0.001	1.36 (1.12–1.64)	<0.001
Fewer opportunities for trainees to perform invasive procedures	1.62 (1.39–1.89)	<0.001	1.43 (1.21–1.69)	<0.001

Table 2. *Continued.*

Associations With Worsening Clinical Education (Attendings)	RR (95% CI)	*P* Value	aRR (95% CI)	*P* Value
Trainees reassigned to areas outside their primary field	1.19 (0.94–1.51)	0.162	—	—
Fewer formal teaching and lectures	1.65 (1.38–1.96)	<0.001	1.44 (1.19–1.74)	<0.001
Trainees asked to make decisions that exceed their level of competence	1.05 (0.88–1.26)	0.578	—	—
Shortages reported				
Limited availability of PAPR	1.65 (1.34–2.04)	<0.001	1.40 (1.08–1.81)	0.012
Lack of intensivists	1.04 (0.89–1.22)	0.622	—	—
Lack of nurses	1.15 (1.00–1.32)	0.048	—	—
Lack of ICU beds	1.29 (1.09–1.52)	<0.001	1.24 (1.00–1.52)	0.047
Bronchoscopy restricted	1.33 (1.10–1.61)	<0.001	1.31 (1.02-1.69)	0.033
Ultrasound testing restricted	1.10 (0.97–1.26)	0.153	—	—
Number of patients with COVID-19 cared for				
<10	Ref.	—	—	—
10–50	0.91 (0.79–1.05)	0.213	—	—
⩾50	0.92 (0.77–1.10)	0.385	—	—

Definition of abbreviations: aRR = absolute risk reduction; CI = confidence interval; COVID-19 = coronavirus disease; ICU = intensive care unit; PAPR = powered air purified respirator; RR = relative risk.

None of the variables assessed were significantly associated with reporting a positive impact on education.

DISCUSSION

In this global survey of critical care physicians, perceptions about the impact of the pandemic on clinical education and training were divided, with most respondents reporting a negative effect (highest in East Asia/Pacific and the United States), and one-third perceiving a positive impact (highest in Brazil and Europe/Central Asia). Reporting a negative impact on education was associated with reductions in formal didactics and less trainee supervision among both trainees and attendings. However, these associations were almost twice as strong among trainees. Similarly, trainees reporting reassignment outside their primary field were twice as likely to report that the pandemic had a negative impact on clinical education, whereas reporting trainee reassignment was not significantly associated with a negative educational impact among attendings. A similar proportion of trainees and attendings reported diminished opportunities for trainees to perform procedures, but this perception was only associated with perceived worse education among attendings. These findings may indicate differences in perceptions regarding the importance of didactics, supervision, procedures, and consequences of trainee reassignment and suggest communication gaps between teachers and learners regarding factors affecting the educational experience.

In multivariate regressions, shortage of resources (ICU beds, PAPRs, and bronchoscopy) was significantly associated with perceived worse education ratings among attendings but not for trainees. It is possible that attendings faced with insufficient resources felt that they had less time to devote to education. However, some of these associations were significant in univariate regressions among trainees, and the smaller sample size of trainees may have reduced power to find significant associations in adjusted analyses. Future studies with larger samples are needed to explore the interplay between insufficient resources and clinical education.

To our knowledge, this is the first study assessing perceptions of education among front-line providers working in the ICU and the first to compare perceptions between trainees and attendings. Our results complement other studies describing the pandemic's effect on trainees from various subspecialties, which all highlight that education has been substantially compromised during the pandemic. We find a higher proportion of respondents reporting a positive educational experience compared with other studies querying trainees from cardiothoracic surgery, radiology, neurosurgery, and gastroenterology (3, 10, 11). This may be due to the reductions of elective procedures and surgeries during the pandemic, and even cancellations of rotations in these subspecialties, but it also highlights the potential for increased learning opportunities in the ICU environment amid the pandemic. None of the variables we assessed were associated with a positive impact on education. However, our survey inquired about resource shortages and did not specifically assess some factors that could have positively influenced education. The differences in perception of education across regions may be related to pandemic severity as well as cultural factors, such as the extent of trainee supervision, varying levels of autonomy and exposure, and different roles and responsibilities for trainees between regions.

Our study has several limitations. First, our survey distribution strategy targeted intensivists and trainees specialized or specializing in critical care, and our findings may not be applicable to other subspecialties. Second, we cannot determine a response rate because of multiple dissemination mechanisms (e.g., critical care societies sharing the survey link on websites) and lack of a denominator, potentially limiting generalizability. Third, healthcare providers facing an extremely high workload may not have had the time to respond to the survey, resulting in potential sampling bias. Fourth, we cannot account for geographic and cultural differences in medical training (e.g., differences in autonomy, roles, and duties), although we did adjust for region in our analysis. In addition, the small sample size of trainees in some regions limits the generalizability of our results in those regions and might be influenced by regional variations of pandemic severity within a country. Fifth, language barriers may have impacted the response rate in non–English-speaking countries. However, the large majority of respondents are from English-speaking countries or regions in which English is commonly spoken. Sixth, the survey was intentionally distributed during two different time frames, as we aimed to administer the survey in Brazil during their COVID-19 surge. However, we do not believe this impacted our results, as we analyzed outcomes based on individual response regarding perceived ICU resource availability. Future studies are needed to assess the relationship between objective metrics of pandemic severity and ICU strain and the perception of learning opportunities. Finally, perceptions of the educational experience may change over time as providers reflect back on lessons learned during the pandemic.

As we anticipate recurrent surges of COVID-19 and long-lasting changes in ICU workflow, a conscious effort to solidify and enhance the quality of clinical education and targeted interventions to promote mental health will be crucial in maintaining a healthy and competent work force to care for critically ill patients with COVID-19. Our results suggest that preserving trainee supervision and learning opportunities despite a high clinical workload and minimizing trainee reassignments may be important factors in maintaining the educational experience for both trainees and attendings across geographic regions.

Because physical distancing and scheduling changes have led to cancellations of in-person didactics, we need to be deliberate in the use of alternative learning strategies in lieu of formal didactics. This may include additional efforts to make teaching explicit on rounds and at the bedside, incorporating learning into clinical care during surges. The innovative use of virtual conference platforms has created new opportunities for learning. Future research is needed to compare the perceived value of formal didactics, virtual lectures, and explicit learning, factoring in the weighted importance of these methods across regions.

Exploring the beneficial and detrimental effects of changes over time as we continue to adjust to the COVID-19 pandemic will be important to enhance clinical education during the pandemic and beyond this crisis (12).

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