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Perceptions of Critical Care Shortages, Resource Utilization, and Provider Well-being during the COVID-19 Pandemic: A Survey of 1,985 Healthcare Providers in Brazil

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Perceptions of Critical Care Shortages, Resource Utilization, and Provider Well-being during the COVID-19 Pandemic: A Survey of 1,985 Healthcare Providers in Brazil

Running head: Survey of Brazilian providers during two COVID-19 surges

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**Key word list:** Brazil, burnout, COVID-19, critical care resources, disparities, end-of-life care, resource utilization, surges

**Abbreviations List:**
adjusted relative risk (aRR), Brazilian Intensive Care Medicine Association (AMIB), cardiopulmonary resuscitation (CPR), extracorporeal membrane oxygenation, healthcare providers (HCPs), intensive care unit (ICU), mechanical ventilation (MV), personal protective equipment (PPE), Strengthening the Reporting of Observational studies in Epidemiology (STROBE), United States (US).
Abstract

Background: Brazil has been disproportionately affected by COVID-19, placing a high burden on intensive care units (ICUs).

Research Question: Are perceptions of ICU resource availability associated with end-of-life decisions and burnout among healthcare providers (HCP) during COVID-19 surges in Brazil?

Methods: We electronically administered a survey to multidisciplinary ICU HCPs during two 2-week periods (June 2020, March 2021) coinciding with COVID-19 surges. We examined responses across geographical regions, and performed multivariate regressions to explore factors associated with report of: (1) families being allowed less input in decisions about maintaining life-sustaining treatments for patients with COVID-19 and (2) emotional distress and burnout.

Results: We included 1,985 respondents (57% physicians, 14% nurses, 12% respiratory therapists, 16% other HCPs). More respondents reported shortages during the second surge compared to the first (P<0.05 for all comparisons), including lower availability of intensivists (66% vs. 42%), ICU nurses (53% vs. 36%), ICU beds (68% vs. 22%), and ventilators for patients with COVID-19 (80% vs. 70%); shortages were highest in the North. One-quarter of HCPs reported that families were allowed less input in decisions about maintaining life-sustaining treatments for patients with COVID-19, which was associated with lack of intensivists (adjusted relative risk (aRR) 1.37, 95%CI:1.05-1.80) and ICU beds (aRR 1.71, 95%CI:1.16-2.62) during the first surge and lack of N95 masks (aRR 1.43, 95%CI:1.10-1.85), non-invasive positive pressure ventilation (aRR 1.56, 95%CI:1.18-2.07), and oxygen concentrators (aRR 1.50, 95%CI:1.13-2.00) during the second surge. Burnout was higher during the second surge (60% vs. 71%, p<0.001), associated with witnessing colleagues at one's hospital contract COVID-19 during both surges (aRR 1.55, 95%CI:1.25-1.93;1.31, 95%CI:1.11-1.55 respectively), as well as worries about finances (aRR:1.28, 95%CI:1.02-1.61) and lack of ICU nurses (aRR:1.25, 95%CI:1.02-1.53) during the first surge.

Conclusions

During the COVID-19 pandemic, ICU HCPs in Brazil experienced substantial resource shortages, healthcare disparities between regions, changes in end-of-life care associated with resource shortages, and high proportions of burnout.
The Brazilian COVID-19 healthcare crisis has been described as a ‘humanitarian catastrophe’ by Médecins Sans Frontières. Brazil accounts for the second highest death and third highest case count of COVID-19 worldwide. The burden on Intensive Care Units (ICUs) has been immense: between February-August 2020, 38% of hospitalized patients with COVID-19 were admitted to an ICU, with ICU mortality ranging from 49-79%. In late 2020, the P1/gamma variant emerged, resulting in a devastating second surge in early 2021.

Managing surge capacity and resource needs while ensuring provider safety and well-being are essential to balancing the demands of ICU patients and maintaining a healthy workforce. Studies have demonstrated a high psychological burden among ICU health care providers (HCPs) during the pandemic, with increasing rates of anxiety and burnout. Regions with limited resources have been under-represented in prior assessments of ICU resource utilization, and frontline provider experiences.

In light of critical medication shortages and ICU bed occupancy levels of >90% in most states, Brazilian HCPs face challenging decisions about starting or maintaining scarce life-sustaining therapies. Physicians may find themselves having to make such decisions based on available resources, and limit family input in the shared decision-making process in favor of a more parental approach.

Given Brazil’s continental proportions and heterogeneous geographic distribution of ICU resources, the Brazilian Intensive Care Medicine Association (AMIB) has led Brazil’s COVID-19 response by facilitating networking among ICUs, guiding development of consistent protocols, and advocating for resources and support with policymakers. To assess the interplay between critical care shortages, resource utilization, and provider distress, AMIB distributed a survey to ICU HCPs during the initial COVID-19 surge in June 2020 and the subsequent surge due to the P1/gamma variant in March 2021.

Our objective was to 1) assess HCPs perceptions of availability and utilization of ICU resources during two surges and across all five regions, 2) evaluate changes in end-of-life decisions and self-reported emotional distress and burnout among HCPs; and 3) examine the associations between resource availability, end-of-life decisions and HCP burnout.
Methods

Survey design

A multidisciplinary team of physicians, nurses, and respiratory therapists at the University of Washington (UW) designed an electronic survey to elicit perceptions of ICU resource shortages and provider concerns related to COVID-19. This survey was distributed worldwide between April 23rd-May 7th, 2020, and results were previously reported. The same survey was translated into Brazilian Portuguese for the present study (supplement) and entered into the Institute of Translational Health Sciences’ Redcap database. The survey was pilot-tested by 30 multidisciplinary HCPs in Brazil. These responses were not included in the analysis.

The study was deemed exempt by the UW Institutional Review Board. Respondents were informed that the survey was anonymous, and summary results would be shared with the scientific community.

Survey Distribution

Our target population included HCPs in Brazil self-attesting to directly caring for patients with COVID-19 hospitalized in an ICU. Respondents who only completed demographic information were excluded.

The survey was disseminated via email by the AMIB and its Associates Registry and was posted on AMIB’s website and social media (Twitter, Instagram and Facebook). With 5,250 members, AMIB is Brazil’s largest medical society, and its only national critical care society. We distributed the survey during two time frames, with the intention of capturing data during COVID-19 surges: 1) June 10th-June 24th, 2020 (‘first surge’) and 2) March 17th-March 31st, 2021 (‘second surge’). Additional questions about provider concerns were added for the second survey based on feedback from Brazilian HCPs.

Data collection

Survey topics included: (1) critical care resource availability (ICU staff, beds, oxygen supplies, testing capacity and personal protective equipment), (2) critical care resource utilization, and (3) provider concerns, including self-reported emotional distress and burnout. Self-reported emotional distress and burnout was assessed as a single item question (yes/no). We followed the STROBE guidelines for the reporting of cross-sectional studies.
To compare respondents perceptions of against empiric data, AMIB collected data regarding ICU resources and number of COVID-19 cases and deaths from the Instituto Brasileiro de Geografia e Estatística,23 Agência Nacional de Saúde24, and Datosus25.

Statistical Analysis

We used descriptive statistics to report survey responses across regions, and McNemar’s Chi-squared test to compare responses between the surges. Brazilian states were categorized into five geographic regions: North, Northeast, Center West, Southeast and South (e-table 1). We conducted univariate regression and multivariate log-binomial regression to examine factors associated with two pre-specified outcomes: (1) report that patients’ families were allowed less input in critical decisions about maintaining life-sustaining treatments for patients with COVID-19 and (2) emotional distress and burnout. Exposure variables that were statistically significant in the univariate regression (p<0.05) were considered for inclusion in multivariate models.26 We conducted a missing data analysis for both surveys to assess how demographics and reported resource availability differed among those who completed the full survey and those who did not. Analyses were conducted using R Software.27

Results

Respondent Characteristics

We received 3,007 responses; 671 responses were excluded (N=301 reported not directly caring for critically ill patients with COVID-19, N=370 only completed demographic information, e-figure 1). We included 2,336 completed surveys from 1,985 unique respondents in all 27 states. Of these, 991 respondents completed the survey during the first surge, 1,345 during the second surge, and 351 reported completing both surveys.

Most respondents were from the Southeast region (54%), followed by the Northeast (18%), South (15%), Center West (8%), and North (7%). Respondents were physicians (57%), nurses (14%), respiratory therapists (12%), and other providers (16%). Among all participants, mean years in practice were 13 (SD 9.2), 62% were female, 55% reported caring for >50 critically ill patients with COVID-19 (Table 1). Most physicians (68%) and 28% of nurses listed critical care as their primary subspecialty. During the second surge, a higher proportion of respondents were physicians (55 vs. 63%, p<0.001) and more HCPs reported caring for >50 critically ill patients with COVID-19 (37% vs. 74%, p<0.001). Survey responses were similar among those who reported completing the survey twice and reporting it only once (e-table 2).
Empiric data show that the number of ICU beds per population and ventilators per population were lowest in the North and Northeast regions during both surges (Table 2). The number of COVID-19 cases per population was highest in the Center West and North during the first surge and highest in the South and Center West during the second surge.

**Critical Care Resource Availability**

Compared to the first surge in June 2020, a greater proportion of respondents reported shortages during the second surge in March 2021 (Table 3a). Specifically, during the second surge, respondents reported lower availability of intensivists (66% vs. 42%, p=0.002, for patients with COVID-19, 69% vs. 50%, p=0.5682 for other ICU patients), ICU nurses (53% vs. 36%, p<0.001; 59% vs. 42%, p<0.001), ICU beds (68% vs. 22%, p<0.001; 60% vs. 31%, p<0.001), and ventilators (80% vs. 70%, p<0.001). Reported availability of intensivists, ICU nurses, and ICU beds were lowest in the North and Northeast during the first surge. During the second surge, shortages were most commonly reported in the South and North (Figure 2, e-table 3). Reported lack of ventilators was highest in the North during both surges.

During both surges, the proportion of HCPs reporting availability of COVID-19 testing for all patients (33% vs. 49%) and all providers (23% vs. 37%) was low. Shortages of personal protective equipment (PPE) were reported during both surges (Table 3a), most notably for Powered Air Purifying Respirators (reported as always available by only 25% vs. 26%). During the second surge, more respondents reported availability for surgical masks (74% vs. 82%), N95 masks (47% vs. 57%) and sterile gowns (51% vs. 62%; P<0.05 for all comparisons). Shortages of PPE were most commonly reported in the North and Northeast during both surges (e-table 3).

**Critical Care Resource Utilization**

**Response to resource shortages:** The majority of HCPs who reported shortages indicated that non-intensivists (82% in June 2020 vs. 88% in March 2021) and non-ICU nurses (72% vs. 81%) were caring for ICU patients with COVID-19 (Table 3b); both proportions were higher during the second surge (P<0.05 for both comparisons). The proportion of non-intensivists (46% vs. 45%) and non-ICU nurses (40% vs. 42%) reported to be caring for other ICU patients were similar between both surges. During the second surge, a higher proportion of respondents reported having to decline transfer requests from other hospitals for critically ill patients with COVID-19 (24% vs. 49%), and other ICU patients (26 vs. 36%) due to ICU bed shortages (P<0.05.
for both comparisons). All these measures were most commonly reported in the North during the first surge and in the South during the second surge (e-table 4).

**Critical care interventions:** Most HCPs reported using prone ventilation in ICU patients with COVID-19 (81% during both surges) and placing them on renal replacement therapy (71% during both surges). ECMO utilization was more frequently reported during the second surge (13% vs. 20%, p<0.001; Table 3b). The proportion of HCPs reporting these treatments was lowest in the North during both surges. Approximately one third of respondents reported consulting palliative care specialists on ICU patients with COVID-19 (37% vs. 36%, lowest in the North at 23% vs. 25%).

**Mechanical ventilation:** More than one in ten (12% vs. 13%) reported having to limit mechanical ventilation in critically ill patients with COVID-19, with the highest proportion (25%) in the North during the first surge and the North and South (17%) during the second surge. Respondents reported that ventilators were allocated based on disease severity (70% vs. 73%), age (26% vs. 24%), comorbidities (21% vs. 24%) and patient’s insurance or financial status (5% vs. 3%).

**Cardiopulmonary resuscitation:** A substantial proportion reported changes in cardiopulmonary resuscitation (CPR) policies (52% vs. 38%) or practices (24% vs. 25%) for ICU patients with COVID-19. Two thirds reported that CPR decisions were determined by physicians (68% vs. 65%), rather than based on families’ preferences (30% vs. 34%). During the second surge, a higher proportion of respondents from the North (7% vs. 30%) and a lower proportion from the South (42% vs. 32%) reported that families determined CPR decisions. Respondents reported that the main factors influencing decisions to limit CPR were disease severity (51% vs. 57%), comorbidities (44% during both surges) and age (36% during both surges).

**Shared decision making for patients with COVID-19:** During both surges, about one quarter of respondents (27% vs. 25%) reported that families were allowed less input in critical decisions about maintaining life-sustaining treatments for patients with COVID-19; which was highest in the North (40% vs. 45%).

**Provider Concerns**

The most commonly reported concerns among HCPs were transmitting COVID-19 to one’s families/community (78% vs. 72%), worries about their own health (62% vs. 51%), and experience of emotional distress and burnout (60% vs. 71%). Most provider concerns were lowest in the North during both surges (e-table 5). A substantial minority (17% vs. 10%) reported living away from their families to protect them.
Most provider concerns were less frequently reported during the second surge compared to the first (Table 3c), including worries about their own health, finances, insufficient access to PPE and social stigma outside the hospital (P<0.05 for all comparisons). However, self-reported burnout (60% vs. 71%, p<0.001) was significantly higher during the second surge. In March 2021, 86% of respondents reported feeling more burned out compared to 6 months prior, and 90% reported feeling more burned out than before the pandemic. Respondents listed the following as factors contributing to their burnout: increased workload (79%), recurring surges (75%), poor patient outcomes (74%), emergence of new variants (66%), social isolation (52%), resource shortages (47%), limited family visitation (45%), and witnessing social disparities in patient care (32%). Emotional distress and burnout were lowest in the North and highest in the South during both surges (e-table 5).

**Associations between resource shortages and shared decision making**

In multivariate regressions (Table 3a), reporting less family input in critical decisions for patients with COVID-19 during the first surge was associated with reporting a shortage of intensivists (adjusted relative risk (aRR) 1.37 95%CI:1.05 - 1.80) and shortage of non-invasive positive pressure ventilation (aRR 1.56, 95%CI:1.18 - 2.07). During the second surge, this outcome was associated with report of palliative consults for ICU patients with COVID-19 (aRR 1.50, 95%CI:1.12-2.01) and lack of: ICU beds (aRR 1.71, 95%CI:1.16-2.62), N95 masks (aRR 1.43, 95%CI:1.10-1.85), oxygen concentrators (aRR 1.50, 95%CI:1.13-2.00).

**Associations between resource shortages and provider distress**

In multivariate regressions, reporting emotional distress and burnout during the first surge was most strongly associated with reporting worries about witnessing colleagues contract COVID-19 (aRR 1.55, 95%CI: 1.25-1.93), it was also associated with reporting concerns about finances (aRR 1.49, 95%CI:1.21-1.84), experiencing social stigma from one's community (aRR 1.28,95%CI:1.02-1.61), lack of ICU nurses (aRR 1.25, 95%CI:1.02-1.53), and caring for more than 10 ICU patients with COVID-19 (aRR 1.36,95%CI:1.03-1.79). During the second surge, reporting emotional distress and burnout was again most strongly associated with reporting worries about witnessing colleagues’ contract COVID-19 (aRR 1.31, 95%CI:1.11-1.55, Table 3b), as well as transmitting COVID-19 infection to one's family/community (aRR 1.21, 95%CI:0.98-1.48).

**Missing data analysis**

We found a drop-off in responses by the end of the questionnaire, leading to missing data in provider concerns (27% and 33% in the first and second survey, respectively). Therefore,
we completed a missing data analysis to assess patterns in the missing observations (e-table 6). In the first surge, participants who completed the full survey were more likely to be male, physicians, from the Center West region, specialized in critical care or internal medicine, and report caring for >50 patients with COVID-19. In the second surge, participants who completed the full survey were similar to those who did not in terms of gender, geographic region, and number of patients with COVID-19 cared for but were more likely to be physicians, work in private institutions, and specialized in critical care. In both surges, participants who completed the surveys were more likely to report shortages of ICU staff and beds, while other resources were similar between those who did and did not complete the full survey.

Discussion

In this survey, exploring perceptions of 1,985 Brazilian ICU HCPs during two COVID-19 surges, we found 1) lower reported availability of intensivists, ICU nurses, ICU beds and ventilators during the second surge; 2) disparities in critical care resource availability and utilization between regions, with respondents from the North and Northeast reporting the highest shortages; 3) HCPs reported allowing families less input when making decisions about maintenance of life-sustaining treatments for patients with COVID-19, which was associated with reporting resource shortages; and 4) high burnout rates, with significantly higher proportions during the second surge, and reporting burnout was most strongly associated with report of witnessing colleagues contract COVID-19 during both surges.

HCPs reported substantial resource shortages and the need for drastic resource utilization measures. When comparing the results of this survey to responses from the same survey distributed worldwide in April 2020, the following shortages were all substantially higher in Brazil: intensivists, ICU nurses, ICU beds, mechanical ventilators, testing availability, and PPE. Challenges in the initial Brazilian COVID-19 response included poor coordination between federal, state and municipal governments, inconsistencies in leadership, miscommunications to the public causing distrust and misinformation, insufficient lockdowns, lack of opportunities for physical distancing in vulnerable populations, and pursuit of medications with unproven efficacy. These problems are not unique to Brazil and have contributed to worsening spread and recurring surges in many other countries. The emergence of the P1/gamma variant in Manaus in late 2020 with higher transmissibility and reinfection potential resulted in a more devastating second surge\textsuperscript{5,6}. Initially underestimated, delayed response and fulminant spread led to an overwhelmed healthcare system and highly publicized-scenes of mass grave burials in early
2021. Lessons learned from these two surges can inform the global pandemic response for future surges, especially as variants continue to emerge worldwide.

The pandemic has exacerbated social disparities in Brazil, resulting in a collapse of the fragile regional healthcare systems serving vulnerable populations in the North and Northeast. A retrospective analysis of outcomes in patients with COVID-19 between February-August 2020 demonstrated the highest ICU mortality in the North (79%) and Northeast (66%) compared to other regions (49-53%). Long-standing inequalities and socioeconomic differences between regions predate COVID-19, and are reflected in the heterogeneous distribution of federal resources and quality of regional health services. Disproportionate shortages of critical resources, lack of organizational structure, and poor adherence to best practices likely contribute to worse outcomes in disadvantaged regions. Additionally, racial disparities in Brazil have been further magnified by the pandemic, with higher in-hospital COVID-19 mortality and differences in resource utilization among patients of color, who are more frequently represented in the North and Northeast. An effective pandemic response and sustainable change in the healthcare system can only be achieved when prioritizing and supporting its most vulnerable populations.

The shared decision-making process between physicians and families may be affected by lack of ICU resources, as suggested by respondents reporting less family input in end-of-life decisions in association with perceived resource shortages. Best practices for end-of-life decisions, including interdisciplinary collaboration and shared decision making, are essential components of ICU care, and have been shown to impact patient and family outcomes, as well as provider well-being. Prior studies suggest that end-of-life decisions and limitations of life-sustaining treatments are less common in Latin America compared to Europe and the United States (US). However, families have been increasingly involved in end-of-life decisions in Brazil over the past decades. The pressure of having to allocate scarce resources among an overwhelming number of critically ill patients may result in pursuit of a more unilateral approach, in effect reverting to a paternalistic model in the absence of the formal invocation of “crisis standards of care”, and protections inherent in this process to the community and the HCPs.

Our findings complement prior studies reporting high rates of burnout among ICU HCPs during the pandemic. While a direct comparison is limited by differences in respondent selection and methodology, the proportion of ICU HCP burnout in our study is higher compared to pre-pandemic studies in Brazil and globally. Self-reported burnout was also higher in this study (60-71%) than previously identified in the same survey among ICU HCPs worldwide (52%,
highest in the US at 58%) in April 2020\textsuperscript{10,11}. While reporting burnout was most strongly associated with witnessing colleagues contract COVID-19 in Brazil, the predominant factors associated with burnout in the US were insufficient access to PPE and poor communication from supervisors\textsuperscript{11}. In both countries, reporting burnout was associated with experience of social stigma outside the hospital, highlighting the juxtaposition of HCPs being praised as heroes while facing isolation and anger from the public. The relationship between psychological strain, resource availability, and socioeconomic factors is highly complex and requires further investigation. Perception and reporting of burnout may be influenced by cultural differences, social norms, and stigma around mental health. Interestingly, the regions reporting the highest resource shortages (North and Northeast) were also the least likely to report burnout in Brazil, and providers from regions with long-standing resource shortages might be more accustomed to the pressure of having to allocate scarce resources.

The pandemic has caused enormous strain to HCPs across the world, with many leaving their profession due to exhaustion, frustration, and disheartening experiences. We find an association between lack of ICU nurses and burnout among all HCPs, emphasizing the importance of valuing and investing in excellent nursing care. Also, our findings suggest that financial concerns negatively impact the mental well-being of HCPs. Supporting the health of our frontline staff, validating their efforts, and rapidly responding to mitigate their challenges early on are critical facets in strengthening our healthcare system during routine and emergency care.

Our study has several limitations. First, HCP perceptions about resource shortages may not reflect true resource availability. However, survey responses were generally aligned with empiric data\textsuperscript{12-28}. Second, our convenience sampling and inability to capture an accurate response rate introduces a risk of response and sampling bias, and may limit generalizability of our results. Our survey response only captured a small proportion of ICU HCPs in Brazil, and might not represent experiences of the entire critical care community. In addition, respondents who completed survey questions regarding provider concerns were more likely to report shortages of ICU staff and ICU beds than those with missing data; which may over-estimate burnout. Further, we cannot assess demographics of individuals who saw the survey but declined to complete it. Third, the ability to compare responses between the two surges is limited as we conducted two cross-sectional surveys, and respondents were mostly different. Further, we conducted many statistical comparisons in this exploratory analysis which increases the likelihood of false positive findings. Therefore, we focus qualitatively on the trends across surges. Fourth, the cross-sectional nature of this study allows us to assess association, but not assign causality. Fifth, our assessment of provider burnout was based on a single item rather
than a validated scale. Finally, practices are rapidly changing as HCPs continue to adjust to the pandemic, and there are many facets of the pandemic not captured in our survey.

Interpretation

Our results highlight how severely the COVID-19 pandemic has burdened HCPs. Findings of critical resource shortages, disparities in resource availability between regions with different social economic status, the need to make EOL decisions based on resource shortages, and burnout among HCPs underscore the challenges imposed by the pandemic and the personal sacrifices made by HCPs. Initiatives to invest in the healthcare system, achieve healthcare equity, and support the providers on the frontline are urgently needed as we continue to confront the pandemic.

Take Home Point

Study question:

How has the COVID-19 pandemic impacted critical care resources and ICU healthcare provider (HCP) well-being in Brazil?

Results:

During two COVID-19 surges in June 2020 and March 2021, participants reported substantial ICU resource shortages, which were lowest in the North. Reported availability of ICU staff, beds, and ventilators was significantly lower during the second surge. HCPs reported allowing families less input in end-of-life decisions for patients with COVID-19, which was associated with reporting resource shortages. Burnout rates were high (60 vs. 71%, p<0.001), and most strongly associated with witnessing colleagues contract COVID-19 during both surges.

Interpretation: During the COVID-19 pandemic, ICU HCPs in Brazil experienced substantial resource shortages, healthcare disparities between regions, changes in end-of-life care associated with resource shortages, and high proportions of burnout.

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Guarantor statement: On behalf of all authors, the corresponding author affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.
Author Contributions:
Drs. Lobo, Wahlster, Sharma and Creutzfeldt had full access to all of the data and take responsibility for the integrity of the data and the accuracy of the data analysis.
All authors contributed substantially to the study design, data acquisition and analysis, as well as interpretation. Dr. Sharma performed the statistical analysis. Drs. Lobo, Wahlster, Sharma and Creutzfeldt wrote the manuscript and all authors edited the manuscript.

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References

1. Failed coronavirus response drives Brazil to humanitarian catastrophe | MSF. Médecins Sans Frontières (MSF) International. Accessed September 4, 2021. https://www.msf.org/failed-coronavirus-response-drives-brazil-humanitarian-catastrophe

2. CSSEGISandData/COVID-19. GitHub. Accessed May 25, 2020. https://github.com/CSSEGISandData/COVID-19

3. Ranzani OT, Bastos LSL, Gelli JGM, et al. Characterisation of the first 250 000 hospital admissions for COVID-19 in Brazil: a retrospective analysis of nationwide data. Lancet Respir Med. 2021;9(4):407-418. doi:10.1016/S2213-2600(20)30560-9

4. Sabino EC, Buss LF, Carvalho MPS, et al. Resurgence of COVID-19 in Manaus, Brazil, despite high seroprevalence. The Lancet. 2021;397(10273):452-455. doi:10.1016/S0140-6736(21)00183-5

5. Wang P, Casner RG, Nair MS, et al. Increased resistance of SARS-CoV-2 variant P.1 to antibody neutralization. Cell Host Microbe. 2021;29(5):747-751.e4. doi:10.1016/j.chom.2021.04.007

6. Faria NR, Mellan TA, Whittaker C, et al. Genomics and epidemiology of the P.1 SARS-CoV-2 lineage in Manaus, Brazil. Science. Published online May 21, 2021. Accessed September 5, 2021. https://www.science.org/doi/abs/10.1126/science.abh2644

7. Azoulay E, Cariou A, Bruneel F, et al. Symptoms of Anxiety, Depression, and Peritraumatic Dissociation in Critical Care Clinicians Managing Patients with COVID-19. A Cross-Sectional Study. Am J Respir Crit Care Med. 2020;202(10):1388-1398. doi:10.1164/rccm.202006-2568OC

8. Azoulay E, De Waele J, Ferrer R, et al. Symptoms of burnout in intensive care unit specialists facing the COVID-19 outbreak. Ann Intensive Care. 2020;10(1):110. doi:10.1186/s13613-020-00722-3

9. Kleinpell R, Ferraro DM, Maves RC, et al. Coronavirus Disease 2019 Pandemic Measures: Reports From a National Survey of 9,120 ICU Clinicians. Crit Care Med. Published online July 6, 2020. doi:10.1097/CCM.0000000000004521

10. Wahlster S, Sharma M, Lewis AK, et al. The Coronavirus Disease 2019 Pandemic’s Effect on Critical Care Resources and Health-Care Providers: A Global Survey. Chest. 2021;159(2):619-633. doi:10.1016/j.chest.2020.09.070

11. Sharma M, Creutzfeldt CJ, Lewis A, et al. Healthcare professionals’ perceptions of critical care resource availability and factors associated with mental well-being during COVID-19: Results from a US survey. Clin Infect Dis Off Publ Infect Dis Soc Am. Published online September 2, 2020. doi:10.1093/cid/ciaa1311
12. Miller AG, Roberts KJ, Smith BJ, et al. Prevalence of Burnout Among Respiratory Therapists Amidst the COVID-19 Pandemic. *Respir Care*. Published online July 16, 2021. doi:10.4187/respcare.09283

13. Morgantini LA, Naha U, Wang H, et al. Factors contributing to healthcare professional burnout during the COVID-19 pandemic: A rapid turnaround global survey. *PLOS ONE*. 2020;15(9):e0238217. doi:10.1371/journal.pone.0238217

14. Kerlin MP, Silvestri JA, Klaiman T, Gutsche JT, Jablonski J, Mikkelsen ME. Critical Care Clinician Wellness during the COVID-19 Pandemic: A Longitudinal Analysis. *Ann Am Thorac Soc*. Published online August 16, 2021. doi:10.1513/AnnalsATS.202105-567RL

15. Kaplan LJ, Kleinpell R, Maves RC, Doersam JK, Raman R, Ferraro DM. Critical Care Clinician Reports on Coronavirus Disease 2019: Results From a National Survey of 4,875 ICU Providers. *Crit Care Explor*. 2020;2(5):e0125. doi:10.1097/CCE.0000000000000125

16. Vranas KC, Golden SE, Mathews KS, et al. The Influence of the COVID-19 Pandemic on ICU Organization, Care Processes, and Frontline Clinician Experiences: A Qualitative Study. *Chest*. Published online May 29, 2021:S0012-3692(21)01069-2. doi:10.1016/j.chest.2021.05.041

17. Amaral PV, Rocha TAH, Barbosa ACQ, Lein A, Vissoci JRN. Spatially balanced provision of health equipment: a cross-sectional study oriented to the identification of challenges to access promotion. *Int J Equity Health*. 2017;16(1):209. doi:10.1186/s12939-017-0704-x

18. GBD 2016 Brazil Collaborators. Burden of disease in Brazil, 1990-2016: a systematic subnational analysis for the Global Burden of Disease Study 2016. *Lancet Lond Engl*. 2018;392(10149):760-775. doi:10.1016/S0140-6736(18)31221-2

19. Szwarcwald CL, Souza Júnior PRB de, Marques AP, Almeida W da S de, Montilla DER. Inequalities in healthy life expectancy by Brazilian geographic regions: findings from the National Health Survey, 2013. *Int J Equity Health*. 2016;15:141. doi:10.1186/s12939-016-0432-7

20. REDCap. ITHS. Accessed May 20, 2020. https://www.iths.org/investigators/forms-templates/citation-information/

21. WHO Coronavirus Disease (COVID-19) Dashboard. Accessed May 20, 2020. https://covid19.who.int/

22. IHME | COVID-19 Projections. Institute for Health Metrics and Evaluation. Accessed September 13, 2021. https://covid19.healthdata.org/

23. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet Lond Engl*. 2007;370(9596):1453-1457. doi:10.1016/S0140-6736(07)61602-X

24. IBGE | Portal do IBGE | IBGE. Accessed September 4, 2021. https://www.ibge.gov.br/

25. Informações de Saúde (TABNET) – DATASUS. Accessed September 4, 2021. https://datasus.saude.gov.br/informacoes-de-saude-tabnet/
26. R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing; 2019. https://www.R-project.org/

27. Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res Methodol*. 2003;3(1):21. doi:10.1186/1471-2288-3-21

28. Ribeiro KB, Ribeiro AF, Veras MA de SM, de Castro MC. Social inequalities and COVID-19 mortality in the city of São Paulo, Brazil. *Int J Epidemiol*. 2021;50(3):732-742. doi:10.1093/ije/dyab022

29. Machado FR, Cavalcanti AB, Bozza FA, et al. The epidemiology of sepsis in Brazilian intensive care units (the Sepsis PREValence Assessment Database, SPREAD): an observational study. *Lancet Infect Dis*. 2017;17(11):1180-1189. doi:10.1016/S1473-3099(17)30322-5

30. Azevedo LCP, Park M, Sulluh JIF, et al. Clinical outcomes of patients requiring ventilatory support in Brazilian intensive care units: a multicenter, prospective, cohort study. *Crit Care Lond Engl*. 2013;17(2):R63. doi:10.1186/cc12594

31. Nassar AP, Zampieri FG, Sulluh JJ, et al. Organizational factors associated with target sedation on the first 48 h of mechanical ventilation: an analysis of checklist-ICU database. *Crit Care*. 2019;23(1):34. doi:10.1186/s13054-019-2323-y

32. Midega TD, Bozza FA, Machado FR, et al. Organizational factors associated with adherence to low tidal volume ventilation: a secondary analysis of the CHECKLIST-ICU database. *Ann Intensive Care*. 2020;10(1):68. doi:10.1186/s13613-020-00687-3

33. Soares M, Bozza FA, Angus DC, et al. Organizational characteristics, outcomes, and resource use in 78 Brazilian intensive care units: the ORCHESTRA study. *Intensive Care Med*. 2015;41(12):2149-2160. doi:10.1007/s00134-015-4076-7

34. Peres IT, Bastos LSL, Gelli JGM, et al. Sociodemographic factors associated with COVID-19 in-hospital mortality in Brazil. *Public Health*. 2021;192:15-20. doi:10.1016/j.puhe.2021.01.005

35. Curtis JR, Vincent J-L. Ethics and end-of-life care for adults in the intensive care unit. *Lancet Lond Engl*. 2010;376(9749):1347-1353. doi:10.1016/S0140-6736(10)60143-2

36. Goldfarb MJ, Bibas L, Bartlett V, Jones H, Khan N. Outcomes of Patient- and Family-Centered Care Interventions in the ICU: A Systematic Review and Meta-Analysis. *Crit Care Med*. 2017;45(10):1751-1761.

37. Avidan A, Sprung CL, Schefold JC, et al. Variations in end-of-life practices in intensive care units worldwide (Ethicus-2): a prospective observational study. *Lancet Respir Med*. 2021;0(0). doi:10.1016/S2213-2600(21)00261-7

38. Lobo SM, De Simoni FH, Jakob SM, et al. Decision-Making on Withholding or Withdrawing Life Support in the ICU: A Worldwide Perspective. *Chest*. 2017;152(2):321-329. doi:10.1016/j.chest.2017.04.176

39. Soares M. End of life care in Brazil: the long and winding road. *Crit Care*. 2011;15(1):110. doi:10.1186/cc9962
40. Kipper DJ, Piva JP, Garcia PCR, et al. Evolution of the medical practices and modes of death on pediatric intensive care units in southern Brazil*. Pediatr Crit Care Med. 2005;6(3):258-263. doi:10.1097/01.PCC.0000154958.71041.37

41. Fumis RRL, Deheinzelin D. Respiratory support withdrawal in intensive care units: families, physicians and nurses views on two hypothetical clinical scenarios. Crit Care Lond Engl. 2010;14(6):R235. doi:10.1186/cc9390

42. Institute of Medicine (US) Committee on Guidance for Establishing Standards of Care for Use in Disaster Situations. Guidance for Establishing Crisis Standards of Care for Use in Disaster Situations: A Letter Report. (Altevogt BM, Stroud C, Hanson SL, Hanfling D, Gostin LO, eds.). National Academies Press (US); 2009. Accessed September 11, 2021. http://www.ncbi.nlm.nih.gov/books/NBK219958/

43. Aragão NSC de, Barbosa GB, Santos CLC, et al. Burnout Syndrome and Associated Factors in Intensive Care Unit Nurses. Rev Bras Enferm. 2021;74(suppl 3):e20190535. doi:10.1590/0034-7167-2019-0535

44. Embriaco N, Azoulay E, Barrau K, et al. High Level of Burnout in Intensivists. Am J Respir Crit Care Med. 2007;175(7):686-692. doi:10.1164/rccm.200608-1184OC

45. Embriaco N, Papazian L, Kentish-Barnes N, Pochard F, Azoulay E. Burnout syndrome among critical care healthcare workers. Curr Opin Crit Care. 2007;13(5):482-488. doi:10.1097/MCC.0b013e3282efd28a

46. Poncet MC, Toullic P, Papazian L, et al. Burnout syndrome in critical care nursing staff. Am J Respir Crit Care Med. 2007;175(7):698-704. doi:10.1164/rccm.200606-806OC

47. Azoulay E, Timsit JF, Sprung CL, et al. Prevalence and factors of intensive care unit conflicts: the conflicus study. Am J Respir Crit Care Med. 2009;180(9):853-860. doi:10.1164/rccm.200810-1614OC

48. West CP, Dyrbye LN, Sloan JA, Shanafelt TD. Single item measures of emotional exhaustion and depersonalization are useful for assessing burnout in medical professionals. J Gen Intern Med. 2009; 24(12):1318–1321.
Table 1: Healthcare provider characteristics by survey time period†

|                     | All participants (N=1,985) | Survey 1 First surge: June 2020 (N=991) | Survey 2 (all) Second surge: March 2021 (N=1,345) | Survey 2 Completed both surveys (N=351) |
|---------------------|-----------------------------|----------------------------------------|------------------------------------------------|----------------------------------------|
| **Gender**          |                             |                                        |                                                 |                                        |
| Female              | 1226 (62 %)                 | 620 (63 %)                              | 802 (60 %)                                      | 196 (56 %)                            |
| **Institution**     |                             |                                        |                                                 |                                        |
| Public              | 1004 (51 %)                 | 474 (48 %)                              | 674 (51 %)                                      | 144 (42 %)                            |
| Private             | 782 (40 %)                  | 407 (42 %)                              | 555 (42 %)                                      | 180 (52 %)                            |
| University          | 174 (9 %)                   | 98 (10 %)                               | 97 (7 %)                                        | 21 (6 %)                              |
| **Region**          |                             |                                        |                                                 |                                        |
| Center West         | 168 (8%)                    | 86 (9%)                                 | 114 (8%)                                        | 32 (9 %)                              |
| North               | 142 (7%)                    | 73 (7%)                                 | 84 (6%)                                         | 15 (4 %)                              |
| Northeast           | 353 (18%)                   | 176 (18%)                               | 235 (17%)                                       | 58 (17 %)                             |
| South               | 300 (15%)                   | 125 (13%)                               | 233 (17%)                                       | 58 (17 %)                             |
| Southeast           | 1022 (54%)                  | 531 (54%)                               | 679 (50%)                                       | 188 (54 %)                            |
| **Qualification***  |                             |                                        |                                                 |                                        |
| Attending physician | 761 (38%)                   | 376 (38%)                               | 579 (43%)                                       | 194 (55 %)                            |
| Physician in training| 382 (19%)                  | 172 (17%)                               | 276 (20%)                                       | 66 (19 %)                             |
| Nurse               | 276 (14%)                   | 150 (15%)                               | 145 (11%)                                       | 19 (5 %)                              |
| Respiratory therapist| 274 (12%)                  | 148 (15%)                               | 138 (10%)                                       | 39 (11 %)                             |
| Others***           | 322 (16%)                   | 148 (15%)                               | 207 (10%)                                       | 33 (9 %)                              |
| **Years in practice**|                           |                                        |                                                 |                                        |
| Mean (SD)           | 13.1 (9.21)                 | 14.0 (9.42)                             | 13.1 (9.21)                                     | 15.6 (9.54)                           |
| **Specialization** (Physicians***) |               |                                        |                                                 |                                        |
| Intensive Care      | 774 (68%)                   | 424 (77%)                               | 586 (69%)                                       | 218 (84%)                             |
| Internal Medicine   | 245 (21%)                   | 110 (20%)                               | 178 (21%)                                       | 43 (17%)                              |
| Specialization          | Number of Respondents |
|------------------------|------------------------|
| Cardiology             | 121 (11%) 65 (12%) 80 (9%) 2 (8%) |
| Emergency Medicine     | 79 (7%) 35 (6%) 60 (7%) 15 (6%) |
| Pulmonology            | 40 (3%) 22 (4%) 27 (3%) 12 (5%) |
| Anesthesiology         | 38 (3%) 15 (3%) 30 (4%) 18 (7%) |
| Other                  | 79 (7%) 35 (6%) 61 (7%) 16 (6%) |
| **Specialization (Nurses)** |                      |
| Intensive Care         | 235 (28 %) 126 (28 %) 126 (26 %) 17 (89%) |

**Number of COVID-19 patients cared for**

| Range | Number of Respondents |
|-------|------------------------|
| < 10  | 284 (14 %) 216 (22 %) 82 (6 %) 14 (4 %) |
| 10 to 50 | 613 (31 %) 408 (41 %) 261 (19 %) 56 (16 %) |
| > 50  | 1088 (55 %) 367 (37 %) 1001 (74 %) 280 (80 %) |

*Number of respondents in each category vary slightly as some responses are optional; multiple responses are possible per respondent regarding area of specialization so most frequent subspecialties are listed. A full list of HCP specializations is available in the appendix. Years in clinical practice includes years in training. Physicians in training include residents and fellows. ICU: Intensive care unit.
P<0.05 between survey 1 and survey 2

** Attending Physicians and Physicians in Training
*** speech therapists, pharmacists, nutritionists, dentists, psychologists, technicians, and research coordinators
### Table 2: ICU and COVID-related metrics during both surges

Sources: Instituto Brasileiro de Geografia e Estatística, Agência Nacional de Saúde, and Datasus

| Metric                          | Center West | North    | Northeast | South     | Southeast | Overall |
|---------------------------------|-------------|----------|-----------|-----------|-----------|---------|
| Population                      | 16,539,298  | 18,705,876 | 57,427,252 | 30,227,208 | 89,118,906 | 212,018,540 |
| % of total population           | 7.18        | 8.81     | 27.03     | 14.24     | 42.91     | 100     |
| Share of National GDP           | 9.92        | 5.53     | 14.35     | 17.07     | 53.13     | 100     |
| No of total ICU beds            | 5,027       | 2,911    | 11,639    | 7,540     | 27,628    | 54,745  |
| ICU beds per population*1000    | 0.30394277  | 0.15561955 | 0.20267381 | 0.24944414 | 0.31001278 | 0.25820855 |
| No of ventilators               | 7,341       | 4,598    | 15,787    | 11,171    | 40,910    | 79,807  |
| Vents per population*1000       | 0.44385197  | 0.24580511 | 0.27490433 | 0.36956771 | 0.45904962 | 0.37641519 |
| COVID-19 cases                  | 497,551     | 543,272  | 1,168,042 | 506,241   | 1,494,506 | 4,209,612 |
| Cases per population*1000       | 30.0829576  | 29.0428526 | 20.3995071 | 16.7478584 | 16.7697974 | 19.854924 |
| Accumulated deaths              | 10,827      | 14,059   | 35,648    | 10,335    | 58,556    | 119,100 |
| Deaths per population*1000      | 0.65462271  | 0.75158202 | 0.62075058 | 0.00034191 | 0.65705474 | 0.56174491 |

| Metric                          | Center West | North    | Northeast | South     | Southeast | Overall |
|---------------------------------|-------------|----------|-----------|-----------|-----------|---------|
| Population                      | 16,664,750  | 18,849,628 | 57,607,139 | 30,357,389 | 89,501,710 | 212,980,616 |
| % of total population           | 7.79        | 8.83     | 26.99     | 14.4      | 41.99     | 100     |
| Share of National GDP           | 9.92        | 5.53     | 14.35     | 17.07     | 53.13     | 100     |
| No of total ICU beds            | 5,818       | 4,333    | 14,634    | 9,915     | 32,868    | 67,568  |
| ICU beds per population*1000    | 0.34912015  | 0.22987191 | 0.25403102 | 0.32660912 | 0.36723321 | 0.31724953 |
| No of ventilators               | 11,516      | 5,682    | 17,846    | 12,766    | 45,541    | 93,351  |
| Vents per population*1000       | 0.69103947  | 0.30143831 | 0.30978799 | 0.42052365 | 0.50882827 | 0.43830749 |
| COVID-19 cases                  | 1,608,006   | 1,546,943 | 3,588,235 | 2,946,490 | 5,754,761 | 15,444,435 |
| Cases per population*1000       | 96.4914565  | 82.0675612 | 62.2880265 | 97.0600601 | 64.2977771 | 72.5156838 |
| Accumulated deaths              | 40,680      | 39,524   | 88,504    | 64,921    | 188,053   | 421,682 |
| Deaths per population*1000      | 2.44108072  | 2.09680531 | 1.53633736 | 2.13855678 | 2.10111069 | 1.97990788 |

†ICU: Intensive care unit.
Table 3: Survey responses by time period

|                                | Survey 1 First surge: June 2020 (N=991) | Survey 2 Second surge: March 2021 (N=1,345) | p-value |
|--------------------------------|----------------------------------------|---------------------------------------------|---------|
| **3a) ICU Resource availability** |                                        |                                             |         |
| Sufficient number of Intensivists (COVID 19) | 659 (66 %)                              | 567 (42 %)                                  | 0.002   |
| Sufficient number of Intensivists (other ICU patients) | 688 (69 %)                              | 678 (50 %)                                  | 0.568   |
| Sufficient number of ICU nurses (COVID 19) | 529 (53 %)                              | 480 (36 %)                                  | <0.001  |
| Sufficient number of ICU nurses (other ICU patients) | 583 (59 %)                              | 563 (42 %)                                  | <0.001  |
| **Space**                     |                                        |                                             |         |
| Sufficient number of ICU beds (COVID 19) | 515 (68 %)                              | 209 (22 %)                                  | <0.001  |
| Sufficient number of ICU beds (other ICU patients) | 455 (60 %)                              | 294 (31 %)                                  | <0.001  |
| **Oxygen supplies - available for all patients** |                                        |                                             |         |
| Ventilators                    | 672 (80 %)                              | 770 (70 %)                                  | <0.001  |
| NIPPV                          | 386 (46 %)                              | 503 (46 %)                                  | 0.113   |
| HFNC                           | 234 (28 %)                              | 228 (21 %)                                  | <0.001  |
| 02 concentrator                | 403 (48 %)                              | 447 (40 %)                                  | 0.736   |
| 02 tank oxygen                 | 796 (95 %)                              | 1022 (92 %)                                 | 0.012   |
| **Testing - always available** |                                        |                                             |         |
|                                | For patients | For providers | p-value |
|--------------------------------|--------------|--------------|---------|
|                                | 316 (33 %)   | 634 (49 %)   | 0.8666  |
|                                | 215 (23 %)   | 475 (37 %)   | <0.001  |
| **PPE - always available**     |              |              |         |
| Surgical mask                  | 685 (74 %)   | 1023 (82 %)  | <0.001  |
| Eye protection                 | 567 (62 %)   | 726 (58 %)   | <0.001  |
| Face Shield                    | 552 (60 %)   | 710 (57 %)   | <0.001  |
| N95                            | 429 (47 %)   | 714 (57 %)   | <0.001  |
| PAPR                           | 231 (25 %)   | 330 (26 %)   | <0.001  |
| Sterile Gowns                  | 473 (51 %)   | 772 (62 %)   | <0.001  |
| Gloves                         | 852 (93 %)   | 1145 (91 %)  | <0.001  |

### 3b) ICU resource utilization

|                                |                |                |         |
|--------------------------------|----------------|----------------|---------|
| **Staffing**                   |                |                |         |
| Non-intensivists care for ICU patients with COVID-19 | 314 (82 %) | 737 (88 %) | 0.002  |
| Non-intensivists care for other ICU patients | 177 (46 %) | 378 (45 %) | 0.568  |
| Non-ICU nurses care for ICU patients with COVID-19 | 354 (72 %) | 741 (81 %) | <0.001 |
| Non-ICU nurses care for other ICU patients | 200 (40 %) | 388 (42 %) | <0.001 |
| ICU nurses care for more patients at the same time | 135 (27 %) | 291 (32 %) | <0.001 |
| **Space**                      |                |                |         |
| ICUs have to transfer ICU patients with COVID-19 | 122 (20 %) | 277 (23 %) | <0.001 |
| ICUs have to transfer other ICU patients | 131 (22 %) | 240 (20 %) | <0.001 |
| ICUs have to decline transfer requests for patients with COVID-19 | 146 (24 %) | 583 (49 %) | <0.001 |
ICUs have to decline transfer requests for other ICU patients

|                           | N=728   | N=903   | p-value |
|---------------------------|---------|---------|---------|
|                           | 153 (26 %) | 432 (36 %) | <0.001 |

**Critical Care intervention used for ICU patients with COVID-9**

| Intervention                  | N=728   | N=903   | p-value |
|------------------------------|---------|---------|---------|
| Proning                      | 799 (81%) | 1093 (81%) | 0.697  |
| ECMO                         | 131 (13%) | 271 (20%) | <0.001 |
| Renal replacement therapy    | 695 (70%) | 949 (71%) | 0.823  |
| Palliative Care Consultation | 287 (37 %) | 367 (36 %) | 0.202  |

**Mechanical ventilation**

| Intervention                             | N=728   | N=903   | p-value |
|------------------------------------------|---------|---------|---------|
| Limiting MV for patients with COVID-19   | 98 (12 %) | 145 (13 %) | 0.36   |

**CPR in patients with COVID-19**

| Condition                                               | N=728   | N=903   | p-value |
|---------------------------------------------------------|---------|---------|---------|
| unchanged compared to before COVID-19                   | 202 (24 %) | 412 (37 %) | <0.001 |
| new CPR policy                                          | 437 (52 %) | 417 (38 %) |         |
| no new policy but changed CPR practices                 | 198 (24 %) | 279 (25 %) |         |

**CPR decisions**

| Decision                                | N=728   | N=903   | p-value |
|-----------------------------------------|---------|---------|---------|
| no CPR in patients with COVID-19        | 16 (2 %) | 5 (0 %) | 0.001  |
| determined by physicians                | 571 (68 %) | 723 (65 %) |         |
| determined by families                  | 248 (30 %) | 380 (34 %) |         |

**Family input for critical decisions in COVID-19 patients**

| Condition                                               | N=728   | N=903   | p-value |
|---------------------------------------------------------|---------|---------|---------|
| less compared to before COVID-19                        | 223 (27 %) | 281 (25 %) | <0.001 |

**3c) provider concerns**

| Concern                                                                           | N=728   | N=903   | p-value |
|-----------------------------------------------------------------------------------|---------|---------|---------|
| Insufficient access to PPE                                                        | 200 (28 %) | 132 (15 %) | <0.001 |
| Hospital unable to keep providers safe                                             | 162 (22 %) | 145 (16 %) | <0.001 |
| Poor communication from supervisors                                               | 159 (22 %) | 156 (17 %) | <0.001 |
| Worries about my own health                                                       | 449 (62 %) | 462 (51 %) | <0.001 |
| Worries about transmitting COVID-19 to my family/community                        | 572 (78 %) | 654 (72 %) | 0.001  |
| **Experiencing social stigma outside of the hospital** | 140 (19 %) | 142 (16 %) | <0.001 |
| **Witnessing colleagues in my hospital contract COVID-19** | 405 (55 %) | 387 (43 %) | <0.001 |
| **Hearing about HCPs contract COVID-19 in the media** | 250 (34 %) | 249 (27 %) | <0.001 |
| **Emotional distress and burnout** | 438 (60 %) | 638 (71 %) | <0.001 |
| **Worries about finances** | 149 (21 %) | 172 (19 %) | <0.001 |

**Living situation**

| **Living away from family to protect my family** | 123 (17 %) | 95 (11 %) | <0.001 |
| **Live in the same my house but completely isolate** | 34 (5 %) | 24 (3 %) |
| **Partially isolate from family members** | 129 (18 %) | 123 (14 %) |
| **Don’t isolate but take extra precautions** | 353 (49 %) | 498 (55 %) |
| **No precautions** | 88 (12 %) | 163 (18 %) |

†ICU: Intensive care unit. ‡ICU: Intensive care unit. HCPs: Healthcare providers. NIPPV: Non-invasive positive pressure ventilation. HFNC: High flow nasal cannula. ECMO: Extracorporeal membrane oxygenation. CPR: Cardiopulmonary Resuscitation.
Table 4a: Univariate and multivariate associations of reporting families have less input in decision making during COVID-19†

| Survey 1. First surge: June 2020 | RR (95% CI) | P value | aRR (95% CI) | P value |
|---------------------------------|-------------|---------|--------------|---------|
| **Region**                      |             |         |              |         |
| Southeast                       |             |         |              |         |
| North                           | 1.55 (0.92 - 2.61) | 0.10 | 1.41 (0.89 - 2.23) | 0.14 |
| Center West                     | 0.73 (0.42 - 1.26) | 0.26 | 0.69 (0.39 - 1.23) | 0.21 |
| Northeast                       | 1.31 (0.90 - 1.89) | 0.16 | 1.16 (0.82 - 1.63) | 0.41 |
| South                           | 0.79 (0.51 - 1.23) | 0.30 | 0.82 (0.52 - 1.27) | 0.37 |
| Palliative care                 | 1.45 (1.07 - 1.96) | 0.02 | –             |       |
| **Shortages reported**          |             |         |              |         |
| Limited availability of N95     | 1.22 (0.93-1.59) | 0.15 | –            |       |
| Limited availability of PAPR    | 1.30 (0.93 - 1.81) | 0.12 | –            |       |
| Insufficient intensivists       | 1.49 (1.14 - 1.94) | <0.01 | 1.37 (1.05 - 1.80) | 0.02 |
| Insufficient nurses             | 1.32 (1.01 - 1.71) | 0.04 | –            |       |
| Insufficient ICU beds           | 1.32 (0.99 - 1.76) | 0.06 | –            |       |
| Limited availability of mechanical ventilators | 1.41 (1.04 - 1.90) | 0.03 | –            |       |
| Limited availability of NIPPV   | 1.66 (1.26 - 2.19) | <0.01 | 1.56 (1.18 - 2.07) | <0.01 |
| Limited availability of HFNC    | 1.33 (0.97 - 1.83) | 0.07 | –            |       |
| Limited availability of O2 concentrators | 1.37 (1.05-1.80) | 0.02 | –            |       |
| Limited availability of tank oxygen | 1.73 (1.07-2.81) | 0.03 | –            |       |
| **Survey 2. Second surge: March 2021** |             |         |              |         |
| **Region**                      |             |         |              |         |
| Southeast                       |             |         |              |         |
| North                           | 2.05 (1.38-3.05) | <0.01 | 1.58 (0.99-2.53) | 0.05 |
| Center West                     | 0.96 (0.60-1.55) | 0.88 | 0.90 (0.54-1.47) | 0.66 |
| Northeast                       | 1.14 (0.82-1.57) | 0.44 | 1.01 (0.70-1.44) | 0.97 |
| South                           | 1.25 (0.91-1.73) | 0.16 | 1.15 (0.82-1.62) | 0.41 |
| Palliative care                 | 1.65 (1.25-2.19) | <0.01 | 1.50 (1.12-2.01) | 0.01 |
| **Shortages reported**          |             |         |              |         |
| Limited availability of N95     | 1.49 (1.18-1.88) | <0.01 | 1.43 (1.10-1.85) | 0.01 |
| Limited availability of PAPR    | 1.65 (1.20-2.25) | <0.01 | –            |       |
| Insufficient intensivists       | 1.48 (1.15-1.90) | <0.01 | –            |       |
| Insufficient nurses             | 1.42 (1.09-1.84) | 0.01 | –            |       |
| Insufficient ICU beds           | 1.98 (1.35-2.90) | <0.01 | 1.71 (1.16-2.52) | 0.01 |
| Limited availability of mechanical ventilators | 1.42 (1.12-1.81) | <0.01 | –            |       |
| Limited availability of NIPPV   | 1.51 (1.18-1.93) | <0.01 | –            |       |
| Limited availability of HFNC    | 1.36 (0.99-1.87) | <0.01 | –            |       |
| Limited availability of O2 concentrators | 1.64 (1.27-2.12) | <0.01 | 1.50 (1.13-2.00) | 0.01 |
| Limited availability of tank oxygen | 1.38 (0.94-2.03) | 0.10 | –            |       |

†RR: relative risk, aRR: adjusted relative risk. HCP: healthcare professional. NIPPV: Non-invasive positive pressure ventilation. HFNC: High flow nasal cannula.
Table 4b: Univariate and multivariate associations of reporting emotional distress and burnout among healthcare providers in Brazil during COVID-19†

| Survey 1. First surge: June 2020 | RR (95% CI) | P value | aRR (95% CI) | P value |
|----------------------------------|-------------|---------|--------------|---------|
| **Gender**                       |             |         |              |         |
| Male                             |             |         |              |         |
| Female                           | 1.17 (0.98-1.43) | 0.11    | -            |         |
| **Provider type**                |             |         |              |         |
| Attending physicians             |             |         |              |         |
| Physicians in training           | 0.95 (0.73-1.24) | 0.71    | 0.95 (0.72-1.26) | 0.74 |
| Nurse                            | 1.03 (0.77-1.36) | 0.85    | 1.05 (0.78-1.41) | 0.75 |
| RT                               | 0.92 (0.68-1.25) | 0.60    | 1.12 (0.84-1.51) | 0.44 |
| Other                            | 1.03 (0.77-1.36) | 0.19    | 0.95 (0.69-1.31) | 0.74 |
| **Region**                       |             |         |              |         |
| Southeast                        |             |         |              |         |
| North                            | 0.88 (0.60-1.30) | 0.53    | -            | -       |
| Center West                      | 1.04 (0.84-1.29) | 0.77    | 0.82 (0.56-1.21) | 0.31 |
| Northeast                        | 1.04 (0.84-1.29) | 0.73    | 0.93 (0.71-1.22) | 0.59 |
| South                            | 1.12 (0.91-1.38) | 0.35    | 1.04 (0.78-1.39) | 0.78 |
| **Palliative care**              |             |         |              |         |
|                                  | 0.98 (0.81-1.19) | 0.84    | -            | -       |
| **Shortages reported**           |             |         |              |         |
| Limited availability of N95      | 1.13 (0.94-1.37) | 0.20    | -            | -       |
| Limited availability of PAPR     | 1.17 (0.90-1.41) | 0.31    | -            | -       |
| Insufficient intensivists        | 1.27 (1.05-1.53) | 0.02    | -            | -       |
| Insufficient nurses              | 1.35 (1.11-1.63) | <0.01   | 1.25 (1.02-1.53) | 0.03 |
| Insufficient ICU beds            | 1.13 (0.93-1.38) | 0.21    | -            | -       |
| Limited availability of mechanical ventilators | 0.96 (0.75-1.23) | 0.76    | -            | -       |
| Limited availability of NIPPV    | 1.02 (0.85-1.23) | 0.82    | -            | -       |
| Limited availability of HFNC     | 1.17 (0.94-1.45) | 0.17    | -            | -       |
| Limited availability of O2 concentrators | 1.04 (0.86-1.25) | 0.69    | -            | -       |
| Limited availability of tank oxygen | 0.99 (0.60-1.63) | 0.97    | -            | -       |
| **Provider concerns**            |             |         |              |         |
| Insufficient access to PPE       | 1.23 (1.01-1.51) | 0.04    | -            | -       |
| Feel that hospital is unable to keep me safe | 1.30 (1.05-1.60) | 0.02    | -            | -       |
| Poor communication from supervisors | 1.32 (1.07-1.64) | 0.01    | -            | -       |
| Worries about own health         | 1.37 (1.12-1.68) | <0.01   | -            | -       |
| Worries about financial situation| 1.49 (1.21-1.84) | <0.01   | 1.28 (1.02-1.61) | 0.03 |
| Worries about transmitting infection my family and community | 1.53 (1.18-1.98) | <0.01 | -            | -       |
| Social stigma from my community  | 1.48 (1.19-1.83) | <0.01   | 1.25 (1.02-1.53) | 0.06 |
| Witnessing colleagues at my hospital contract COVID-19 | 1.71 (1.39-2.08) | <0.01 | 1.55 (1.25-1.93) | p<0.01 |
| Hearing about other providers contracting COVID-19 from news | 1.51 (1.25-1.83) | <0.01 | - | - |

**Number of COVID-19 patients cared for**

| | < 10 | Ref. | ≥ 10 | 1.35 (1.04 – 1.75) | 0.03 | 1.36 (1.03-1.79) | 0.03 |

**Survey 2. Second surge: March 2021**

**Gender**

| | Male | Ref. | Female | 1.10 (0.94-1.29) | 0.23 | - |

**Provider type**

| | Attending physicians | Ref. | Physicians in training | 1.08 (0.88-1.32) | 0.48 | 1.06 (0.87-1.30) | 0.57 |
| | Nurse | 1.13 (0.87-1.47) | 0.35 | 1.11 (0.85-1.44) | 0.45 |
| | RT | 1.01 (0.76-1.32) | 0.96 | 0.97 (0.74-1.28) | 0.84 |
| | Other | 0.81 (0.62-1.05) | 0.11 | 0.79 (0.60-1.03) | 0.08 |

**Region**

| | Southeast | Ref. | North | 0.90 (0.61-0.77) | 0.61 | 0.91 (0.62-1.34) | 0.63 |
| | Center West | 1.04 (0.61-1.33) | 0.77 | 1.03 (0.78-1.37) | 0.83 |
| | Northeast | 1.04 (0.84-1.29) | 0.73 | 1.03 (0.83-1.28) | 0.81 |
| | South | 1.12 (0.91-1.38) | 0.28 | 1.08 (0.88-1.34) | 0.46 |

**Palliative care**

| | 1.00 (0.85-1.17) | 0.96 | - | - |

**Shortages reported**

| | Limited availability of N95 | 1.03 (0.88-1.21) | 0.68 | - | - |
| | Limited availability of PAPR | 1.09 (0.91-1.32) | 0.35 | - | - |
| | Insufficient intensivists | 1.09 (0.93-1.28) | 0.28 | - | - |
| | Insufficient nurses | 1.13 (0.95-1.33) | 0.17 | - | - |
| | Insufficient ICU beds | 1.27 (1.04-1.55) | 0.02 | - | - |
| | Limited availability of mechanical ventilators | 1.05 (0.89-1.24) | 0.55 | - | - |
| | Limited availability of NIPPV | 1.09 (0.94-1.28) | 0.26 | - | - |
| | Limited availability of HFNC | 1.25 (1.02-1.54) | 0.04 | - | - |
| | Limited availability of O2 concentrators | 1.03 (0.88-1.21) | 0.42 | - | - |
| | Limited availability of tank oxygen | 0.95 (0.70-1.28) | 0.72 | - | - |

**Provider concerns**

| | Insufficient access to PPE | 1.14 (0.92-1.40) | 0.23 | - | - |
| | Feel that hospital is unable to keep me safe | 1.16 (0.95-1.42) | 0.15 | - | - |
| | Poor communication from supervisors | 1.26 (1.04-1.52) | 0.02 | - | - |
| | Worries about own health | 1.19 (1.02-1.39) | 0.03 | - | - |
| | Worries about financial situation | 1.31 (1.09-1.58) | <0.01 | - | - |
| | Worries about transmitting infection my family and community | 1.34 (1.11-1.62) | <0.01 | 1.21 (0.98-1.48) | 0.07 |
| Event                                                | RR (95% CI)          | p       | Adjusted RR (95% CI) | Adjusted p  |
|------------------------------------------------------|----------------------|---------|----------------------|-------------|
| Social stigma from my community                      | 1.29 (1.06-1.57)     | 0.01    | -                    | -           |
| Witnessing colleagues at my hospital contract COVID-19| 1.40 (1.20-1.63)     | <0.01   | 1.31 (1.11-1.55)     | <0.01       |
| Hearing about other providers contracting COVID-19 from news | 1.34 (1.14-1.58)     | <0.01   | -                    | -           |
| Number of COVID-19 patients cared for                |                      |         |                      |             |
| < 10                                                 | Ref.                 | -       | -                    | -           |
| ≥ 10                                                 | 1.33 (0.90-1.95)     | 0.15    | -                    | -           |

†RR: relative risk, aRR: adjusted relative risk. HCP: healthcare professional. NIPPV: Non-invasive positive pressure ventilation. HFNC: High flow nasal cannula.
Figure 1: Map of Brazil by region and states

Figure legend (region/states)

Center West – population 16,664,750
542 AMIB members
Distrito Federal
Goiás
Mato Grosso
Mato Grosso do Sul

North - population 18,705,876
344 AMIB members
Acre
Amapá
Amazonas
Pará
Rondônia
Roraima
Tocantins

Northeast – population 57,607,139
839 AMIB members
Alagoas
Bahia
Ceará
Maranhão
Paraíba
Pernambuco
Piauí
Rio Grande do Norte
Sergipe

Southeast – population 89,501,710
2,688 AMIB members
Espírito Santo
Minas Gerais
Rio de Janeiro
São Paulo

South - population 30,357,389
837 AMIB members
Paraná
Rio Grande do Sul
Santa Catarina
Figure 2: Perceived availability of resources to care for ICU patients with COVID-19

- Intensivists - for ICU patients with COVID-19
  - June of 2020: Blue, March of 2021: Orange

- ICU nurses - for ICU patients with COVID-19
  - June of 2020: Blue, March of 2021: Orange

- ICU beds - for ICU patients with COVID-19
  - June of 2020: Blue, March of 2021: Orange

- Ventilators
  - June of 2020: Blue, March of 2021: Orange
Intensivists - for other ICU patients

ICU nurses - for other ICU patients

ICU beds - for other ICU patients

June of 2020
March of 2021