

the risk of pneumococcal disease has been observed (10). The lack of an observed association with asthma might be explained by a mediation effect by ICSs (10).

An advantage of our study is that we have been able to use registry data to include use of oral steroids, other immunomodulating drugs, and chronic diseases in our model. We adjusted for education, income, and ethnicity as proxies for socioeconomic status. Smoking data were not available. Caution is warranted, however, in causal interpretations of these estimates (11). Confounding by indication, as previously shown for PPIs and H<sub>2</sub>-receptor antagonists (12), could also contribute to the observed associations, as ICSs tend to be reserved for more severe COPD, which could be associated with increased IPD risk.

**Conclusions.** Use of ICSs is associated with increased odds of invasive pneumococcal pneumonia, and furthermore, manifests a dose–response relation (13, 14). ■

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## Critical Care Clinician Wellness during the COVID-19 Pandemic: A Longitudinal Analysis

To the Editor:

Critical care clinicians experienced high rates of burnout and depression early in the coronavirus disease (COVID-19) pandemic

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(1–3). We sought to longitudinally evaluate burnout, depression, and professional fulfillment—as measures of overall clinician wellness—among critical care healthcare professionals at seven hospitals within our hospital network. We hypothesized that well-being and depression would initially worsen over time but would improve with the arrival of the vaccine and that burnout rates would be higher among nonphysicians with less professional time dedicated to nonclinical activities such as education and research, which may allow time for renewal.

## Methods

We administered a questionnaire quarterly to attending physicians, advanced practice providers (APPs) (including nurse practitioners and physician assistants), respiratory therapists (RTs), and clinical pharmacists who staffed intensive care units (ICUs) of seven hospitals at Penn Medicine. Nurses did not participate because of concurrent

**Table 1.** Cumulative COVID-19 ICU census as of February 9, 2021, and burnout, by hospital

	Cumulative COVID-19 ICU Census	Burnout (%)		
		Quarter 1	Quarter 2	Quarter 3
Hospital A	580	69	56	78
Hospital B	528	54	66	67
Hospital C	489	56	62	59
Hospital D	310	7	25	30
Hospital E	271	59	71	66
Hospital F	203	66	Unavailable	50
Hospital G	Unavailable	57	83	50

Definition of abbreviations: COVID-19 = coronavirus disease; ICU = intensive care unit.

research studies and leadership concern about survey fatigue. As detailed elsewhere, our integrated academic medical center leveraged the health system Critical Care Alliance to create the COVID-19 Task Force, which served to develop and disseminate standardized clinical protocols, educate critical care clinicians, and monitor and optimize outcomes (4, 5).

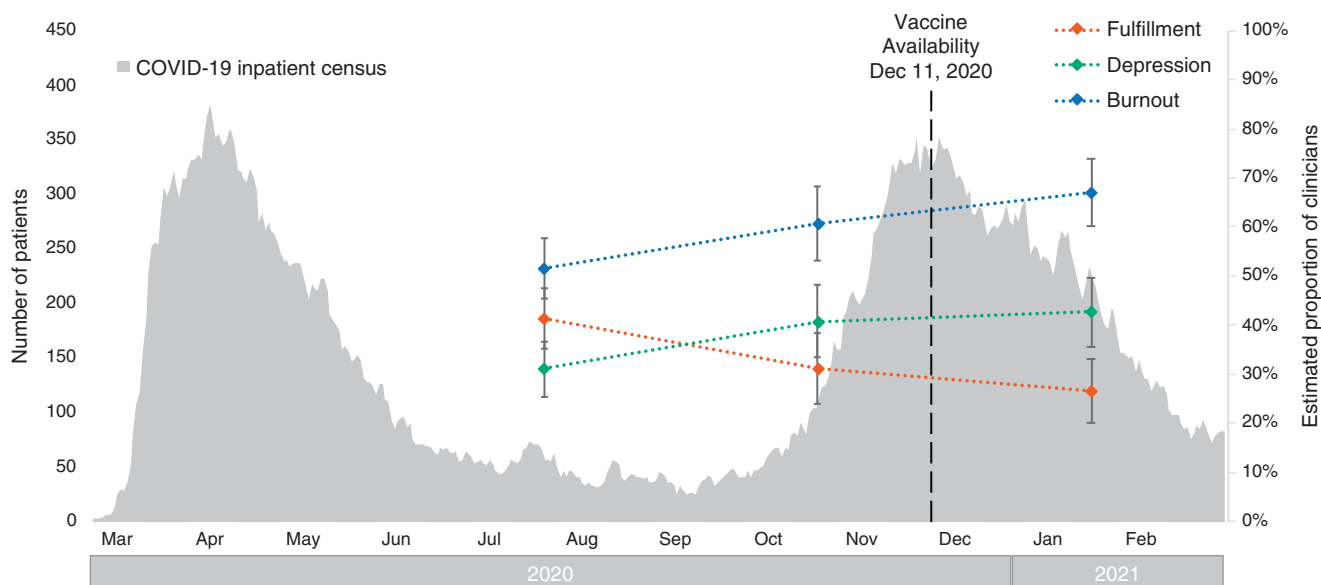
We invited participants by e-mail in July of 2020, October of 2020, and January of 2021 to complete the questionnaire electronically via the Research Electronic Data Capture platform (the questionnaire is available from corresponding author upon request) (6). The questionnaire included the 7-item Well-Being Index (WBI) (7) and the 16-item Stanford Professional Fulfillment Index (SPFI) (8). As in previous studies, we defined burnout as an SPFI average burnout score of  $\geq 1.33$  or a WBI score of  $\geq 4$  and fulfillment as an SPFI fulfillment score of  $\geq 3$  (2). We defined depression as a response of “yes” to the single WBI question about depression symptoms.

To test our hypotheses, we built three separate mixed-effect logistic regression models with dependent variables of burnout,

depression, and professional fulfillment. Each model included a random effect for participant to account for multiple responses by individuals over time. We *a priori* selected female sex and years of experience to include as potential confounders on the basis of previous literature (9, 10). We used a *P* value of 0.05 as the threshold for statistical significance and used Stata 16.1 (StataCorp) for all statistical analyses. This study was approved by the University of Pennsylvania Institutional Review Board.

## Results

Of 550 clinicians invited, 296 (54%) responded to at least one survey, including 73 attending physicians, 105 APPs, 18 pharmacists, and 100 RTs. Of the 296 participants, 171 (58%) were female, with a median number of years in clinical practice of 7 (interquartile range, 3–15). One hundred thirty-seven (46%) participants completed one survey, 88 (30%) completed two surveys, and 71 (24%) completed three surveys. The proportion of clinicians who completed the survey over time, by professional role, did not change significantly ( $P = 0.61$ ).



**Figure 1.** Adjusted estimates of wellness measures during the pandemic. The dashed lines represent the predicted proportion of clinicians with burnout (blue), depression (green), and fulfillment (orange), which were estimated from multivariable models to account for differences in sex and years in practice. The gray bars indicate the inpatient census of confirmed COVID-19 cases across all University of Pennsylvania Health System hospitals over time. COVID-19 = coronavirus disease.

**Table 2.** Multivariable analyses of wellness measures

Variable	Burnout		Depression		Fulfillment	
	OR (95% CI)	P Value	OR (95% CI)	P Value	OR (95% CI)	P Value
Professional role						
Attending physician	Reference	Reference	Reference	Reference	Reference	Reference
APP	0.64 (0.21–1.97)	0.43	1.06 (0.29–3.85)	0.93	0.92 (0.31–2.70)	0.88
Clinical pharmacist	0.79 (0.14–4.52)	0.79	2.05 (0.28–14.8)	0.48	0.53 (0.09–3.07)	0.48
Respiratory therapist	3.70 (1.21–11.3)	0.02	8.13 (2.17–30.5)	0.002	0.28 (0.10–0.82)	0.02
Survey quarter						
Quarter 1	Reference	Reference	Reference	Reference	Reference	Reference
Quarter 2	2.04 (1.05–3.98)	0.04	2.45 (1.18–5.09)	0.02	0.45 (0.23–0.88)	0.02
Quarter 3	3.50 (1.75–7.02)	<0.001	2.87 (1.40–5.87)	0.004	0.30 (0.15–0.59)	0.001

Definition of abbreviations: APP = advanced practice provider; CI = confidence interval; OR = odds ratio. Analyses included 509 responses that had complete data for potential confounders.

Among all participants, 198 (67%) reported burnout symptoms in response to at least one quarterly survey, 136 (46%) reported depression symptoms, and 126 (43%) experienced professional fulfillment. By professional role, 41 (56%) physicians, 71 (68%) APPs, 12 (67%) pharmacists, and 74 (74%) RTs reported burnout symptoms at least once. Twenty-two (30%) physicians, 45 (47%) APPs, 10 (56%) pharmacists, and 57 (57%) RTs reported having symptoms of depression. And 41 (56%) physicians, 42 (40%) APPs, 7 (39%) pharmacists, and 36 (36%) RTs experienced professional fulfillment. As shown in Table 1, rates of burnout differed across hospitals. In general, burnout increased over time across hospitals and was the highest in hospitals with the greatest burden of critically ill patients with COVID-19.

In multivariable analyses, burnout and depression significantly increased and professional fulfillment significantly decreased in the second and third quarterly surveys, compared with the first. Figure 1 illustrates predicted estimates of proportions of all clinicians experiencing burnout, depression, and fulfillment over time, accounting for differences in sex and years in practice. When using attending physicians as the reference group, burnout and depression were significantly worse and professional fulfillment were significantly lower among RTs, but not among other groups (Table 2). Among the 71 clinicians who completed all surveys, burnout increased from 56% to 60–71% over the three surveys, and depression increased from 29% at the first survey to 40% in the latter two surveys.

## Discussion

In this longitudinal evaluation of critical care healthcare professional wellness during the pandemic, we found that symptoms of burnout and depression have increased and that fulfillment has decreased during the course of the pandemic. Furthermore, wellness is particularly low among RTs, who have the highest rates of burnout and depression and the lowest rates of fulfillment. Contrary to our hypothesis, there was no noticeable improvement after the start of vaccination efforts.

There are several possible explanations for the findings that wellness overall has worsened over time among all groups. All critical care professionals have likely experienced an excessive workload and may have clinical schedules that do not permit time for renewal. There have been changes in practices during the pandemic, such as

increased death and suffering witnessed, challenges to shared decision-making and family communication related to restrictive visitation policies, and the loss of community at work. The vaccination efforts were slow and uncertain at the start, and COVID-19 activity remained high, so the impact of the vaccine may not have yet altered clinicians' perceptions of the outlook for the pandemic or mitigated the existing burnout and fatigue from the preceding months. Alternatively, the vaccination efforts may have mitigated what would have been even worse burnout.

That burnout was worst among RTs bears noting. RTs may perceive even higher personal risk, as they are directly responsible for administering aerosol-generating treatments to patients with COVID-19 with respiratory compromise. Furthermore, in many places, including our institution, RTs faced staffing challenges during the pandemic that resulted in an increased workload, exposing them to greater risk and a greater volume of patients, many of whom did not survive. Future studies should target RTs to better understand and intervene regarding these findings to maintain this essential component of the critical care workforce.

Our study has a few important limitations. It was conducted within a single health system, which may limit generalizability; however, we included seven hospitals that are organizationally distinct and serve different patient populations. Second, we could not survey nurses, vital members of the interdisciplinary critical care team. Third, our well-being measures, although validated and recommended (11), rely on self-report. Finally, our response rate, although modest and lower than that of Azoulay and colleagues (1), was higher than the 45% response rate of our prepandemic survey (2) and was substantially higher than the 20% response rate reported in a recent survey conducted during the pandemic (12).

In summary, this study confirms earlier reports that revealed the impact of the pandemic on critical care healthcare professional well-being (1–3, 12) and reveals that wellness among this group has declined further during the pandemic, with RTs faring the worst among all groups studied. Although future studies are needed to examine the impact of the pandemic on the critical care workforce and their long-term mental health, these data serve as an urgent call to action for healthcare organizations to tend to the well-being of the critical care workforce. ■

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## Video Telehealth Pulmonary Rehabilitation for Chronic Obstructive Pulmonary Disease Is Associated with Clinical Improvement Similar to Center-based Pulmonary Rehabilitation

To the Editor:

Pulmonary rehabilitation (PR) for adults with chronic obstructive pulmonary disease (COPD) results in substantial improvement in

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dyspnea and functional exercise tolerance, and it is also associated with reduction in exacerbations and improved survival rates (1). Despite these proven benefits, only a minority of patients with COPD are able to access PR. In 2012, only 3.7% of Medicare beneficiaries used PR (2). Even after hospitalization for an exacerbation, only 1.9% received PR within 6 months of discharge (3). PR is traditionally delivered at centers equipped with exercise tools. A major barrier to access is the limited number of PR centers within a reasonable distance from patients' homes (4–6). Indeed, even a distance of 10 miles lowers the odds of participating in PR by approximately half (3). The limited access to center-based PR—especially in light of the increase in PR-center closures because of poor reimbursement and the ongoing coronavirus disease (COVID-19) pandemic—provides an impetus to find alternative avenues for administration of PR.

The benchmark for PR is a supervised, center-based program wherein higher-intensity exercise can be achieved compared with non-center-based interventions with minimal equipment. Only a few studies have evaluated alternative avenues for delivery of PR. Although