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ARTIGO ORIGINAL

Personal Protection Equipment for COVID-19 – Can less be more?

Equipamento de Proteção Individual para COVID-19 – Menos pode ser mais?

Equipos de Protección Personal para el COVID-19 – ¿Menos puede ser más?

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ABSTRACT

Justification: Several institutions opted for prolonged use of full body personal protective equipment (PPE) for healthcare workers (HCW) in intensive care COVID-19 units. Nevertheless, to the extent of our knowledge, no prior study has evaluated. the efficacy of long-term use of whole-body PPE in reducing SARS-COV-2 transmission and its impact on quality of patient care **Purpose:** This study aims to compare the incidence of HCW infected with SARS-Cov-2 and indicators of patient quality of care in two personal protection equipment (PPE) care models used in the same intensive care units (ICU) in different periods of the COVID-19 pandemic. **Patient and Methods**: This is a before and after study. The incidence of HCW infected with SARS-Cov-2, the incidence of central venous catheter (CVC) infections per 1000 CVC-day, Gram-negative carbapenem resistant (CARB-R) bacteremia per 1000 patients-day 48h after ICU admission and confirmed/suspected COVID-19 patients' ICU mortality rate were compared in two different periods. To evaluate HCW perceptions regarding the two PPE models, a structured questionnaire was applied to ICU HCWs. **Results**: The main characteristics of patients admitted to the ICUs during the two periods were similar in both periods. The mean number of infected HCW (t=2.6, p=0.029) and patient mortality was significantly higher in the first period, (t=2.9, p=0.017). Although central venous catheter infections and gram-negative carbapenem resistant infection rates were higher in whole-body PPE, the differences were not statistically significant. **Conclusion**: A less aggressive PPE approach did not lead to higher risks to HCW and yet may have aided in improving patients' outcomes and the quality of work provided by HCW.

Keywords: *SARS-Cov-2, health care workers, intensive care units, transmission, contaminated surfaces, hospital infection control.*

RESUMO

Justificativa: Diversas instituições optaram pelo uso prolongado de equipamentos de proteção individual (EPI) de corpo inteiro para profissionais de saúde (PS) em unidades de terapia intensiva COVID-19. No entanto, até onde sabemos, nenhum estudo anterior avaliou a eficácia do uso a longo prazo de EPI de corpo inteiro na redução da transmissão de SARS-COV-2

e seu impacto na qualidade do atendimento ao paciente. **Objetivo:** Este estudo tem como objetivo comparar a incidência de profissionais de saúde infectados com SARS-Cov-2 e indicadores de qualidade do atendimento ao paciente em dois modelos de atendimento de equipamentos de proteção individual (EPI) utilizados nas mesmas unidades de terapia intensiva (UTI) em diferentes períodos da pandemia de COVID-19. **Paciente e Métodos:** Este é um estudo antes e depois. A incidência de profissionais de saúde infectados com SARS-Cov-2, a incidência de infecções por cateter venoso central (CVC) por 1.000 CVC-dia, bacteremia Gram-negativa resistente a carbapenem (CARB-R) por 1.000 pacientes-dia 48h após admissão na UTI e confirmada A taxa de mortalidade na UTI de pacientes suspeitos de COVID-19 foi comparada em dois períodos diferentes. Para avaliar a percepção dos profissionais de saúde em relação aos dois modelos de EPI, foi aplicado um questionário estruturado aos profissionais de saúde da UTI. **Resultados:** As principais características dos pacientes internados nas UTIs nos dois períodos foram semelhantes nos dois períodos. O número médio de profissionais de saúde infectados (t=2,6, p=0,029) e mortalidade de pacientes foi significativamente maior no primeiro período (t=2,9, p=0,017). Embora as infecções por cateter venoso central e as taxas de infecção resistentes a carbapenêmicos gram-negativos tenham sido maiores em PPE de corpo inteiro, as diferenças não foram estatisticamente significativas. **Conclusão:** Uma abordagem de EPI menos agressiva não levou a maiores riscos aos profissionais de saúde e ainda pode ter ajudado a melhorar os resultados dos pacientes e a qualidade do trabalho prestado pelos profissionais de saúde.

Palavras-chave: *SARS-Cov-2, profissionais de saúde, unidades de terapia intensiva, transmissão, superfícies contaminadas, controle de infecção hospitalar.*

RESUMEN

Justificación: Varias instituciones optaron por el uso prolongado de equipos de protección personal (EPP) de cuerpo completo para los trabajadores de la salud (HCW) en unidades de cuidados intensivos COVID-19. Sin embargo, según nuestro conocimiento, ningún estudio previo ha evaluado la eficacia del uso a largo plazo de EPP para todo el cuerpo en la reducción de la transmisión del SARS-COV-2 y su impacto en la calidad de la atención al paciente. **Objetivo:** Este estudio tiene como objetivo comparar la incidencia de TS infectados con SARS-Cov-2 e indicadores de calidad de atención del paciente en dos modelos de atención de equipos de protección personal (EPP) utilizados en las mismas unidades de cuidados intensivos (UCI) en diferentes períodos de la pandemia de COVID-19. **Paciente y Métodos:** Este es un estudio de antes y después. La incidencia de HCW infectados con SARS-Cov-2, la incidencia de infecciones de catéter venoso central (CVC) por 1000 CVC-día, bacteriemia Gram-negativa resistente a carbapenem (CARB-R) por 1000 pacientes-día 48 h después de la admisión en la UCI y confirmado Se comparó la tasa de mortalidad en UCI de pacientes con sospecha de COVID-19 en dos períodos diferentes. Para evaluar las percepciones de los HCW con respecto a los dos modelos de EPP, se aplicó un cuestionario estructurado a los HCW de la UCI. **Resultados:** Las principales características de los pacientes ingresados en las UCI durante los dos períodos fueron similares en ambos períodos. El número medio de trabajadores sanitarios infectados (t=2,6, p=0,029) y la mortalidad de los pacientes fue significativamente mayor en el primer período (t=2,9, p=0,017). Aunque las infecciones del catéter venoso central y las tasas de infecciones resistentes a los carbapenémicos gramnegativos fueron más altas en el EPP de cuerpo entero, las diferencias no fueron estadísticamente significativas. **Conclusión:** Un enfoque de EPP menos agresivo no condujo a mayores riesgos para el HCW y, sin embargo, puede haber ayudado a mejorar los resultados de los pacientes y la calidad del trabajo proporcionado por el HCW.

Palabras clave: *SARS-Cov-2, trabajadores de la salud, unidades de cuidados intensivos, transmisión, superficies contaminadas, control de infecciones hospitalarias.*

INTRODUCTION

From the outset of the coronavirus disease 19 (COVID-19) pandemic, in-hospital transmission played a major role in virus dissemination with a particularly high morbidity and mortality toll in health care workers (HCW).[1]

According to the World Health Organization (WHO), SARS-CoV-2 is primarily transmitted in the hospital setting through respiratory droplets, aerosol, contact routes and fomites in the immediate environment around the infected person.[2] However, doubts have arose regarding a possible exaggerated perception of risk of transmission of COVID-19 by fomites with limited evidence of SARS-CoV-2 transmission through contaminated surfaces.[3] Prior work suggests that transmission through fomites requires a higher viral load as compared to significantly lower concentration present in droplets in real-life situations, with the amount of virus actually deposited on surfaces likely to be several orders of magnitude smaller.[4,5]

Over the course of the COVID-19 pandemic, the recommendations for personal protective equipment (PPE) were modified as evidence of in-hospital transmission routes began to emerge. Some recommendations, such as the universal use of surgical masks in institutions, proved to be effective in reducing transmission rates, while others have never been tested.[6,7] For instance, several institutions opted for prolonged use of full body PPE for HCW in intensive care COVID-19 units, with the time of use being equal to or greater than 4 hours without the ability to take a break.[8] Nevertheless, to the extent of our knowledge, no prior study has evaluated the efficacy of long-term use of whole-body PPE in reducing SARS-COV-2 transmission and its impact on quality of patient care. A multi country web survey done with HCW found many adverse effects associated with prolonged whole-body PPE use including heat, thirst, pressure areas, headaches, inability to use the bathroom and extreme exhaustion.[8]

The present study aims to compare the incidence of HCW infected with SARS-Cov-2, as well as indicators of patient quality of care in two PPE care models used in the same intensive care units (ICU) in different periods of the COVID-19 pandemic.

MATERIAL AND METHODS

This is a before and after study undertaken in the Instituto Couto Maia (ICOM), a hospital specialized in infectious

disease located in Bahia, Brazil. Before the pandemic, ICOM capacity included a total of 120-beds with 20 ICU beds. Beginning March 17, 2020, ICOM became a reference hospital for the care of patients with COVID-19 exclusively. As a result, the hospital expanded capacity to 162 beds, 80 of which were ICU beds. Twenty of the 80 ICU beds were in two cohort units, where 10 patients were geographically cohorted in the same environment with HCW using whole-body PPE during their 12-hour shifts. The use of full body PPE (N95, cap, face shield, long-sleeved gown, gloves) in the cohort units were maintained uninterruptedly for a median duration of 4-6 hours at a time, with glove changes and hand hygiene performed in between each patient contact. In this study this is designated as "Model A". The rational for this model emerged from concern for potential higher risk of contamination of HCW in continuous exposure with the same environment as infected patients in addition to possible self-contamination with frequent removal of PPE. In these units only those HCW that provided direct patient care were allowed to enter the sector. Consultants, infection control and other professionals had limited access. Contact with the treating team of HCW was made outside the unit, by phone or electronic medical record.

In contrast to these cohort ICU groups, re-purposed individual or dual occupancy medical ward rooms served as the expanded ICU to the other 60 ICU beds. One to two COVID-19 patients were in a closed room with limited negative pressure capability. HCW used N95 masks continuously over the duration of their shifts, combined with long-sleeved gowns and gloves donned only when entering a patient room.

From September to November, 2020 a significant reduction in COVID-19 cases was observed in the State of Bahia, Brazil, leading to closure the cohort ICUs and return to admission of primarily non-COVID critically ill infectious disease patients. During this period, patients with COVID-19 in need of intensive care continued to be admitted to the other individual or dual occupancy adapted ICUs.

On December 3rd, 2020, with the new increase in the number of COVID-19 cases, the 20 cohort ICU beds began to restrict admission to patients with COVID-19 again. Given a lack of evidence of COVID-19 transmission through fomites and the high dissatisfaction of health professionals with long-term PPE, a shift was made to continuous use of N95 masks and cap over the course of shift duration. Other items of PPE, such as face-shield, gloves and long sleeve covers were donned only before providing direct assistance to the patient (Model B). A yellow line more than 1.5 meters from the patients' head was demarcated on the floor in front of the patients' beds to signal the location from which the care team should use complete PPE. The entry of other professionals not part of the primary patient care team was authorized and followed the same protocol. Throughout the two periods, in accordance with the hospital screening protocol, HCW reported presence or absence of COVID-19 symptoms and performed a nasopharyngeal swab for COVID-19 RT-PCR every 15 days even if asymptomatic.

To determine the effectiveness of HCW safety and quality of patient care of the two different models for PPE (A and B), we evaluated the following indicators: number of HCW infected by COVID-19, the monthly incidence of central venous catheter (CVC) infections per 1000 CVC-day, Gram-negative carbapenem resistant (CARB-R) bacteremia per 1000 patients-day 48h after ICU admission and confirmed/suspected COVID-19 patients´ ICU mortality rate. All these were secondary data routinely collected by the hospital infection control department.

To evaluate HCW perceptions regarding the two models, a structured questionnaire was applied to ICU HCWs, using the model proposed by the Employer Net Promoter Score (eNPS). The HCW graded their perception of safety for themselves and for patients, and provided information about their experience in the ICU, past COVID-19 infection and vaccination history.

The work was approved by the Ethics Committee of ICOM: CAAE 45214621.7.0000.0046. All HCW who responded to the survey signed an informed consent. As de-identified general hospital data used in the statistical analysis was available as part of routinely collected information by the infection control department, this study met criteria for exemption from informed consent requirements.

Statistical Analysis

Characteristics such as median number of patients admitted per month, median number of days in the ICU, median age, gender, percentage of patients in mechanical ventilation (MV) and SAPS 3 were compared. As the data was not normally distributed, nonparametric tests were used to compare these variables in the two studied periods.

The following variables were included in the analysis: a) number of WCH infected with COVID-19; b) monthly incidence of bloodstream infections per 1000 CVC-day happening 48h after admission; c) monthly incidence of gram-negative carbapenem resistant bacteremia per 1000 patients-day happening 48h after admission; d) monthly mortality in ICU of confirmed/suspected COVID-19 patients.

These variables were evaluated in model A (April, 2020 to August, 2020) and model B (December, 2020 to Abril,2021), using two samples independent T-test with a 95% confidence interval. The analysis was performed in IBM SPSS Statistics 25. The data collected in September, October and November 2020 were excluded from the analysis as the studied ICUs were not admitting patients with COVID-19 over those months.

RESULTS

The main characteristics of patients admitted to the ICUs during the two studied periods were largely similar though the median number of patients/month was significantly lower during the first period (17.8 compared to 46 in Model B, *p=0.008*). The median age was 60.03 years in Model A and 56.42 in Model B (*p=1.51*) and 57.8% of patients were male in Model A, opposed to 56.6% in Model B (*p=1.00*). Patients seemed to have similar case severity in both periods, as shown by the median percentage of patients in MV (45.93% in Model A and 54.91% in Model B, *p=0.22*), the median number of days spent in the ICU (10 in Model A and 12.76 in Model B, *p=1*), and the median SAPS-3 score (42.36 in Model A and 49.78 in Model B, *p=0.548*). (Table 1)

Table 2 presents the comparison of mean values of each variable in Model A (April, 2020 to August, 2020) and Model B (December, 2020 to April, 2021). The mean mortality of patients with confirmed COVID-19 in the two periods were 35.83%. (Figure 1) Notably, the patient mortality was significantly higher in model A compared to Model B (t=2.9, p=0.017). The median CVC infections were 9.71 per 1000 catheter-day and CARB-R bacteremia 4.54 per 1000 patient-day in the two periods. (Figure 2) Although CVC infection and CARB-R infection rates were higher in Model A, the differences were not statistically significant.

From April, 2020 to April, 2021, 85 HCW had confirmed COVID-19 (mean= 8.5, median= 7). Figure 3 highlights the distributions of confirmed cases of COVID-19 in the general population in Bahia and our HCW of the COVID-19 cohort

Table 1. Characteristics of patients admitted to the COVID-19 cohort ICUs in Model A and Model B at ICOM from April, 2020 to April, 2021.

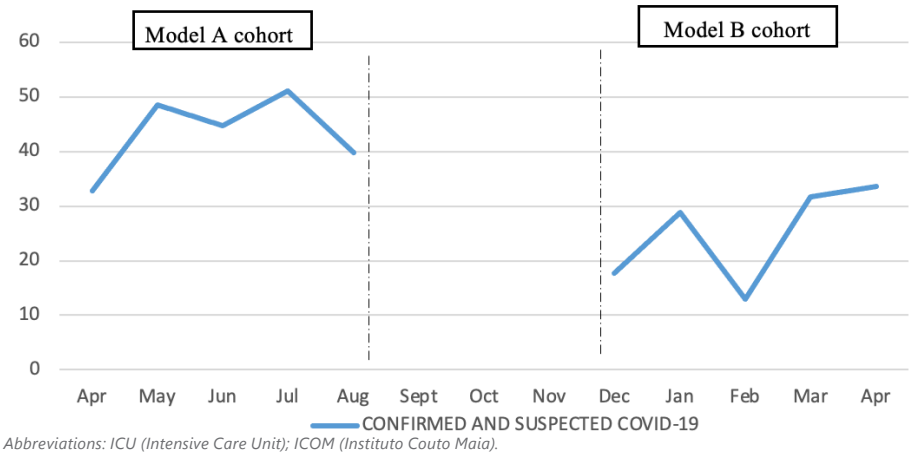
Variables	Model A			Model B			*P-value*
	Median	Minimum	Maximum	Median	Minimum	Maximum	
Age (years)	60.03	54.81	64	56.42	53.12	61.67	1.51
Monthly number of patients admitted to the ICU	17.8	11	31	46	36	54	0.008
Percentage of males	57.8	46	68	56.6	50	70	1
Percentage of patients in mechanical ventilation	45.93	36.36	68.42	54.91	42	65.22	0.222
Number of days spent in the ICU	10	9.84	15.06	12.76	9.66	20.49	1
SAPS–3	42.36	39.65	53.86	49.78	48.27	53.51	0.548

Abbreviations: ICU (Intensive Care Unit).

Table 2. Comparison of mean number of infected HCW, ICU patient's mortality (%), CVC infections per 1000 CVC-day and CARB-R bacteraemia per 1000 patient-day in Model A and Model B at ICOM from April, 2020 to April, 2021.

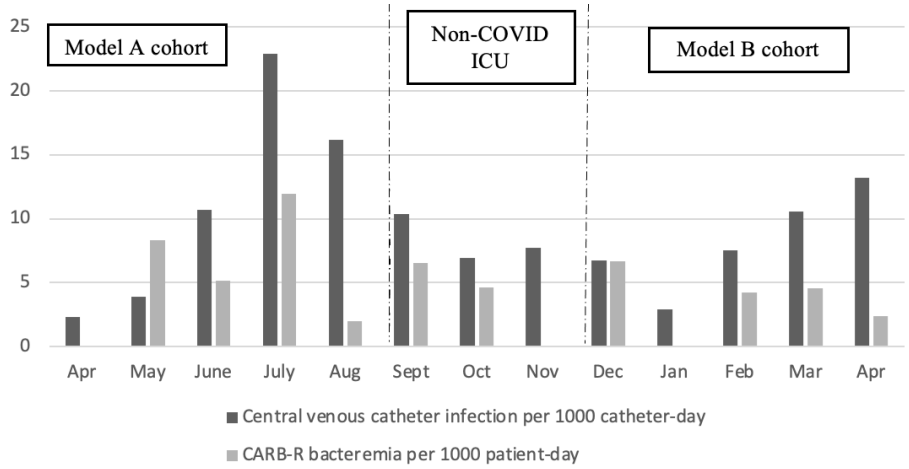
Variables	Model A	Model B	*t-value*	95% CI of the difference	*P-value*
HCW infection	13.4 (7.5)	3.6 (3.4)	2.6	1.26 - 18.34	0.028
ICU mortality (%)	44.7 (5.0)	27.0 (12.3)	2.9	2.80 - 32.72	0.017
CVC infection	11.2 (8.6)	8.2 (3.9)	0.1	-7.48 - 13.54	0.502
CARB_R infection	5.5 (3.6)	3.6 (2.5)	0.8	-3.99 - 7.84	0.457

Abbreviations: HCW (health care workers); CVC (central venous catheter); CARB-R (gram-negative carbapenem resistant); ICU (Intensive Care Unit); ICOM (Instituto Couto Maia).



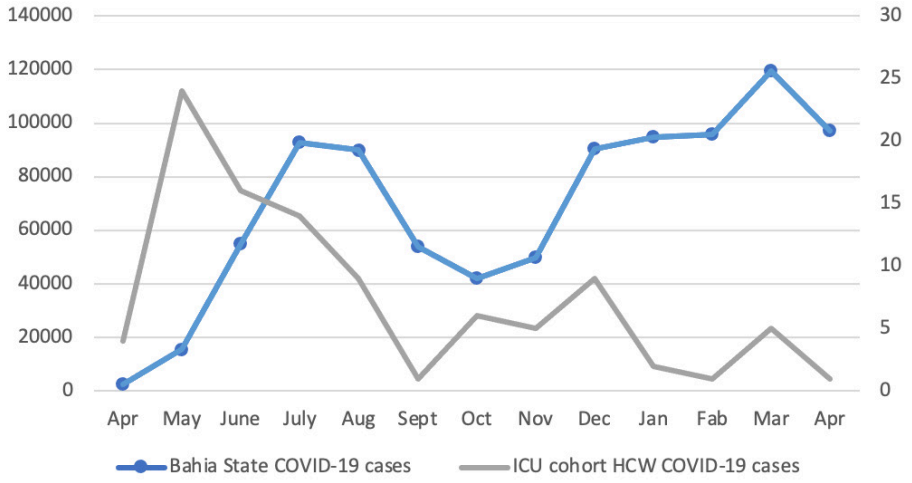
Abbreviations: ICU (Intensive Care Unit); ICOM (Instituto Couto Maia).

Figure 1. COVID-19 confirmed general mortality rate in the COVID-19 cohort ICUs at ICOM from April, 2020 to April, 2021.



Abbreviations: CVC (central venous catheter); CARB-R (gram-negative carbapenem resistant); ICU (Intensive Care Unit); ICOM (Instituto Couto Maia).

Figure 2. Incidence of CVC infection per 1000 CVC-day and of CARB-R bacteraemia per 1000 patients-day in the cohort ICUs at ICOM from April, 2020 to April, 2021.



Abbreviations: ICU (Intensive Care Unit); HCW (health care workers)

Figure 3. INumber of COVID-19 confirmed cases per month in Bahia, Brazil and number of HCW with confirmed COVID in the cohort ICUs at ICOM from April, 2020 to April, 2021.

ICUs. The COVID-19 vaccination of HCW began on January 19, mainly using CoronaVac, an inactivated vaccine. The mean number of infected HCW was significantly higher in model A (t=2.6, p=0.029). (Table 2)

Fifty-six ICU HCWs of the COVID-19 cohort ICUs voluntarily answered a survey from April 2021 to May 2021. From the sample surveyed, 32.73% (n = 18) were doctors, 29.09% (n = 16) nurses, 20% (n = 11) nursing technicians, 18.18% (n = 10) physical therapists and 1.78% (n = 1) were of unknown work category. Most HCW (38.89%, n=21) stated work in critical care settings greater than 5 years, 22.22% (n = 12) for 4 to 5 years, 35.19% (n = 19) for 1 to 3 years and 3.7% (n = 2) for less than 1 year.

84% (n=47) of HCW had been working in COVID-19 units for over 9 months. During the pandemic 46.30% (n=25) of responders only worked in Model B, 38.89% (n = 21) worked in both model A and Model B and 14.81% (n = 8) worked in more than 2 models of COVID-19 ICU cohorts. Using a scale from 1 to 10, in which 1 corresponded with "would not recommend it" and 10 with "would definitively recommend it", the mean answers regarding HCW safety were 6 for Model A and 6.8 for Model B. Regarding the quality of care provided to patients, the mean answers were 4.4 for model A and 7.15 for Model B. 67.27% (n = 37/55) suggesting that HCW viewed model B as the most appropriate model for care of critically ill patients.

58.93% (n = 33/56) of all HCW who responded to the survey had COVID-19 infection in the first half of the pandemic, with most cases occurring between May 2020 and September 2020. Regarding vaccination, 96.43% (n = 54) of HCW who responded were vaccinated from February to April, 2021. Most received the first dose in January and February (27.22% and 51,85%, respectively).

DISCUSSION

In this study, we evaluated two PPE models in a cohort ICU during the COVID-19 pandemic. We have found that use of the less stringent model used (Model B) compared to full time use of all components of whole-body PPE (Model A) did not lead to an increase of COVID-19 infections in HCW that were being progressively vaccinated for COVID-19. Furthermore, surveyed HCW did not feel safer in Model A compared to Model B, and felt they were providing inferior care to patients in Model A.

Probably, the decrease in HCW COVID-19 cases may have occurred due to the beginning of vaccination and the immunity after previous COVID-19 infection.[9] Nevertheless, the first vaccination doses in HCW only started to be offered for some HCW in January 19th, and many only received their first doses in the following months.

While HCW COVID-19 infections are likely expected to peak in the beginning of the pandemic as HCW are continuously exposed, our data did not identify an increase in the number of COVID-19 cases in HCW after the institution of less restrictive PPE.[10] This suggests that the previous model, referred to here as Model A, might be unnecessary for the protection of HCW in the current context of vaccinated HCW.

We found a significant reduction in ICU mortality of confirmed COVID-19 patients in Model B compared to Model A. We do not attribute the reduction in mortality to the PPE model used, but most likely to factors such as the learning curve of ICU teams in the care of COVID-19 patients and the widespread use of steroids as a therapy for critical COVID-19 patients. A similar trend occurred worldwide.[11]

We identified a trend that the incidence of CVC infections and CARB-R bacteraemia was lower in Model B, which could be associated with lower mortality. We hypothesize that Model A could reduce effective patient safety practices such as hand hygiene, as the continued use of gloves and long-sleeved covers may generate a false sense of protection that leads to the use of gloves in lieu of hand hygiene. In response to a rapid increase in SARS-CoV-2 infections, many health care facilities have changed conventional infection prevention and control practices that might have contributed to the spread of multidrug-resistant organisms.[12,13]

The airborne transmission of COVID-19 has been increasingly reported as the main form of disease dissemination in contrast to the underwhelming evidence available for transmission by fomites. [14,15] This is in accordance with our findings and should serve as a rationale for health institutions to review their PPE protocols, by removing excessive requirements that are potentially harmful to patients and HCW. Following this rationale, the National Health Service (NHS) has updated their guidelines reinforcing the use of adequate masks in risk areas and advising that use of gowns must be minimized in cohorts of confirmed COVID-19 patients.[16]

While our study has significant strengths including a robust cohort of ICU patients and HCW during the COVID pandemic, there are certain limitations that must be acknowledged. The inability to differentiate COVID infections in HCW that were acquired in the community or other units may have overestimated the incidence of HCW COVID infection, rather than reflecting a difference in model of PPE used. Moreover, we were unable to determine whether vaccination impacted incidence of HCW COVID infection rates, though as vaccine rollout in Brazil was delayed to the end of the study period this is less likely to have impacted our findings. As a study focused on hospital infection rates and HCW acquisition, there may be other unmeasured factors that contributed to patient mortality including comorbidities, multi-organ failure.

Similarly, other unmeasured factors independent of PPE model used may have impacted the rate of CVC and Gram-negative nosocomial infections. Finally, mortality rates may have differed as a consequence of COVID treatment evolution with emerging evidence from clinical trials in addition to public health interventions of lockdown and mask mandates.

Our study found that adopting a less aggressive PPE approach did not lead to a higher risk of COVID-19 infection in vaccinated HCW and and yet may have aided in improving patients' outcomes and the quality of work provided by HCW. These results emphasize the importance of rigorous evaluation of practices that continue without evidence of efficacy and highlight the need for re-evaluation of PPE institutions protocols, particularly in the context of COVID-19 vaccination.

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DISCLOSURE

The author reports no conflicts of interest in this work.

REFERENCES

1. *Mehta S, Machado F, Kwizera A, Papazian L, Moss M, Azoulay É, et al. COVID-19: a heavy toll on health-care workers. The Lancet Respiratory Medicine. 2021 Mar;9(3):226–8. doi: 10.1016/S2213-2600(21)00068-0.*
2. *World Health Organization. Infection prevention and control during health care when coronavirus disease (COVID-19) is suspected or confirmed: interim guidance, 29 June 2020. World Health Organization [Internet]. 2020 Jun; Available from: https://apps.who.int/iris/handle/10665/332879.*
3. *Goldman E. Exaggerated risk of transmission of COVID-19 by fomites. The Lancet Infectious Diseases. 2020 Aug;20(8):892–3. doi: 10.1016/S1473-3099(20)30561-2.*
4. *Rabenau HF, Cinatl J, Morgenstern B, Bauer G, Preiser W, Doerr HW. Stability and inactivation of SARS coronavirus. Med Microbiol Immunol. 2005 Jan;194(1–2):1–6. doi: 10.1007/s00430-004-0219-0.*
5. *Duan S-M, Zhao X-S, Wen R-F, Huang J-J, Pi G-H, Zhang S-X, et al. Stability of SARS coronavirus in human specimens and environment and its sensitivity to heating and UV irradiation. Biomed Environ Sci. 2003 Sep;16(3):246–55.*
6. *Seidelman JL, Lewis SS, Advani SD, Akinboyo IC, Epling C, Case M, et al. Universal masking is an effective strategy to flatten the severe acute respiratory coronavirus virus 2 (SARS-CoV-2) healthcare worker epidemiologic curve. Infect Control Hosp Epidemiol. 2020 Dec;41(12):1466–7. doi: 10.1017/ice.2020.313.*
7. *Wang X, Ferro EG, Zhou G, Hashimoto D, Bhatt DL. Association Between Universal Masking in a Health Care System and SARS-CoV-2 Positivity Among Health Care Workers. JAMA. 2020 Aug 18;324(7):703. doi: 10.1001/jama.2020.12897.*
8. *Tabah A, Ramanan M, Laupland KB, Buetti N, Cortegiani A, Mellinghoff J, et al. Personal protective equipment and intensive care unit healthcare worker safety in the COVID-19 era (PPE-SAFE): An international survey. Journal of Critical Care. 2020 Oct;59:70–5. doi: 10.1016/j.jcrc.2020.06.005.*
9. *Núñez López C, González de Abreu JM, Pérez-Blanco V, de Miguel Buckley R, Romero Gómez MP, Díaz-Menéndez M, et al. Effectiveness of the BNT162b2 mRNA Covid-19 vaccine in Spanish healthcare workers. Enferm Infecc Microbiol Clin (Engl Ed). 2021 Jul 27:S0213-005X(21)00223-8. doi: 10.1016/j.eimc.2021.06.021.*
10. *Gross JV, Mohren J, Erren TC. COVID-19 and healthcare workers: a rapid systematic review into risks and preventive measures. BMJ Open. 2021 Jan 20;11(1):e042270. doi: 10.1136/bmjopen-2020-042270.*
11. *Ruggeri A, Landoni G, Ciceri F. Trend towards reduction in COVID-19 in-hospital mortality. Lancet Reg Health Eur. 2021 Apr;3:100059. doi: 10.1016/j.lanepe.2021.100059.*
12. *Perez S, Innes GK, Walters MS, Mehr J, Arias J, Greeley R, et al. Increase in Hospital-Acquired Carbapenem-Resistant Acinetobacter baumannii Infection and Colonization in an Acute Care Hospital During a Surge in COVID-19 Admissions — New Jersey, February–July 2020. MMWR Morb Mortal Wkly Rep. 2020 Dec 4;69(48):1827–31. doi: 10.15585/mmwr.mm6948e1.*
13. *García-Meniño I, Forcelledo L, Rosete Y, García-Prieto E, Escudero D, Fernández J. Spread of OXA-48-producing Klebsiella pneumoniae among COVID-19-infected patients: The storm after the storm. Journal of Infection and Public Health. 2021 Jan;14(1):50–2. doi: 10.1016/j.jiph.2020.11.001.*
14. *Zhang N, Chen X, Jia W, Jin T, Xiao S, Chen W, et al. Evidence for lack of transmission by close contact and surface touch in a restaurant outbreak of COVID-19. J Infect. 2021 May 29;S0163-4453(21)00273-5. doi: 10.1016/j.jinf.2021.05.030.*
15. *Goldman E. SARS Wars: the Fomites Strike Back. Appl Environ Microbiol. 2021 Jun 11;87(13):e0065321. doi: 10.1128/AEM.00653-21.*
16. *NHS England and NHS Improvement coronavirus. Infection prevention and control for seasonal respiratory infections in health and care settings (including Sars-Cov-2) for winter 2021 to 2022. [Internet]. 2021 Nov; Available from: https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/covid-19-guidance-for-maintaining-services-within-health-and-care-settings-infection-prevention-and-control-recommendations.*