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Short Report

Unintended consequences of long-sleeved gowns in a critical care setting during the COVID-19 pandemic

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SUMMARY

At the peak of the coronavirus disease 2019 (COVID-19) pandemic, hand hygiene audits indicated decreased compliance in a 12-bed critical care (CC) area with ventilated COVID-19 patients, where staff used personal protective equipment (PPE), including sessional use of long-sleeved gowns in accordance with the recommendations of Public Health England. There was also a cluster of three central venous catheter (CVC) infections along with increases in the number of patients from whom enteric Gram-negative bacteria (GNB) were isolated from sterile sites. Environmental sampling of near-patient surfaces and frequently touched sites demonstrated that 11.5% of areas were contaminated with enteric GNB in the COVID-19 CC area, compared with 2.6% and 2.7% in COVID-19 and non-COVID-19 general wards, respectively. Following a risk assessment, hospital policy was changed to replace long-sleeved gowns with short-sleeved gowns. The CC unit underwent enhanced cleaning with hypochlorite-based disinfectant and was resampled 8 days later. On resampling, no GNB were isolated from the CC unit. Following this change in PPE, hand hygiene compliance returned to baseline standards and no further CVC infections were identified. Staff reported a preference for short-sleeved gowns. No evidence currently exists that PPE beyond that recommended for pandemic influenza (respiratory protection plus standard PPE) adds to the protection of healthcare workers (HCWs) from severe acute respiratory syndrome coronavirus-2. Long-sleeved gowns prevent HCWs performing hand hygiene effectively. While it is imperative that HCWs are adequately protected, protection of patients from infection hazards is equally important. Further studies are necessary to establish risks from PPE to inform a review of current guidance.

Background

Guidance on personal protective equipment (PPE) use in high-risk areas, such as critical care (CC) units, during the coronavirus disease 2019 (COVID-19) pandemic advised that staff working with suspected or confirmed COVID-19 cases should wear a fit-tested FFP3 respirator, a long-sleeved fluid-repellent gown, eye/face protection and disposable single-use gloves [1]. The guidance published later the same month
advised that fluid-repellent surgical gowns could be worn as sessional use within those units [2].

In April 2020, at the height of the COVID-19 pandemic in the UK, observations and audits of infection prevention and control (IPC) practices were carried out by the IPC team in a 12-bedded CC area at the study hospital that was used exclusively for patients with confirmed COVID-19 requiring mechanical ventilation. Audits identified a reduction in hand hygiene compliance after introduction of long-sleeved gowns. Hand hygiene audit compliance with the World Health Organization’s Five Moments for Hand Hygiene’ [3] prior to COVID-19 in December 2019 was 92%, compared with 75% in May 2020.

A cluster of three central venous catheter (CVC) infections was also noted, caused by Citrobacter sp., Proteus sp. and Staphylococcus aureus, over a 4-week period from mid-April to mid-May; there had been no CVC infections at all in this area during the preceding 12 months, and none with these three bacteria in the preceding 10 years. In addition, through routine surveillance, a 350% increase in the number of patients (from 4 to 18) with Klebsiella sp. isolated from normally sterile sites (predominantly blood cultures and bronchoalveolar lavage samples) was noted compared with the same period in 2019. These included different Klebsiella sp. with differing antibiotic resistance profiles, except for four patients from whom Klebsiella pneumoniae with identical antibiotic resistance profiles was isolated. Similar increases in other enteric Gram-negative bacteria (GBN), including Enterobacter cloaca (seven cases vs zero cases), were noted. This can be classified as an outbreak of different genera and species of GNB in the CC unit as the infections were linked in time and place.

This article describes environmental contamination of a CC unit with non-environmental-type GNB in an acute secondary care hospital in the UK during the peak of the COVID-19 pandemic in April–May 2020.

Methods

To understand and demonstrate the degree of contamination of the near-patient environment with these bacteria, the IPC team carried out environmental swabbing for GNB in the 12-bedded part of the CC unit used for ventilated patients with COVID-19 (Area A). This was compared with two general ward areas of the hospital: a ward with patients with COVID-19 who were not ventilated (Area B), and a medical admissions ward area with patients not known to have COVID-19 infection (Area C). PPE used in the ward areas included surgical masks, gloves and aprons. IPC precautions were promoted in all areas of the hospital, in accordance with the organization’s COVID-19 IPC guidance.

The swabbing method included use of cotton-tipped swabs in Amies transport media. An area of approximately 5 cm² was swabbed by firmly rubbing a pre-moistened swab and rolling the swab several times across the sampling area. The swab was labelled and transported immediately to the on-site laboratory. Swabs were incubated in nutrient broth for 24 h and streaked on CLED agar (PP0080-CLED Agar, E & O Labs, Bonnybridge, UK). Plates were read at 24 h and colonies were identified using matrix-assisted laser desorption/ionization-time of flight mass spectrometry (MALDI Biotyper, Bruker, Billerica, MA, USA). Swabs were collected from high-touch areas, horizontal surfaces, PPE and CC equipment (e.g. ventilators, syringe pumps). A list of sites sampled and results is available in Table S1 (see online supplementary material).

Results

Table S1 (see online supplementary material) shows the results of environmental surface swabbing for GNB on 18th May 2020 before any changes were made to PPE. Area A, where ventilated CC patients were nursed, had GNB isolated from 11.5% of areas, while these bacteria were detected in only one area in the COVID-19 general ward and non-COVID-19 general ward.

Following feedback of hand hygiene audit results to staff, a risk assessment and consultation with the CC multi-disciplinary team and hospital senior management was undertaken. A decision was made to use short-sleeved gowns to enable effective handwashing. The hospital changed its PPE guidance on 26th May 2020 to replace long-sleeved gowns with short-sleeved gowns (just above elbow length).

Cleaning in this part of the CC unit prior to the pandemic involved locally employed housekeeping staff who undertook cleaning responsibilities for surfaces and equipment with 1:1000 hypochlorite-based disinfectant (ChlorClean), at a frequency of at least three times per day between 07:00 h and 19:00 h. Overnight, these staff cleaned on request of the nursing staff. Nursing staff were responsible for cleaning medical devices, their work stations and frequently touched areas, using the same disinfectant as above, at least three times per day. In addition, enhanced cleaning of the bed space was undertaken on discharge of a patient. After the onset of the pandemic, the same regime was continued with reminders and education on the importance of cleaning high-touch surfaces. Enhanced cleaning with hypochlorite-based disinfectant of all surfaces in the entire unit was undertaken on 30th and 31st May 2020. Enhanced cleaning involved the deployment of a specifically trained team of housekeeping staff who undertook more thorough cleaning of all areas, which included changing curtains, and cleaning walls, radiators and ventilation ducts.

Environmental swabbing was undertaken again in the same areas on 8th June 2020 after the above change to PPE was implemented (Table S1, see online supplementary material).

Discussion

Environmental sampling in the CC unit revealed that patient areas and frequently touched sites were more likely to be contaminated by what are generally considered to be non-environmental GNB that are not usually expected to be found in these areas. Similar levels of contamination with these bacteria were not found in the general wards (COVID-19 and non-COVID-19). This supports the fact that the non-environmental GNB are not commonly prevalent in the hospital patient environment under non-outbreak circumstances, other than in aqueous environments (e.g. drains). Outbreaks with these pathogens have been reported predominantly from aqueous sources [4].

This study focused on screening the environment for GNB because these were the predominant organisms isolated from sterile sites. However, at least one CVC infection due to S. aureus was noted.
Since the time of Ignaz Semmelweis, it has been known that appropriate PPE, as well as effective hand hygiene, are important components of IPC [5]. Long-sleeved gowns prevent HCWs from performing hand hygiene effectively. The problem is likely to be compounded by sessional gown use. Although GNB was not isolated directly from PPE in this study, PPE has the potential to act as a vector for pathogens, especially when combined with inadequate hand hygiene. At the time of the first sampling in the CC unit, nursing staff had recently changed shift. This could have impacted the results from PPE as the samples were taken from predominantly 'new' PPE. Sampling PPE at the end of a shift, during sessional use of gowns, may be more useful. Figures 1 and 2 illustrate the movement of staff within the CC unit in gowns, and their contact with the environment, with the potential for contamination around the unit. Outbreaks from similar vectors (e.g. hospital uniforms, linen, curtains) have been reported [6,7].

The Personal Protective Equipment at Work Regulations 1992, Section 4(1), Provision of Personal Protective Equipment, states that 'Every employer shall ensure that suitable personal protective equipment is provided to his employees who may be exposed to a risk to their health or safety' [8]. However, what constitutes 'suitable' PPE for a respiratory virus such as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) has not been established to date.

Transmission has been reported to occur through infectious aerosols, droplets and direct/indirect contact [9]. To the best of the authors’ knowledge, transmission through a bloodborne route has not been reported to date. Detection of small amounts of viral genetic material was reported by Wang et al. [10] in 1% of blood samples tested. The reasoning behind the requirement for long-sleeved gowns to be part of PPE in CC areas is therefore unclear.

The Health and Safety Executive ‘Pandemic Flu - Workplace Guidance’, while emphasizing the need for respiratory protection, states 'Workers should adopt good working practices and not rely solely on personal protective equipment as a means of protection. They need to adopt sensible hygiene measures by washing their hands thoroughly and more frequently than normal and avoiding unnecessary hand to mouth or hand to eye contact’ [11]. It is interesting to note that the guidance adopted for a pandemic coronavirus is different to that recommended in this document, although the transmission modes of both viruses are expected to be similar.

Some countries have adopted coveralls, and there has been intense pressure from the media and on social networking sites on how ‘inadequate PPE’ has led to a number of deaths among HCWs in the UK and elsewhere. However, there is currently no robust scientific evidence to suggest that PPE other than good respiratory protection combined with general infection control measures, such as hand hygiene, adds benefit to the protection of HCWs.

The Health and Social Care Act 2008 in England states, ‘Provide and maintain a clean and appropriate environment in managed premises that facilitates the prevention and control of infections’ [12]. While PPE is designed to protect HCWs, healthcare professionals also have a duty to protect patients and their environment from risks that will promote transmission of infection.

Local risk assessments and a review of the above legislation and recommendations enabled the IPC team, hospital health and safety, and senior management teams to move to a policy of using short-sleeved gowns within the CC unit to facilitate effective hand hygiene. For 8 weeks after instituting the policy change, no further CVC infections have been observed, and an immediate reduction in the environmental sites contaminated by GNB in the CC unit was noted (Table S1, see online supplementary material), although this was nearly 1 week after enhanced cleaning of the CC unit. Hand hygiene compliance has also returned to the hospital’s baseline standards. Staff have reported that they prefer to wear short-sleeved gowns as they allow more effective handwashing. Effective communication by the IPC team and IPC link nurses and doctors with various grades of staff enabled staff to support this change by providing them with information regarding the rationale for the change in PPE, describing the risks involved to patients, and describing how risks to staff could be mitigated by handwashing. Close monitoring of all hospital-acquired infections and ongoing active surveillance for GNB from sterile sites continues at the study hospital.

Discussion in regional networks and in British infection forums in the UK has recently highlighted similar concerns of
increased incidence of GNB infections in other CC units. Of particular concern would be contamination of CC areas with multi-drug-resistant GNB which, if acquired by patients with COVID-19, would add to the risk of healthcare-associated infection, prolonged stay in the CC unit and hospital, and/or death.

A limitation of this study is that it reports the experience from one 12-bedded CC area of one hospital in South-east England. Following a bundle of interventions that included a change from long-sleeved gowns to short-sleeved gowns and enhanced cleaning, with feedback of hand hygiene audit scores to staff, an improvement in both hand hygiene audit scores and environmental sampling results was observed. It was not possible to identify the contribution of each intervention, and hence it can only be concluded that the bundle as a whole appeared to result in an improvement.

More detailed studies are required to fully understand the scientific rationale for recommendations of PPE, in particular long-sleeved gowns or coveralls, in SARS-CoV-2 infections, and how these may contribute to the transmission of infectious agents. Given the current pandemic situation, urgent action is needed by Public Health England and the UK Government to establish these risks and review current PPE guidance.

In conclusion, long-sleeved gowns were observed to be a barrier to HCWs cleaning their hands effectively after glove removal. They may have contributed to contamination of the patient environment and frequently touched sites in the CC unit with GNB. This has the potential, therefore, for transmission of these bacteria to patients through contact spread from contaminated fomites.

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Conflict of interest statement
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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jhin.2020.07.036.

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Figure 2. Staff who change apron and gloves only during sessional use of gowns have potential to contaminate common areas.
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