Editorial

Occupational COVID-19 risk for anaesthesia and intensive care staff – low-risk specialties in a high-risk setting

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In early November, the first death from COVID-19 of an anaesthetist working in the UK was announced [1]. This very sad event is a moment for pause and reflection. Every death is a tragedy, and first thoughts should be with family, friends and colleagues. Dr Subramanian's death is perhaps also an appropriate time to reflect on the occupational risk to those working in anaesthesia and intensive care medicine and more widely in healthcare. Before Dr Subramanian's death, the absence of deaths among anaesthetists and those they work with was highlighted as an indicator that anaesthesia and intensive care medicine are not high-risk specialties [2–4].

This editorial explores our knowledge about UK healthcare worker safety, rates of infection, hospitalisation and death, during the first pandemic surge and in particular the safety of those working in anaesthesia and intensive care unit (ICU). The analysis is limited to the UK because findings may differ in other healthcare systems, although an analysis in May reported relatively low rates of mortality among anaesthetists in international data [2]. This information is important in its own right but may also aid us in decision-making in the second surge.

Occupational risk for healthcare workers

Several hospital-based studies have examined the incidence or prevalence of current or recent infection with severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) in healthcare workers, through detection of antigen by polymerase chain reaction (PCR) or serum antibodies, respectively. These studies are summarised in Table 1.

Eyre et al. identified factors increasing infection risk as follows: employment in a patient-facing role 2.5-fold; portering and cleaning roles two-fold; and black or Asian ethnicity 1.7 and 1.5-fold, respectively [7]. Known or suspected contact with an infected household contact (odds ratio 4.8 and 1.8, respectively) were more strongly associated with infection than contact without personal protective equipment in a clinical setting (odds ratio 1.4). Nurses and allied health professionals had the highest rates of infection among clinical staff (approximately 15%), closely followed by junior doctors (13%), whereas infection rates among senior doctors (8%) were notably lower and were much closer to the risk of staff in non-patient-facing roles. The study reported ten healthcare worker admissions to hospital and four deaths. Martin et al. similarly reported increased risk of infection in those of non-white ethnicity and in less senior nursing and medical staff [8]. Shields et al. reported the highest rates of infection in housekeeping staff, a third of whom were infected, and increased risk from non-white ethnicity (odds ratio 1.9) or living in an area of social deprivation [6].

Large, population-based surveillance studies have also highlighted increased infection risk in healthcare workers.

Table 1 UK hospital-based and population surveillance studies comparing incidence of infection with severe acute respiratory syndrome coronavirus-2 among healthcare workers and others.

Population	Dates of study	Number in study	Healthcare staff	Antigen positivity rate		Seroprevalence rate		Ratio of healthcare to public prevalence
				Healthcare workers	Public	Healthcare workers	Public	
Hospital-based								
Hospital staff, London [5]	26/3/20 – 8/4/20	200	200	21%		44%	13%	4
Hospital staff, Birmingham [6]	24/3/20 – 25/4/20	545	545	2.4% asymptomatic		24.4%	5.8%	4.
Hospital staff, Oxford [7]	23/4/20 – 8/6/20	10,034	10,034	6% overall 23% symptomatic 3% asymptomatic		11%	4.2%	2.4
Hospital staff, Leicester [8]	29/5/20 – 13/7/20	10,662	10,662	n/a		10.8%	4.2%	2.6
Population surveillance								
COVID symptom study app users [9]	24/3/20 – 23/4/20	2,135,190	99,795	3.96%	0.33%	–	–	3.4* adjusted for testing eligibility 2.1 asymptomatic
General population, England*	1/5/20 – 1/6/20	120,610	3801	0.47%	0.13%			5.2 fully adjusted
General population, England†	26/4/20 – 28/6/20	34,992	1485 estimated	n/r	0.08–0.32%			4.1
General population, England‡	20/6/20 – 13/7/20	99,908	3138 estimated			11.7%	5.6%	2.1

Data on the community prevalence of infection confirmed by polymerase chain reaction (PCR) testing were sparse during the first surge, but surveillance data from the UK Office for National Statistics (ONS) and the Imperial College Real-time assessment of community transmission (REACT) studies suggested a community prevalence of approximately 0.1% between surges and of approximately 0.5–2% in most areas during a surge, rising to perhaps 3% in London [10] (Riley et al., REACT-1 unpublished data: https://www.imperial.ac.uk/media/imperial-college/institute-of-global-health-innovation/imperial_react1_r7_interim.pdf). Public prevalence of seropositivity by geographical region is taken from Riley et al., REACT-3 unpublished data, Ward et al., preprint, https://www.medrxiv.org/content/10.1101/2020.10.26.20219725v1.

*Riley et al., REACT-1 unpublished data: https://www.imperial.ac.uk/media/imperial-college/institute-of-global-health-innovation/imperial_react1_r7_interim.pdf.

†Pouwels et al., preprint, https://www.medrxiv.org/content/10.1101/2020.07.06.20147348v1.

‡REACT 2 Ward et al., REACT-2 preprint, https://www.medrxiv.org/content/10.1101/2020.08.12.20173690v2.

An analysis of Office for National Statistics (ONS) data up to June reported a four-fold increase in PCR-positivity in patient-facing healthcare staff, and that visiting a hospital doubled risk in a those attending and their household contacts (Pouwels et al., preprint, https://www.medrxiv.org/content/10.1101/2020.07.06.20147348v1).

Among > 350,000 serum samples (Ward et al., preprint, https://www.medrxiv.org/content/10.1101/2020.10.26.20219725v1) a recent study reported patient-facing healthcare workers had a 2.5-fold increased risk compared with those in non-patient-facing roles and the general population. Although seroprevalence waned significantly between June and September in most groups, including in care home workers, this was not reported in patient-facing healthcare workers. In Nguyen et al.'s study, risk factors included working with COVID-positive patients (hazard ratio 4.8), non-white ethnicity (hazard ratio 1.8) and inadequate personal protective equipment (hazard ration 1.3) [9]. Working with patients with documented COVID-19 and inadequate personal protective equipment was associated with an increase in hazard ratio of 5.9.

Occupational harm in healthcare workers

Shah at al. linked national level employment and healthcare data in > 150,000 Scottish healthcare workers [11]. Hospital admissions with COVID-19 between March and June were three-fold more likely in patient-facing healthcare workers than those in non-patient-facing roles and the wider population. As the pandemic progressed, this excess risk increased. Household contacts of front-line healthcare workers had a 1.8-fold increased risk of hospital admission. Notably, hospitalised healthcare workers had lower rates of ICU admission rates (12.3% vs. 16.1%) and mortality (2.5% vs. 13.1%) than members of the general population despite similar distributions of age and comorbidity. Healthcare workers are generally healthy and have and approximately 20% lower average mortality rate than the wider population [12,13] but it is not clear if this explains this finding.

National data on critical care admission or deaths among healthcare workers are sparse. The intensive care national audit and research centre (ICNARC) dataset does not include occupation. Deaths associated with exposure to COVID-19 at work should be reported to the Health and Safety Executive under the RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations) 2013 legislation [14] and there are coronial systems in place for this [15]. In April 2020, NHS England and NHS Innovation indicated that fatalities among healthcare workers from COVID-19 should be reported within 24 h of their occurrence including details of their professional role [16,17]. The ONS, in August, reported 313 healthcare workers' deaths in England and Wales between 9 March and 20 July [13]. Deaths with COVID-19 accounted for 22% of all deaths among healthcare workers during this period and 31% of male healthcare worker deaths. Deaths among healthcare workers accounted for 4.3% of deaths in the whole population aged 20–64 yrs, but 5.8% of all COVID-19 associated deaths and 8.9% of those among women. Compared to the age-matched general population, mortality rates among healthcare workers were higher for COVID-19 but lower for all cause mortality. Amnesty International, as of November 30, report 324 healthcare worker deaths, seemingly based largely on this ONS publication [18].

The authors have, throughout the pandemic, collated publicly available data on reports of UK healthcare worker deaths using media and social media sources, the results of which have been published previously [4]. These data have inherent limitations, both because they are likely to be incomplete and because there is no certainty whether the healthcare worker acquired their illness as a consequence of their employment. However, they provide a minimum dataset and we believe they are the most detailed available. Our May report included 166 healthcare worker deaths with COVID-19, including no anaesthetists or intensivists and one ICU nurse [3,4]. Since that publication, our database has increased to include 207 healthcare worker deaths.

In summary, available data indicates a two- to four-fold increased risk of infection and harm for healthcare workers in patient-facing, but not in non-patient-facing roles. This relative risk has not lessened as the pandemic progresses. Household exposure is a noted risk factor both for infection of healthcare workers and for infection of those in their household. There is uncertainty whether working in a patient-facing healthcare role significantly increases the risk of death from COVID-19, but this seems plausible.

Occupational risk for anaesthetic and ICU staff

Anaesthetists and intensivists might be expected to be at high risk of SARS-CoV-2 infection because they undertake high-risk procedures judged likely to spread bioaerosols, and because they treat the sickest patients [19]. In both previous outbreaks of coronavirus respiratory epidemics (severe acute respiratory syndrome (SARS) and middle east respiratory syndrome (MERS)) ICU doctors have been at increased risk of infection and death from the infectious disease [20,21].

In Houlihan et al.'s London study although not analysed statistically, those working in ICU had the lowest rates of PCR-positive infection (9% vs. 19–26% in all other settings) and of seropositivity (37% vs. 38–51%) [5].

In Oxford, risk of healthcare worker infection increased with the rate of COVID-19 bed occupancy, except in critical care areas where it remained low, irrespective of COVID-19 work intensity [7]. By location, ICUs had an approximately 30% lower prevalence of staff infection compared to other wards. Among medical staff, those working in anaesthesia (odds ratio 0.74) or critical care (0.44) had low risks of infection, with ICU staff having a risk that was less than a third of those working in acute medicine (odds ratio 0.44 vs. 1.52). This occurred despite those working in anaesthesia (25%) or ICU (24%) being as likely as other staff groups to report unprotected exposure to an infected patient (13–42%).

In Leicester, anaesthetists had an adjusted odds ratio of 0.4 compared with the reference group of acute and emergency physicians [8]. In Birmingham, housekeeping staff and those working in acute (33%) or general medicine (30%) had more than double the risk of infection compared with those working in ICU (15%): working in ICU was associated with an odds ratio of 0.28 [6].

Among Scottish healthcare workers, working in ICU roughly halved risk of hospital admission compared with working in 'front door' roles [11]. Indeed, household contacts of front-line healthcare workers had a higher risk of hospital admission than those working in ICU.

Overall, those working in anaesthesia and ICUs are seen to be at lower risk of infection and hospitalisation than other front-line healthcare workers.

Risk of mortality for anaesthetists and intensivists

When considering severe harm, among 31 deaths of UK doctors from COVID-19 reported in May, none were anaesthetists or intensivists [4]. With the death of Dr Subramanian, it is appropriate to consider what number of deaths among anaesthetists might have been expected, through their position in hospitals and in wider society.

The Royal College of Anaesthetists census in September 2015 recorded approximately 14,000 anaesthetists practicing in the UK [22]. NHS Digital reports 15,595 UK anaesthetists and intensivists comprising 13,183 anaesthetists (84.5%) and 2411 intensivists (15.5%) as of August 2020 [23]. Anaesthetists account for 10.0% of all doctors (10.3% of all doctors in patient-facing roles) and 12.8% of all hospital doctors (13.4% of patient-facing doctors) [23]. The NHS staff population is approximately 1.32 million, [23] of whom approximately 70% are in patient-facing roles and 98% are aged < 65 years [24], with anaesthetists and intensivists accounting for approximately 1% of all staff. The UK has a population aged 15–64 years of 46.4 million [25] and, as of December 2019, an employed population of approximately 33 million [26].

Using these denominators and knowledge of the number of deaths in the UK from COVID-19 in people aged 15–64, we can compare the expected and observed number of deaths among UK anaesthetists/intensivists with various comparator groups. Deaths in this age group up to October 2020 include 6427 in the general population [27], 207 healthcare staff and 39 doctors (including 11 general practitioners, 1 anaesthetist and 27 other hospital doctors). For small numbers, confidence intervals are large and the data therefore have inherent uncertainty but provide a useful guide. General health and risk factors may also impact on mortality risk [12]. However, this analysis indicates that, irrespective of the comparator group used, deaths among anaesthetists and intensivists are notably lower than expected (Table 2).

Implications for staff and patient safety

The data indicate that anaesthetists, intensivists and those work with them are at low risk of infection from SARS-CoV-2 and from harm or death from it, particularly compared with other healthcare workers in patient-facing roles on the wards. For some this is an unexpected finding and potential reasons are worth exploring.

First, those undertaking aerosol-generating procedures (and in areas where these are frequent) wear higher performing personal protective equipment and this may be effective [28]. Second, anaesthetists and intensivists may use personal protective equipment well because they are behaviourally attuned to infection control precautions and use of protective equipment through other aspects of their roles such as maintaining surgical sterility in operating theatres or reducing nosocomial infection in ICU. Third, anaesthetists and intensivists work in well-ventilated environments. Fourth, droplet and aerosol-generating events on wards, such as coughing and

Table 2 Actual and expected deaths with COVID-19 among anaesthetists and intensive care doctors by population groups they are included in. Numbers of healthcare worker deaths are derived from reports in the media [4] and may be underestimates and confidence intervals, which are not presented, are likely to be wide. Numbers of doctors are whole time equivalents.

	Anaesthetists and intensivists	All doctors	All patient-facing doctors	Hospital doctors	Patient-facing hospital doctors	NHS workforce	Patient-facing NHS workforce	Population aged 15–65
Number	15,595	157,142	151,796	121,726	116,380	1,320,000	92,4000	4,2641,000
Proportion that are anaesthetists and intensivists	n/a	10%	10.3%	12.8%	13.4%	1.1%	1.6%	0.035%
Deaths in that group	1	39	38	28	27	207	187	6427
Death rate (1 per n)	15,595	4029	3995	4347	4310	6377	4941	6635
Expected deaths among anaesthetists and intensivists	n/a	3.9	3.91	3.56	3.61	2.3	3.0	2.2
Observed/ Expected anaesthetist and intensivist deaths	n/a	25.6%	25.5%	27.9%	27.6%	43.1%	33.4%	44.8%

sneezing, occur much more commonly that aerosol-generating procedures in operating theatres and ICUs. Fifth, critical illness from COVID-19 usually presents 10–12 days after symptoms started [29] and secretion of viable virus decreases rapidly after 9–10 days so infection risk in the critically ill may be low [30] (Cevik et al., preprint, https://www.medrxiv.org/content/10.1101/2020.07.25.20162107v2). Finally, procedures designated as 'aerosol-generating procedures' such as tracheal intubation, extubation, non-invasive ventilation and high-flow nasal oxygen may not generate significant amounts of aerosols, though notably these same studies confirm high rates of aerosols generation during coughing [31,32].

This analysis highlights both the relative safety of anaesthetists and intensivists from occupational infection and harm from SARS-CoV-2 and the increased risks for others working on the wards, both in clinical and non-clinical roles. Several studies have highlighted the importance of ward-based outbreaks of COVID-19 and transmission by asymptomatic carriers in spreading the disease within hospitals [7,33]. In the second surge, unlike in the first, there is the new challenge of maintaining non-COVID-19 healthcare activity [34]. This will lead to increased rates of hospital admission of patients from the community and recent guidance from the National Institute for Health and Care Excellence (NICE) and public health bodies mean that many of these will enter hospital after a minimal period of self-isolation [35] and onto patient pathways that do not include transmission-based precautions [36]. These changes increase the risks of admission to hospital of patients who are highly infectious asymptomatic or presymptomatic carriers of SARS-CoV-2 (Cevik et al., preprint, https://www.medrxiv.org/content/10.1101/2020.07.25.20162107v2). It is, therefore, likely that we will see more hospital outbreaks of COVID-19 than in the first surge, and many are already observing this. Such outbreaks put hospital staff at risk, but also patients: both surgical and medical patients who acquire COVID-19 in hospital fare poorly, with mortality > 20% [37,38]. Up to one in nine of all patients in hospital with COVID-19 has acquired it there [39] and this perhaps should be a measure of quality of care. Finally, control of hospital epidemics of COVID-19 has implications not only for staff and patient safety but also for maintenance of services.

In the light of these findings, it is essential that all staff in hospital and primary care diligently comply with hand washing, social (physical) distancing, mask wearing and appropriate use of personal protective equipment including strict donning and doffing procedures. These practices should already have become the norm but are often poorly adhered to. It is our opinion that, pending better evidence, those working in anaesthesia and critical care should continue with current practices regarding use of personal protective equipment in order to maintain their own safety and that of their working environment. A more challenging question is whether some of the safety practices common to practice in these locations (more widespread use of airborne precaution personal protective equipment and formal donning and doffing practices) can be extended to general practice and the wards where other healthcare workers are more at risk.

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