7 COVID-19 and perioperative cardiac arrest

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Key findings

- In the Activity Survey, 0.6% of all cases were SARS-CoV-2 positive and 3.3% of unknown status, so approximately 4% (1 in 25) patients would have been managed through a 'COVID-19 pathway'.
- Patients who were SARS-CoV-2 positive accounted for 0.2% of elective case load and 1.5% of urgent and emergency surgery.
- The majority of patients who were SARS-CoV-2 positive in the Activity Survey underwent non-elective surgery with obstetrics and other emergency focused specialties managing the highest caseloads.
- Patients who were SARS-CoV-2 positive accounted for 2.4% (n = 21) of cardiac arrests and were four-fold overrepresented in reports of cardiac arrest: an estimated incidence of 1 in 780.
- Two-thirds (62%) were known to be SARS-CoV-2 positive preoperatively and reports included 4 children and 17 adults, 1 of whom was pregnant.
- Compared with other cardiac arrest cohorts, patients with COVID-19 were more likely to be ASA 4 (43% vs 29%) and of non-white ethnicity (15% vs 11%).
- A large proportion of cases were significantly ill, often with multisystem disease.
- Vascular surgery had a more than expected caseload (5.8% of vascular cardiac arrests were SARS-CoV-2 positive vs 1.6% of all other cardiac arrests).
- Urgency of surgery was high but distribution of mode of anaesthesia did not differ between COVID-19 cases and other patients reported to NAP7.
- The nature of cardiac arrest differed little in this cohort from other cases and chest compressions were administered to all patients.
- Although most causes of cardiac arrest were as expected, 24% of reported causes included unusual causes of cardiac arrest, such as heart block, severe raised intracranial pressure, stroke, severe acidaemia and severe hyperkalaemia, likely reflecting the underlying critically ill state of many patients.
- COVID-19 related comorbidities likely contributed to several cardiac arrests including myocarditis (two confirmed cases and several other possible cases), pneumonitis (six cases), thrombotic disease (six cases) and multiorgan failure (four cases).
- In the Baseline Survey, anaesthetists with experience of perioperative cardiac arrest in the COVID-19 era reported an increased use of airborne precautions at the point of cardiac arrest. Among comments about managing cardiac arrest before and during the pandemic, 54% reported their experiences were 'worse' or 'much worse' during the pandemic and commented on personal protective equipment (PPE) causing difficulty communicating, discomfort, and delays in care due to donning and doffing.
- In eight (0.9%) of all reports to NAP7, issues relating to PPE were cited but none caused cardiac arrest or appeared to alter outcome. Issues included delay in staff attending due to the need to don PPE, hindrance of resuscitation or communication and the need to work without PPE that was judged necessary, due to clinical urgency.
- Outcomes of cases with COVID-19 were somewhat poorer than the whole dataset. Survival at cardiac arrest was similar (71% vs 76%) but overall outcome was less good as more patients with COVID-19 died or experienced severe harm (71% vs 64%).
- Of 11 (52%) deaths, 4 were judged to be part of an inexorable dying process.
- Debriefs were less common after cardiac arrest in patients with COVID-19 than for other patients (debrief done 29% vs 46%, no debrief and none planned 48% vs 35%).
- Care was generally judged to be good (COVID-19 cases, care good in 60% and poor in 0%, all cases good in 53% and poor in 2.1%).

What we already know

In March 2020, when the NAP7 panel were two months away from launching data collection, the SARS-CoV-2 pandemic reached the UK. A rapid decision was made to postpone the launch, with an anticipation that this might be for several months. It was judged important that NAP7 should sample the healthcare system at a time that was typical, in order for its findings to be as generalisable as possible.

It soon became apparent that the delay would need to be for longer than anticipated. The project infrastructure and resources were diverted to the Anaesthesia and Critical Care COVID Tracking survey (ACCC-Track) to determine how the COVID-19 pandemic was altering anaesthetic and surgical activity (Kursumovic 2021; see also Chapter 8 ACCC-Track).

Through the ACCC-Track survey and other sources it became apparent that healthcare would likely be forever changed and waiting for a 'return to normal' was impractical. NAP7 was therefore re-planned:

- the project data collection period started 13 months later than planned
- panel meetings were changed from face to face to virtual
- the Activity Survey was changed from paper based to online
- the case review process, which had hitherto been face to face and paper based, was also changed to a secure online and virtual process.

Early in the pandemic, several publications highlighted the high mortality associated with surgery in patients infected with SARS-CoV-2 (Lei 2020, COVIDSurg Collaborative 2020a). The COVIDSurg study, which acquired data in late 2020 when the delta variant was circulating and before vaccination was widely implemented, showed that risk of mortality and respiratory, cardiovascular and thrombotic complications was increased substantially for seven weeks after infection (COVIDSurg Collaborative 2020b, COVIDSurg Collaborative and GlobalSurg Collaborative 2021, Nepogodiev 2022), leading to general deferral of non-urgent surgery for that period of time (El-Boghdadly 2021).

More recently, an OpenSAFELY analysis of 2.4 million surgical episodes in the English NHS examined population outcomes before and during the pandemic (McInerney 2023). Compared with before the pandemic, surgical mortality increased three-fold in the first year of the pandemic and remained two-fold higher than pre-pandemic in the second year.

Throughout the pandemic, there has been controversy over appropriate PPE for healthcare staff and the classification of procedures as aerosol generating procedures (AGPs; Cook 2021, Hamilton 2021) including whether cardiopulmonary resuscitation (CPR) should be considered an AGP (RCUK 2020, PHE 2022, RCUK 2022). Throughout most of the NAP7 data collection period, hospitals maintained separate patient pathways for patients at high or low risk of existing SARS-CoV-2 infection. In low-risk pathways, PPE was restricted to gloves, a plastic apron and surgical face mask, while in high-risk pathways, and when so-called AGPs were undertaken, the requirement was gloves, gown, eye protection and a high efficiency filtering face piece (FFP3/FFP2) (UK HSA 2022). The impact of wearing PPE during the conduct of clinical care (especially airway management) and during CPR remains controversial (Potter 2022) and anaesthetists have varying attitudes to COVID-19 (Shrimpton 2022).

The NAP7 data collection period took place during a period of endemic SARS-CoV-2 infection, predominantly with the omicron variant, in a largely but not completely vaccinated population (approximately 70% of adult population of England were vaccinated once by June 2021 and 87% at least once by June 2022; UK HSA 2023). This provides an opportunity to explore the logistical challenges of a continuing respiratory pandemic both on anaesthetic-surgical activity (see Chapter 8 ACCC-Track) and on working practices, processes and the risk and management of perioperative cardiac arrest. This small cases series of cardiac arrests in patients with SARS-CoV-2 infection provides insight into the case mix, causes, complications and outcomes in this cohort.

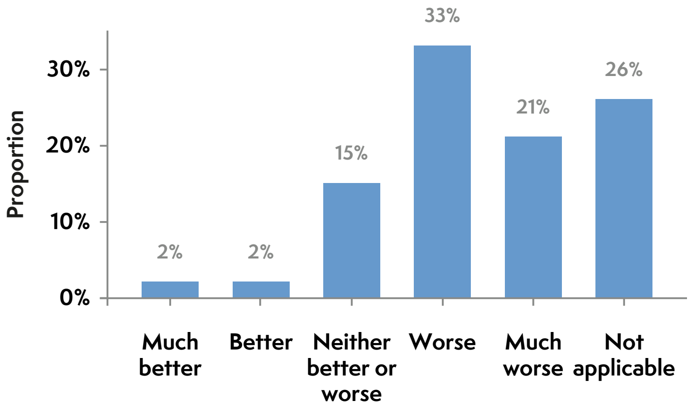
What we found

Baseline Survey

The Baseline Survey, conducted in June 2021, captured anaesthetists' perspectives on PPE precautions during their most recent perioperative cardiac arrest experience (Chapter 10 Anaesthetists' survey). There was a small difference in the type of PPE used by anaesthetists just before the cardiac arrest and during the event – airborne precautions increased from 25% to 29%, whereas droplet and contact precautions decreased marginally (both < 1%).

Of the 4664 anaesthetists with experience of perioperative cardiac arrest in the COVID-19 era, 54% reported that their experiences were 'worse' or 'much worse' than before the pandemic (Figure 7.1). A total of 1687 (36.2%) anaesthetists provided free-text statements about their experiences of PPE use; 950 (56%) described 'difficulty communicating'

Figure 7.1 Anaesthetist's experiences of managing cardiac arrest in PPE during the pandemic compared with before the pandemic



while wearing PPE, with 140 (8.3%) specifically mentioned FFP3 facemasks here; 338 (20%) reported PPE to be 'hot and uncomfortable'; 91 (5.3%) stated that donning and doffing PPE added to delays in managing cardiac arrests: a small number described impaired vision due to misting of visors/spectacles.

Activity Survey

In the Activity Survey, conducted in autumn 2021, 149 (0.6%) of all cases were SARS-CoV-2 positive and 793 (3.3%) had an unknown status (eg awaiting a test result). This means approximately 4% (1 in 25) patients would likely have been managed through a 'COVID-19 pathway' at this time. The prevalence of SARS-CoV-2 infection at the time in the UK was between 1.4% (Northern Ireland) and 2.6% (Wales) (ONS 2021).

Patients who were SARS-CoV-2 positive accounted for 0.2% of elective case load and 1.5% of urgent and emergency surgery. Of SARS-CoV-2 positive patients, 17% were undergoing elective surgery and 43% urgent or immediate priority surgery. The surgical specialties undertaking most surgery on SARS-CoV-2 positive patients are shown in Table 7.1, with obstetric care being prominent.

The severity of COVID-19 varied by urgency of surgery. Of 26 elective cases with COVID-19, 18 were not hospitalised, 2 were hospitalised but not requiring oxygen, 1 was reported as receiving advanced oxygen therapy and in 5 cases status was unknown. In contrast of 93 non-elective cases, 49 were not hospitalised, 21 were hospitalised but not requiring oxygen, 6 were receiving supplemental oxygen and 16 were receiving mechanical ventilation or extra-corporeal membrane oxygenation and the status of 1 was unknown.

Cases of perioperative cardiac arrest

Patients who were SARS-CoV-2 positive accounted for 21 (2.4%) of cardiac arrests and were therefore four-fold overrepresented in reports of cardiac arrest to NAP7: an estimated incidence of 1 in 780.

Two-thirds (62%) of patients were known to be SARS-CoV-2 positive preoperatively and one-third were diagnosed postoperatively. Reports included 4 children and 17 adults, 1 of whom was pregnant.

Patients with COVID-19 reported to NAP7 were, compared with the Activity Survey, more likely to be in the age group 66–75 years (41% vs 19%), ASA 4 (43% vs 4%), of non-white ethnicity (15% vs 8%) and male (59% vs 46%; Figure 7.2) and compared with other cases of cardiac arrest reported to NAP7 were more likely to be ASA 4 (43% vs 29%), of non-white ethnicity (15% vs 11%). Two (7%) patients had a 'do not attempt CPR' recommendation in place at the time of surgery: this was suspended in one case and its status unknown in another.

Vascular surgery had a more than expected COVID-19 caseload: vascular surgery accounted for 24% of COVID-19 positive cardiac arrests and 5.8% of vascular cardiac arrests were COVID-19 positive before surgery (vs 1.6% of all other cardiac arrests) but otherwise case distribution was in keeping with the specialties undertaking predominantly emergency surgery. Urgency of surgery was high in this cohort (immediate 43% vs 19% of other cardiac arrest cases and 1.3% of Activity Survey cases). The distribution of mode of anaesthesia did not differ between COVID-19 cases and other patients reported to NAP7.

Cardiac arrest occurred in a wide variety of locations including six (29%) that might be considered remote locations. The rhythm at cardiac arrest was broadly in line with other causes of cardiac arrest, though asystole was more common (29% vs 15%). Chest compressions were administered to all patients and duration of cardiac arrest did not differ from other causes of cardiac arrest.

The most common aetiologies of cardiac arrest were bradyarrhythmia (21%), haemorrhage (10%) and septic shock, hypoxaemia and stroke (each 7%). Relatively unusual causes of cardiac arrest (heart block, severe raised intracranial pressure, stroke, severe acidaemia, severe hyperkalaemia) accounted for 24% of reported causes, likely reflecting the underlying critically ill state of many patients in this group. COVID-19 related comorbidities likely contributed to several cardiac arrests including myocarditis (two confirmed cases and several possible cases), pneumonitis (six cases), thrombotic disease (six cases) and multiorgan failure (four cases).

Table 7.1 Surgical specialties with the greatest exposure to patients who were SARS-CoV-2 positive or uncertain status. Specialties only included if total cases exceed 20.

Specialty	Patients who were SARS-CoV-2 positive (%)	Patients who were SARS-CoV-2 positive or status unknown (%)	Patients who were SARS-CoV-2 positive or status unknown (*n*)
Obstetrics – caesarean section	1.3	7.6	127
Ear, nose and throat	1.2	2.3	30
Obstetrics – labour analgesia	1.1	12.7	128
General surgery	1.0	5.1	114
Trauma	0.9	4.9	62
Obstetrics – other	0.8	12.8	103

Debriefs were less common after cardiac arrest in patients with COVID-19 than for other patients who had a cardiac arrest (debrief done 29% vs 46%, no debrief and none planned 48% vs 35%).

Personal protective equipment

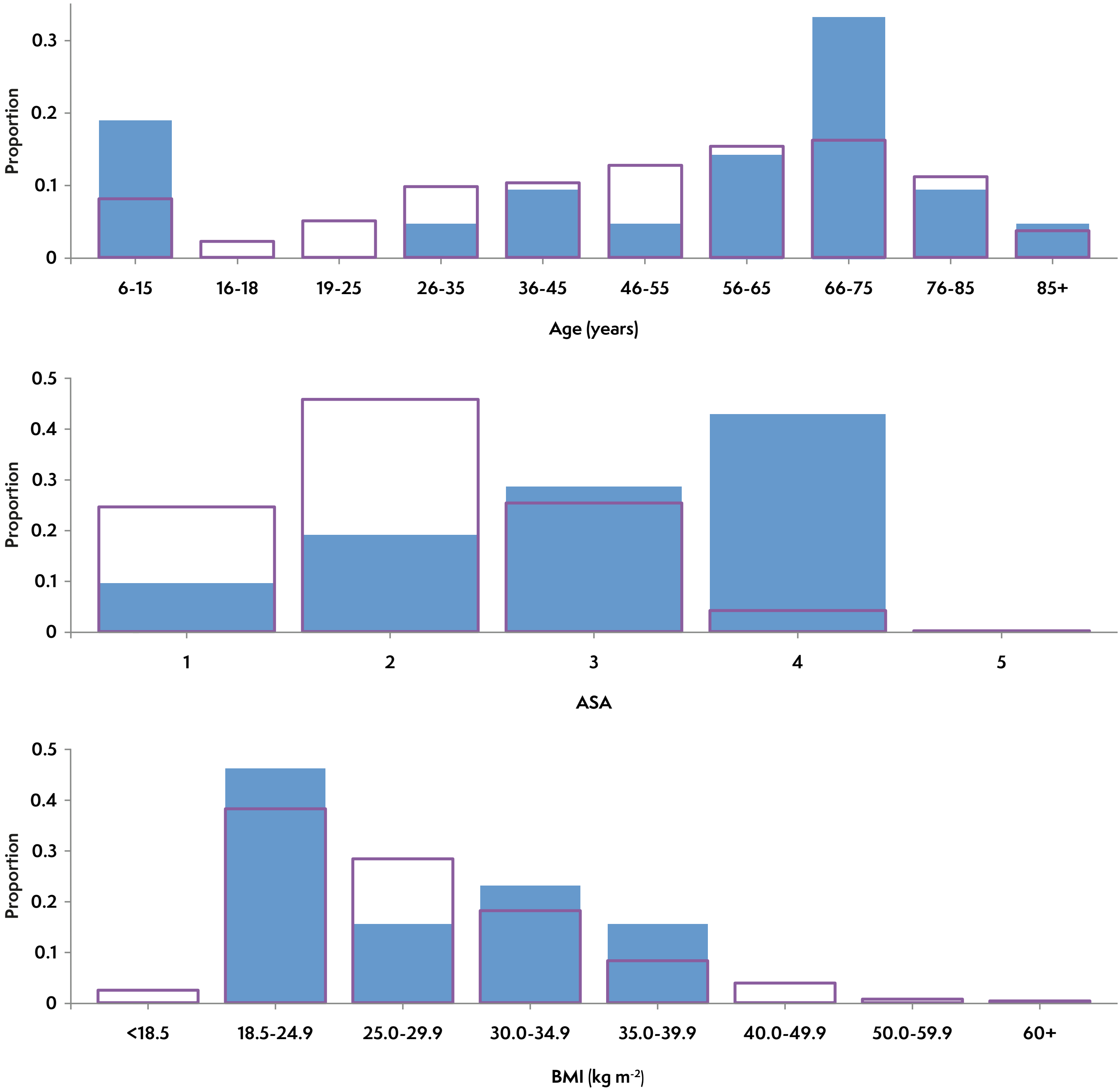
There were eight (0.9%) reports in which issues relating to PPE were cited in the reports of cardiac arrest to NAP7. These events were more likely to occur out of hours and at weekends than other cardiac arrests. Not all cases were COVID-19 positive/uncertain, indicating that PPE was being used by some in patients with negative tests, which is consistent with surveys showing wide variation in anaesthetists' attitudes and actions relating to COVID-19 related risk (Shrimpton 2022).

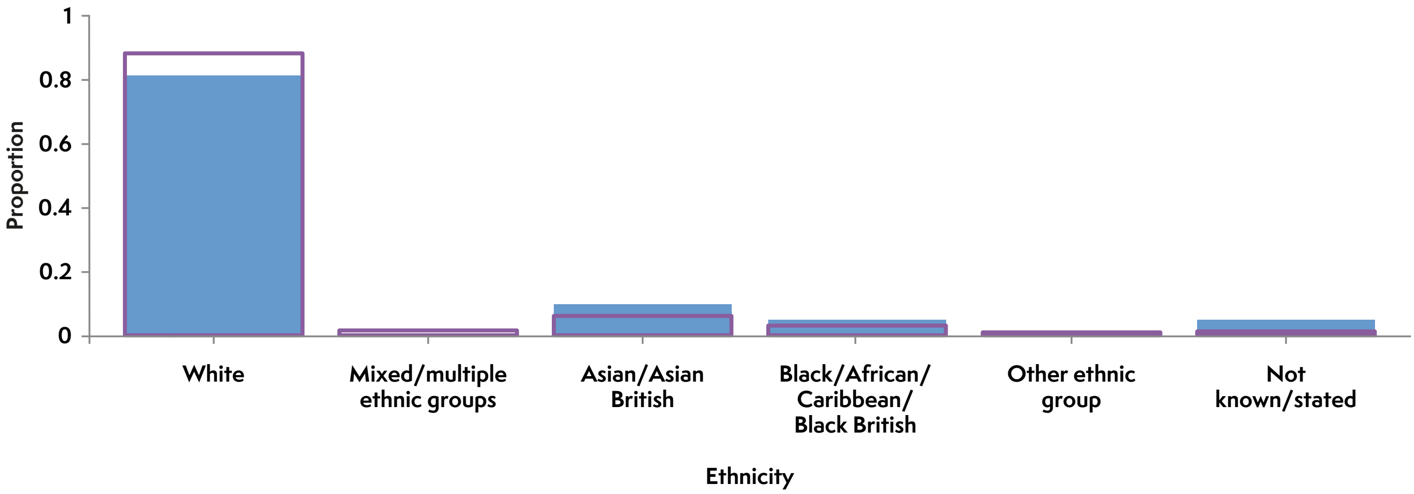
No reported cardiac arrests were caused by problems with PPE.

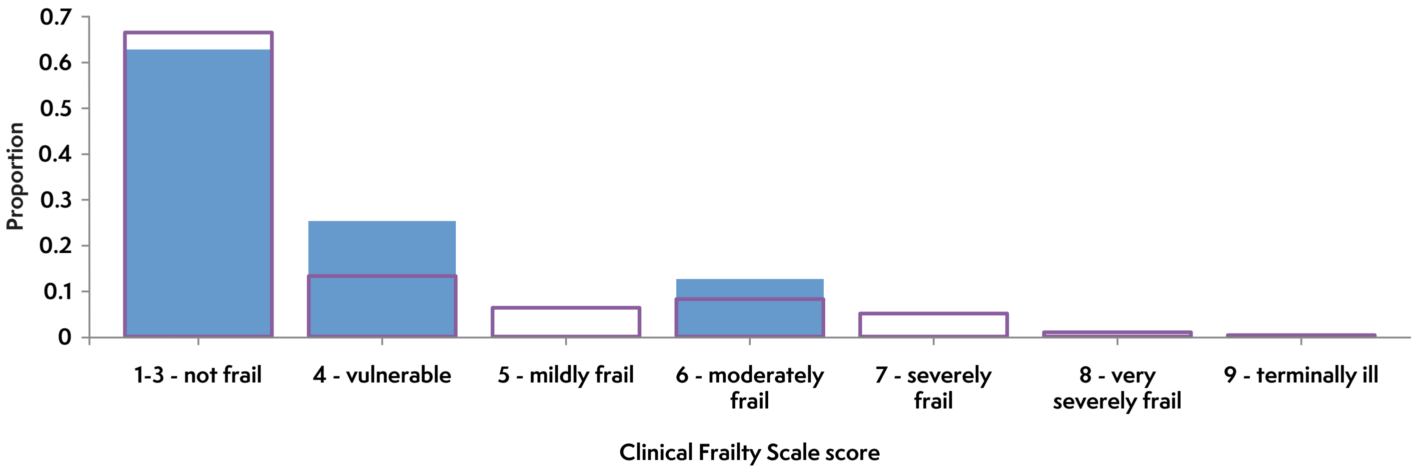
Reported problems with PPE included:

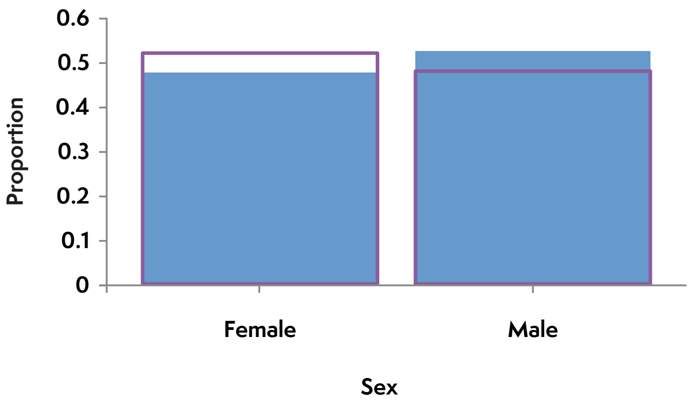
- delay in attending staff being able to assist at cardiac arrest due to the need to don PPE (six cases)
- resuscitation hindered by the need to wear PPE (three cases)
- interference with communication (two cases)

Figure 7.2 Patient characteristics of patients who were SARS-CoV-2 positive reported to NAP7 (bars), compared with the same characteristics in the NAP7 Activity Survey (line). Any bar substantially above or below the line indicates a relative excess or absence of that characteristic among patients with SARS-CoV-2 infection who experienced cardiac arrest.









- delay in drug delivery due to PPE issues (one case)
- inability to wear the PPE that was judged necessary, due to clinical urgency of the situation (two cases).

In cases citing problems with PPE (compared with those that did not), time to initiating CPR, time until assistance arrived and reports of delays in treating cardiac arrest provided no clear signal that any of these were increased.

Five of these eight patients died and one experienced severe harm, but in no case was this deemed to have been due to or contributed to by PPE issues. Overall, quality of care was similar to other cases and no care was rated poor.

> Induction took place in theatre in a high-risk patient who was bleeding significantly. The surgical team remained outside during induction 'to avoid AGPs'. When there was a cardiac arrest there was a delay in the full team attending due to the need to don personal protective equipment.

Contributory factors and outcomes

The main contributory factor to the cardiac arrest was recorded as patient more often in these cases (56%) than in all NAP7 cases (47%) but all other elements differed little from the main dataset.

Outcomes of cases with COVID-19 were somewhat poorer than the whole dataset. Although survival of the cardiac arrest was similar in patients with and without COVID-19 (71% vs 76%), more patients with COVID-19 subsequently died. Overall, 15 (71%) patients died (*n* = 11) or experienced severe harm (*n* = 4) compared with 64% of all patients. Of the 11 deaths, 4 were judged to be part of an inexorable dying process.

Care was generally judged to be good in these cases: overall care was judged as good in 60% of COVID-19 cases compared with 53% of all cases, and overall care was poor in 0% of COVID-19 cases compared with 2.1% of all cases.

Discussion

The data collection period for NAP7 ran from June 2021 to June 2022 and included a period in which SARS-CoV-2 was circulating, largely as the omicron variant, and when most of the UK population was vaccinated. The Activity Survey was undertaken at a time when, for most UK regions, activity was between surges, although significant COVID-19 surges occurred throughout the latter half of our data collection period (Figure 7.3) and are likely to have impacted surgical activity.

The Activity Survey data illustrate that even 18 months into the pandemic, approximately 1 in 25 patients needed to pass through a 'COVID-19 secure' pathway, on the basis of known or possible SARS-CoV-2 infection. The specialties most affected were the frontline emergency services, particularly obstetrics, for whom so much work is non-elective. The case load of SARS-CoV-2 positive patients was skewed significantly to urgent and immediate surgery. During most of the data collection period, national guidelines strongly recommended a postponement of non-urgent surgery for a minimum of seven weeks after a diagnosis of SARS-CoV-2 infection (El-Boghdadly 2021), although in March 2022 the recommendation changed to emphasise risk assessment and shared decision making, balancing risk and benefit of postponement (El-Boghdadly 2022).

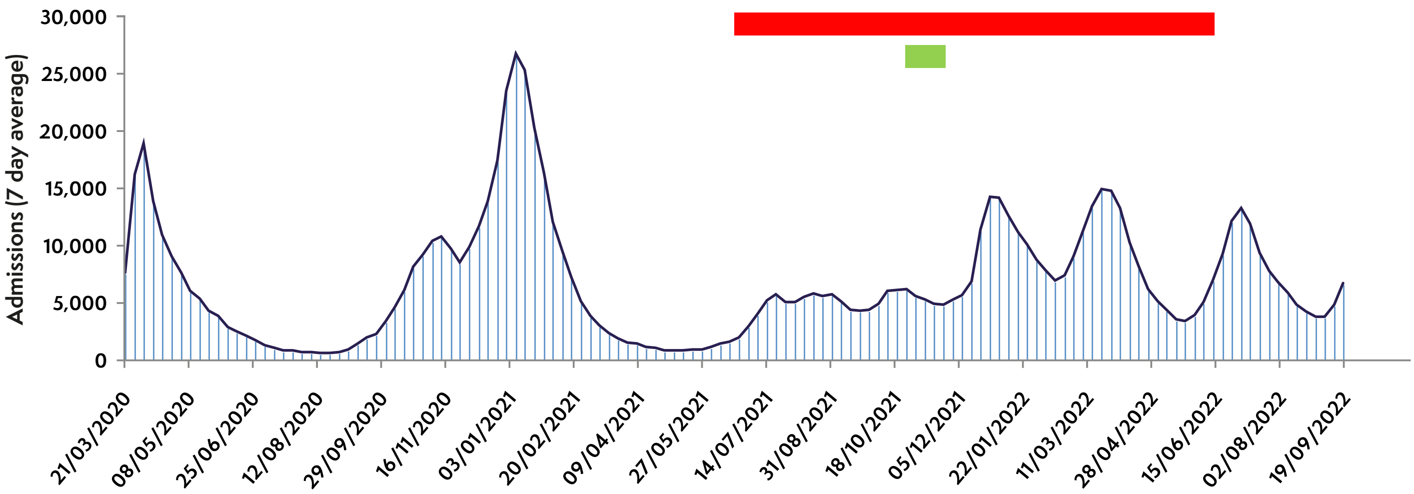
This is the largest series reported of perioperative cardiac arrest in patient with SARS-CoV-2, that we are aware of. Cardiac arrest in patients with SARS-CoV-2 infection was four-fold more common than in patients without the disease, with an estimated incidence of 1 in 780. The case mix of patients experiencing cardiac arrest is consistent with those known to be at greatest risk of acquiring SARS-CoV-2 infection and harm from it: male, older age and of non-white ethnicity.

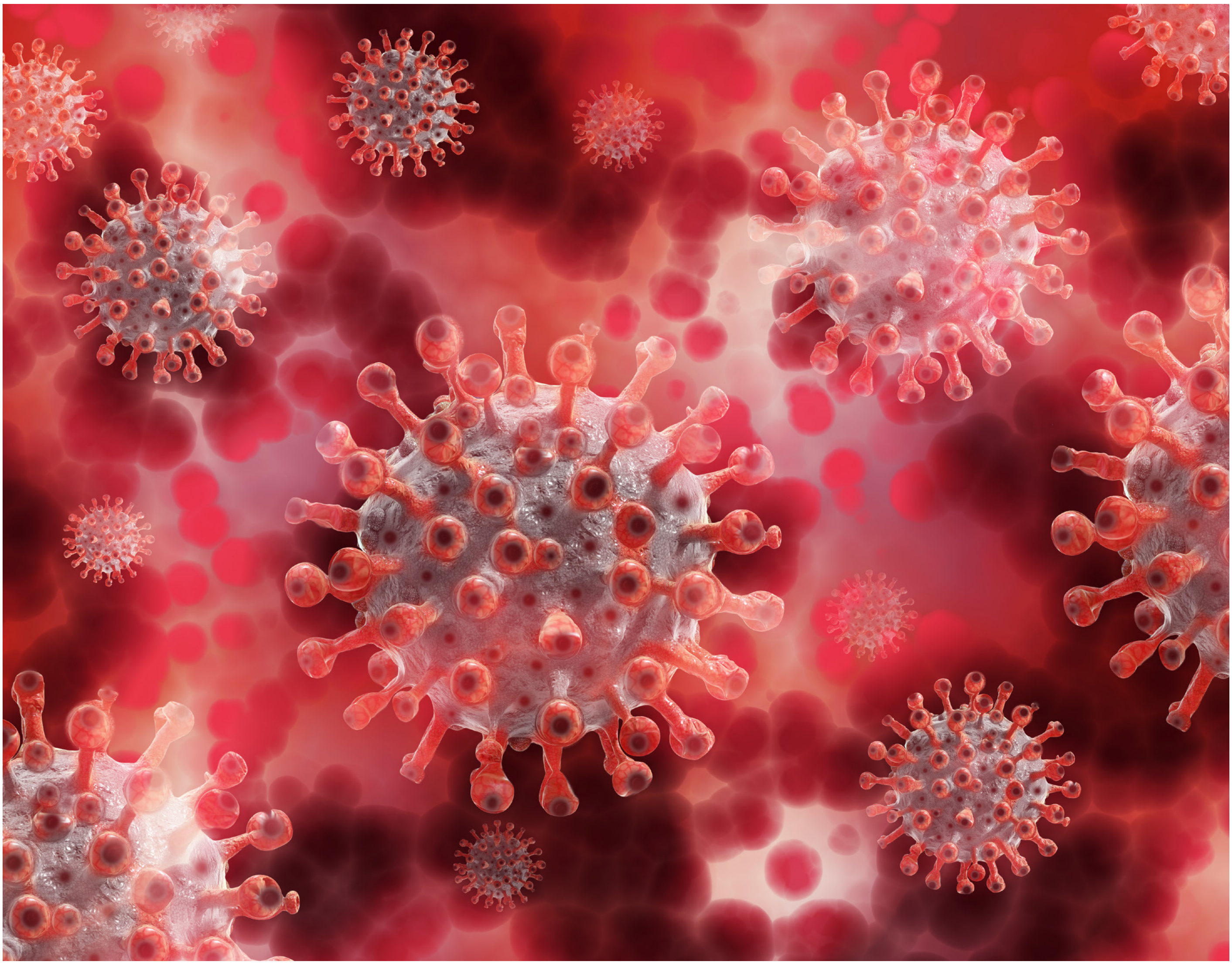
In one-third of these patients, SARS-CoV-2 infection was only identified postoperatively and some of them appeared to have incidental infection. For the majority of cases with infection identified preoperatively, patients were notably sick (a high rate of ASA 4 cases, many with multisystem illness, several who were in ICU and ventilated before surgery and two sick enough to have a do not attempt CPR recommendation before surgery). Finally, the cohort included a significant number of cases with complications of the disease (pneumonitis, myocarditis and thrombosis – cerebral, peripheral vascular and pulmonary emboli – that probably contributed to their cardiac arrest).

The mode, conduct and immediate outcomes of perioperative cardiac arrest differed little from other causes of cardiac arrest, but overall outcome was poorer, most likely due to the poor prognosis of severe SARS-CoV-2 infection and its multisystem effects.

Although problems with PPE were cited in approximately 1% of NAP7 cases, these do not appear to have caused major problems. There were no cases where hindrance by PPE was cited as a cause of cardiac arrest. In the current cohort, there

Figure 7.3 Hospital admissions with SARS-CoV-2 infection in England 2020–23. The red bar indicates the period of NAP7 case reports (16 June 2021 to 16 June 2022) and the green bar the approximate dates of Activity Survey data collection. Source: data from https://coronavirus.data.gov.uk (accessed 19 May 2023).





were several cases of airway difficulty, including a tracheostomy that was incorrectly sited and it is at least plausible that wearing PPE contributed to some of these difficulties (Potter 2022). The need to don PPE did, on occasion, delay the readiness of assistance but did not materially impact on the time to start CPR. A small number of reports highlighted hindrance to communication while wearing PPE but the impact was not reported to be clinically critical. In the Baseline Survey, there were notable opinions expressed about the difficulty in managing cardiac arrest in the pandemic due to PPE, including worse experience, difficulties in communication and delay.

Despite these findings, there remain inconsistencies in PPE guidance. Use of PPE when it is not needed is wasteful of money and disposables and is likely to delay or hinder care. Conversely, not using PPE when the need for it is evidence based (eg FFP3/2 masks in the setting of an airborne disease) puts staff at risk of infection, which is morally and practically unacceptable. At present, the definitions of what is and is not an AGP differ between England (NHS England 2023) and other devolved nations of the UK (eg in Scotland ARHAI 2022), meaning that infection prevention and control practices also differ across borders. This is illogical and inefficient.

Recommendations

National

- Research is needed to establish whether and, if so, the extent chest compressions generate respiratory aerosols which may harm those undertaking CPR.
- Such research should be followed by clear consensus guidance on the use of PPE during CPR across the four nations of the UK.
- Organisations responsible for infection prevention and control in the UK should agree definitions of what is and is not an aerosol generating procedure to enable evidence-based and consistent clinical care that is safe for patients and staff.

Individual

- Anaesthetists should recognise that patients who have COVID-19 are at increased risk of perioperative cardiac arrest.

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