Monitoring the impact of COVID-19 on anaesthesia and critical care services in the UK. A serial service evaluation.

E Kursumovic,[1,2] TM Cook,[3] C Vindrola-Padros,[4] AD Kane,[2,5] RA Armstrong,[2,6] O Waite,[7] J Soar.[8]
Collaborators are listed in Supplementary Material

1, Specialty Registrar, Department of Anaesthesia, Royal United Hospitals Bath NHS Foundation Trust, Bath, UK, ORCID ID: 0000-0003-0864-3564, @emirakur
2, Health Services Research Centre Clinical Research Fellows at the Royal College of Anaesthetists, London, UK
3, Consultant, Department of Anaesthesia and Intensive Care Medicine, Royal United Hospitals Bath NHS Foundation Trust, Bath, and Honorary Professor of Anaesthesia, University of Bristol, Bristol, UK, ORCID ID: 0000-0002-3654-497X, @doctimcook
4, Senior Research Fellow, Department of Targeted Intervention, University College London and Social Scientist, NIAA Health Services Research Centre, Royal College of Anaesthetists, London, UK, ORCID ID: 0000-0001-7859-1646, @CeciliaVindrola
5, Specialty Registrar, Department of Anaesthesia, James Cook University Hospital, Middlesbrough, UK, ORCID ID: 0000-0001-9488-4086, @adk300
6, Academic Clinical Fellow and Specialty Registrar, Department of Anaesthesia, Severn Deanery, UK, ORCID ID: 0000-0001-9479-0143, @drrichstrong
7, Audit and Research Administrator, Health Services Research Centre, Royal College of Anaesthetists, London, UK;
8, Consultant, Department of Anaesthesia and Intensive Care Medicine, Southmead Hospital, Bristol, UK; ORCID ID: 0000-0001-5970-6073, @jas_soar

Correspondence to: Prof TM Cook, Consultant, Department of Anaesthesia and Intensive Care Medicine, Royal United Hospitals Bath NHS Foundation Trust, Bath, BA2 3NG.
Email: timcook007@gmail.com

A summary of the results of Rounds 1 and 2 of the survey have been published on the Health Service Research Centre website at https://www.nationalauditprojects.org.uk/ACCC-track-Anaesthesia-and-Critical-Care-COVID-Activity#pt

Keywords: COVID-19; anaesthesia; critical care; perioperative medicine
Short title: The impact of COVID-19 on UK anaesthesia and critical care services

Summary

Between October 2020 and January 2021 we conducted three national surveys to track anaesthetic, surgical and critical care activity during the second UK COVID-19 pandemic wave. We surveyed all NHS hospitals where surgery is undertaken. Response rates, by round, were 64%, 56% and 51%. Despite important regional variations, the surveys showed increasing systemic pressure on anaesthetic and perioperative services due to the need to support critical care pandemic demands. During Rounds 1 and 2 approximately 1 in 8 anaesthetic staff were not available for anaesthetic work. Approximately 1 in 5 operating theatres were closed and activity fell in those that were open. Some mitigation was achieved by relocation of surgical activity to other locations. Approximately a quarter of all surgical activity was lost with paediatric and non-cancer surgery most impacted. During January 2021 the system was largely overwhelmed. Almost one third of anaesthesia staff were unavailable, 42% of theatres were closed, national surgical activity reduced to less than half, including reduced cancer and emergency surgery. Redeployed anaesthesia staff increased critical care workforce by 125%. Three-quarters of critical care units were so expanded that planned surgery could not be safely resumed. At all times, the greatest resource limitation was staff. Due to lower response rates from the most pressed regions and hospitals these results may underestimate the true impact. These findings have important implications for understanding what has happened during the COVID-19 pandemic, for planning recovery and building a system that will better respond to future waves or new epidemics.

During the COVID-19 pandemic there has been considerable focus on the escalation of critical care capacity, capability and delivery. In many UK hospitals, critical care and anaesthesia departments work together and share staff. The expansion of critical care capability has inevitably led to redeployment of staff, spaces and equipment, and drugs intended for anaesthesia and perioperative care [1,2]. In the first wave of the pandemic most planned surgery was stopped for several months but, after this, there were specific efforts made to restore surgical activity and to maintain this even in the face of subsequent waves of pandemic activity [3,4]. The extent of disruption of anaesthetic and perioperative activity in the second wave has not been clearly documented.

The Royal College of Anaesthetists' (RCoA) 7th National Audit Project (NAP7) is a national service evaluation examining perioperative cardiac arrest which had been due to start in May 2020. Early in the first wave, NAP7 was postponed, and as part of assessing when anaesthetic and perioperative services might have returned to a stable baseline and thus be ready for starting NAP7, we undertook a series of national surveys to track activity during the second wave of the pandemic.

Methods

The Anaesthesia and Critical Care COVID-19 Activity Tracking (ACCC-track) survey did not meet the definition of research as per the UK Policy Framework for Health and Social Care Research [5], was deemed a service evaluation and therefore did not require Research Ethics Committee approval. The conduct of ACCC-track was approved by the RCoA Clinical Quality and Research Board. During the planning stages of NAP7, a network of 330 local co-ordinators was established in all NHS hospitals and many independent sector hospitals in the UK. After the postponement of NAP7, as part of planning for re-starting, we initially devised the ACCC-track survey to determine the degree of disruption of perioperative services and readiness to start NAP7. A questionnaire was submitted to all local co-ordinators in July 2020 which showed most (75%) supported the concept of the ACCC-track survey.

An electronic survey tool (SurveyMonkey®) was used to conduct three successive ACCC-track surveys. The survey tracked changes systemic stress in surgical and critical care during different stages of the COVID-19 pandemic. Rounds 2 and 3 differed from Round 1 (online Supporting Information Appendix) by removal of questions that did not need repetition and addition of new questions as indicated (see below). Drafts of the survey were reviewed and tested by clinicians involved with NAP7 and the RCoA Quality Improvement committee.

Rounds 1 and 2 of the survey was sent to all local co-ordinators. Responses were encouraged by email reminders at regular intervals to local co-ordinators and anaesthetic department clinical leads once per round. Respondents were asked to provide information for the main hospital site they represented, which was identified by region and name of hospital. Response rates from the independent sector were limited and for Round 3 only the 273 local co-ordinators representing the 420 NHS hospitals were asked to respond [6]. This analysis only includes data from NHS hospitals. Duplicate responses and those which did not record a hospital site and/or region were excluded. Since some local co-ordinators represented more than one hospital across multiple sites, the hospital response rate was calculated using the 420 NHS hospitals with anaesthesia provision as the denominator. This denominator was cross-referenced using NHS digital [7] and NAP7 lists of hospital sites [6].

Data collection periods were as follows: Round 1 (R1) for the month of October 2020; Round 2 (R2) for two weeks between 1-18th December 2020; Round 3 (R3) for two weeks from 18-31st January 2021. Surveys could be submitted for 4-5 weeks after distribution.

These three rounds corresponded to different stages of the second wave, as recorded on the UK government's COVID-19 data website [8]: Round 1 from the start of the second wave and before the second lockdown in England; Round 2 shortly after the end of this lockdown, during a period of slowly increasing hospital activity and Round 3 during the third lockdown and shortly after the peak of the secondary surge caused by the SARS-CoV-2 Kent B117 variant [9]. The relationship between the timing of the surveys and UK hospital admissions due to COVID-19 is shown in Figure 1.

In each round, respondents were asked about anaesthesia-surgical activity, including the number of operating theatres open for activity at the hospital site and their productivity compared to the previous year, measures taken to increase theatre capacity at other locations (e.g., another NHS or independent sector hospital), reorganisation of care pathways and changes to staffing levels including COVID-19 related staff sickness and redeployment (online Supporting Information Appendix).

Organisational disruption of anaesthetic and critical care departments were assessed using the Red-Amber-Green (RAG) rating criteria for 'Space, Staff, Stuff (equipment) and Systems' described in 'Restarting planned surgery in the context of the COVID-19 pandemic' [10] which was a joint publication of the four UK organisations supporting the Intensive Care Medicine-Anaesthesia-COVID-

19 hub (ICM-anaesthesia hub) (https://icmanaesthesiacovid-19.org/). Each 'red' rating describes a system "not ready for a return", 'amber' a system "close to being ready for a return" and 'green' a system "ready for a return" to undertaking planned surgery (online Supporting Information Appendix) [10]. Overall organisational disruption of perioperative services can be measured by combining red and amber responses. Round 1 examined the types of personal protective equipment and organisational processes used in operating theatres for patients designated as low and high risk of SARS-CoV-2 infection. Rounds 2 and 3 assessed the degree of critical care expansion and disruption using the levels of the Staged Resurgence Plan (SRP) described in the ICM-anaesthesia hub document 'Anaesthesia and critical care: guidance for Clinical Directors on preparations for a possible second surge in COVID-19' which in September 2020 advised departments across the UK how to respond to the second COVID-19 wave by increasing critical care capacity while also protecting planned surgery [4]. Five stages of critical care capacity surge are described (online Supporting Information Appendix): stage 1 an endemic level of COVID-19 activity; stage 2 increased demand but met within established capacity; stages 3-5 normal capacity (or capability) is exceeded and in stage 5 there is a need to transfer to external local or regional networks as part of mutual aid. Round 3 collected the number of critically ill COVID-19 patients transferred into and out of respondents' hospital as part of mutual aid.

Data from SurveyMonkey® were exported into, cleaned and analysed in Microsoft Excel version 2021 (Microsoft, Inc., Redmond, USA). Qualitative data were imported and analysed using NVivo version 2020 (QSR, International Pty Ltd., Massachusetts, USA), identifying common themes.

Incomplete responses to individual questions were accepted with missing data noted as a non-response except in questions that required comparative analysis (e.g. difference in the number of theatres open or difference in the number of cases performed compared to a previous time point) in which case the responses were excluded from analysis.

When estimating changes in anaesthesia and ICU workforce and the number of lost operations per day, an adjustment was made for non-responders and survey response to provide an estimate of national impact. Data from August 2020 NHS Workforce Statistics [11] was used as the denominator for the number of current anaesthesia (13 119) and critical care (2 404) staff in England and this was scaled up to UK levels by multiplying by 1.187 [12].

Results

Included responses were received from 176 (64%) NHS local co-ordinators in R1, 154 (56%) in R2 and 140 (51%) in R3. These local co-ordinators represented 65% of NHS hospitals in R1, 54% in R2 and 51% in R3.

The response rate varied by region (online Supporting Information Appendix). In R1 this ranged from 80% from the East and West Midlands, to 46% from Wales, in R2 80% from Yorkshire and Humber region to 35% from Wales and in R3 from 68% from the South West to 32% from the East Midlands. Response rate fell most between R2 and R3 with half of the regions having a <50% response rate in R3.

A summary of key results is presented here, with a more detailed analysis of theatre processes and personal protective equipment and detailed results by region presented in the online Supporting Information Appendix.

Staff and space were the resources most frequently affected (Figure 2). Nationally, between R1 and R3 green ratings for staff reduced from 58.3% to 16.5% and for space from 61.1% to 20.3%. Stuff (equipment) and systems were less impacted both fell to close to 50% in R3. In R1 and R2, 54% and 68% of departments respectively had at least one red or amber domain and therefore self-declared as not ready for return to planned surgery. In R3 this rose to 90%. In R3 no region reported being above 50% green for space or staff with most above 80% amber/red, of which most were red.

In R2 45% reported ICU expansion beyond baseline capacity (SRP 3-5) and 15% the imminent or actual need of mutual aid to transfer critically ill COVID-19 patients to other hospitals (SRP 4-5) (Figure 3). In R3 74% of ICUs were expanded above capacity and 39% likely or actually needing mutual aid. In R3 133 respondents (accounting for approximately 40% of all UK hospitals but perhaps a greater proportion of all critical care units) reported admission of approximately 900 patients transferred under mutual aid and transfer out of 600 to another hospital under mutual aid.

In R2, by nation, ICU expansion above normal capacity was highest in England (49%) and lowest in Scotland (17%). The South West was the least impacted region in England with 33% of ICUs needing to expand, compared to 60% in North East England and the East Midlands. Potential or actual use of mutual aid transfers ranged from 0% in the North West and South West England to 36% in East of England. In R3, 75% of hospitals in England, Northern Ireland and Wales expanded their ICUs and

67% of hospitals in Scotland. Within English regions, expansion rates ranged from 45% (Yorkshire and Humber) to 100% (North East). The potential or actual need for mutual aid transfers range from 0% in North East England and 78% in West Midlands.

Workforce redeployment and absence

Figure 4 shows the impact of COVID-19 on absences within the anaesthetic workforce. A progressive loss of the anaesthesia workforce was seen through the survey rounds largely due to redeployment to critical care, resulting in a simultaneous increase in the ICU workforce. Loss of anaesthetic staff due to redeployment to non-patient-facing roles, shielding, self-isolation, quarantine and sickness as a result of COVID-19 did not change substantially between R1 and R3. The overall impact on national anaesthesia staffing was: 12% loss in October 2020, 15% in December 2020 and 29% in January 2021. The redeployment to ICU increased the critical care workforce by approximately 38% in October 2020 rising to an approximately 125% increase in January 2021.

Theatre and surgical capacity

A progressive decrease in anaesthesia and surgical activity was observed across the UK with the highest impact in R3. Among all respondents, the average proportion of theatres closed increased from 15% in R1 to 42% in R3 (Figure 5). Regionally the steepest rises in theatre closures were in the East of England, London and South East England regions, which all had amongst the lowest rates of closure until R3. In R3, five regions (42%) had more than 50% of their normal theatre capacity closed, eight (67%) more than 40%, and ten (83%) more than 30%.

The overall use of external sites to maintain surgical activity decreased from R1 (10%) to R3 (8%) (online Supporting Information Appendix). While some regions were able to maintain external surgical capacity between R1 and R3 (London and South East England both maintained >10%), this reduced in many (e.g. North West England 10% to 8%, and Yorkshire and the Humber 12% to 7% and increased in only one (East of England 14% to 15%). In R1, in five regions (East of England, London, South East, South West and North East) external theatre expansion exceeded theatre closures. This reduced to two regions (East of England and London) in R2 and in R3 theatre closures significantly exceeded external expansion in all regions.

In those theatres that were open theatre activity declined in all rounds compared to the corresponding previous year (Figure 6). Between R1 and R3 near-normal productivity (75-100%) fell from 48% to 32% and operating at <50% productivity increased from 10% to 27%.

Surgical activity, compared to 12 months previously, reduced in all rounds of the survey, but most markedly in R3 (Figure 7). At all times, the greatest impacts were in descending order on paediatric, non-cancer elective, cancer and emergency surgery. In R3 paediatric and non-cancer elective surgery activity were at less than a third of the previous year's activity and cancer surgery was reduced by more than a third. Regional variation in impact was noted particularly among paediatric and non-cancer surgical activity (online Supporting Information Appendix).

Measured over 24 hours, in R1 and R2 overall surgical activity was reduced by a little over one quarter compared to 12 months previously (Figure 8). This equates to approximately 5000 operations not performed each day in the NHS. In R3 surgical activity was reduced by 54% compared to 12 months previously; equivalent to 9770 operations lost per day across the UK.

Qualitative open responses for factors facilitating the delivery of perioperative care included staff flexibility (e.g. new rotas, extra shift work), use of virtual communications, and presence of separate low-risk COVID-19 areas. Barriers included staffing issues, critical care bed and theatre availability. Although themes were similar during R1 and R3 (online Supporting Information Appendix) in R1, issues surrounding personal protective equipment supply and testing facilities were reported, whereas cessation of elective work only featured in R3, where there was also an increase in number of respondents reporting lack of staff and space compared to R1.

Discussion

The three rounds of this service evaluation have provided a clear picture of increasing systemic stress and disruption of anaesthetic and perioperative services throughout the UK, as a consequence of the second wave of the COVID-19 pandemic and the need to support increased critical care demand.

During Rounds 1 and 2 anaesthetic staff and perioperative services were significantly impacted by the pandemic. Staff and space constraints had the greatest impact. Surgical activity was reduced by both significant closure of operating theatres and reduced activity within those that were open. Some mitigation of this was achieved by relocation of surgical activity to external sites, but in most locations this did not fully match the surgical activity lost and overall more than a quarter of all surgical activity was lost. Paediatric and non-cancer surgery were most impacted, with less impact on cancer surgery and emergencies reduced. Round 1 of the survey was undertaken when UK

COVID-19 hospital activity was increasing and shortly before much of the UK entered lockdown in November 2020. Round 2 took place after that lockdown finished and as UK COVID-19 hospital activity continued to slowly increase. Overall measures of system stress increased by a small amount between October and December 2020, including redeployment of staff from anaesthesia to critical care, and by December around half of critical care units were expanded to the extent that planned surgery could not be safely undertaken.

Round 3 took place shortly after the peak of the second surge and showed the system was close to breaking point. The number of theatres open fell further as did efficiency in those that were open. Hospitals were less able to relocate activity to other locations, though whether this was due to staff shortage or other factors such as contractual arrangements is not clear. Almost one in three anaesthetic staff were unavailable for anaesthetic activity as redeployments increased the ICU workforce by 125% of its former size. All but a quarter of critical care units were expanded to the extent that planned surgery could not be safely undertaken. As a result, surgical activity fell precipitously, with all types of surgery affected. In hard-pressed regions, paediatric and non-cancer surgery fell to 12-20% of normal activity and even cancer surgery fell to below half of normal activity.

In rounds 1 and 2 reduced perioperative capability led to a fall in surgical activity of a little over one quarter compared with previous years. In round 3 surgical activity fell to below half of normal. With estimates of NHS surgical activity, in which anaesthetists are involved, being approximately 4 million [13] these figures represent an annual loss of surgical activity of approximately 1-2 million cases per year. In spring of 2020, almost all planned surgical activity ceased and despite explicit efforts to resume and maintain this from July 2020 onwards, it is clear that this has been hampered. Other sources make similar estimates of surgical workload lost – with numbers of patients added to waiting lists being estimated as approximately 1.5-2 million (Dobbs TD, unpublished data at https://www.medrxiv.org/content/10.1101/2021.02.27.21252593v1) and 2 million [14]. When this accumulated surgical activity is added to pre-existing waiting lists, cumulative waiting lists are estimated to now be between 4.5 (Dobbs TD, unpublished data at https://www.medrxiv.org/content/10.1101/2021.02.27.21252593v1) and 7.5 million [14]

Optimistically, control of COVID-19 in the UK will be achieved by a combination of prolonged lockdown and extensive vaccination [15]. Resumption of surgical activity and perioperative services will need to go hand in hand with decompression and step down of expanded critical care provision

[1,10]. Our data illustrate very clearly that anaesthetists (and in all probability other healthcare workers working in operating theatres) have been central to the critical care response to the pandemic, and equally that they will have been impacted similarly. It is acknowledged that as a consequence of increased amount and intensity of workload, decreased leave, psychological burden and moral injury the physical and psychological needs of the workforce must be considered in planning recovery of non-COVID healthcare services, and this is discussed elsewhere [16].

There is a marked regional variation in most of the measures we have examined. To some extent, this variation may reflect temporal variations in the impact of the pandemic on different regions. However, as well as variation in demand, different regions may vary in baseline capacity and ability to expand services. In regions or hospitals with lower numbers of critical care beds per head of population or staff per hospital bed, relatively smaller rises in community prevalence of COVID-19 might lead to higher system stress. For instance, London has approximately 10 critical care beds per 100,000 head of population, compared to the South West where the figure is <6 [17]. This perhaps partially explains why we observed similar impacts on service delivery in London and the South West region despite them having almost four-fold differences in rates of critical care occupancy per head of population in the three periods of the survey [2].

The surveys in part illustrate the pressure points in the current system. These are clearly space and most particularly staff. The fact that critical care expansion requires redeployment of substantial numbers of anaesthetists is likely to have important implications for at least the next year as critical care services work flexibly to address fluctuations in demand or stepwise expansion. This in turn will have important implications for addressing the surgical waiting list. Expansion of both space and anaesthetic workforce are likely inevitable requirements.

There is some evidence that we sampled from less stressed hospitals. The hospitals that responded, likely to represent between a third and half of all critical care units, reported approximately 900 mutual aid admissions in December 2020 to January 2021. This is broadly consistent with data from the Intensive Care Research and Audit Centre which recorded 1971 transfers between critical care units in December 2020 and January 2021 including 1634 for mutual aid [18] (compared to 54 12 months previously) [19]. Our respondents reported 50% more mutual aid admissions to their hospitals than transfers out, and as each mutual aid transfer much have a decompressing and receiving unit, this provides some support for the idea that we preferentially sampled from less systemically stressed sites.

There are some limitations to our surveys. We have had decreasing response rates, falling to 50% in Round 3. In normal circumstances some will consider response rates of above 60% to be necessary to be judged representative of the population sampled. Others regard 40% as sufficient [20]. These surveys specifically targeted departments during a pandemic, including when capability pressures were increasing or saturated and survey responses were required rapidly. It is plausible and perhaps likely that within regions the more stressed hospitals were less likely to respond and the data described above support this. It is therefore also plausible that the results of the survey underestimate the true extent of the 'system stress' due to failure to capture data from the most stressed part of the system. This is likely to be most marked when overall clinical pressure was highest, in Round 3. The surveys required respondents to compare activity at the time of the survey to activity a year previously and also to measure activity over 24 hours. In some cases, the responses were estimated but sub-analysis of only those reported as accurate did not change overall results. Finally, for some regions, only a small number of hospitals replied so that these regional results may be less reliable.

We have documented the systemic stress on anaesthetic and perioperative services in the UK through the second wave of the COVID-19 pandemic. This shows growing pressures between October and December 2020 because of critical care demands predominantly on staff and space. Falls in surgical activity caused by having to close operating theatres and reduced activity was mitigated by use of resources in other locations. In January 2021, shortly after the peak of the second surge, there is evidence that systemic resilience was overwhelmed, almost a third of anaesthesia staff were unavailable, surgical activity reduced to less than half impacting all surgery including cancer surgery and emergencies. At all times the greatest resource limitation was staffing, followed by space. The findings have important implications for understanding what has happened in the COVID-19 pandemic, for planning recovery and building a system that will be better able to respond to future waves or new epidemics.

Acknowledgements

We would like to thank the NAP7 local co-ordinators and other clinicians who have completed any round of the ACCC-track surveys. Those that have responded and expressed interest in being included in publication have been listed as collaborators. We would also like to thank the NAP7 Steering Panel and the HSRC/RCoA research team including Karen Williams (Audit Coordinator), Jose

Lourtie (Head of Research), Dr Sharon Drake (Director of Clinical Quality and Research) and Prof Iain Moppett (Deputy Director for NIAA HSRC) for supporting and collaborating on the project.

Competing Interests

No funding was received for this service evaluation and ethical approval was not required. The authors confirm no conflicts of interest. A summary of the results of Rounds 1 and 2 of the survey have been published on the Health Service Research Centre website.

References

1 Intensive Care Society. Recovery and Restitution of Critical Care Services during the COVID-19 pandemic, February 2021. https://www.baccn.org/static/uploads/resources/Recovery_and_Restitution_-_finalV2.pdf (accessed 08/04/2021)

2 Intensive Care National Audit & Research Centre. ICNARC report on COVID-19 in critical care: England, Wales and Northern Ireland, 26 March 2021. https://www.icnarc.org/Our-Audit/Audits/Cmp/Reports (accessed 8/4/21)

3 Stevens S, Pritchard A. Third phase of NHS response to COVID-19, 31 July 2020. https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/07/Phase-3-letter-July-31-2020.pdf bel at https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/07/Phase-3-letter-July-31-2020.pdf (accessed 10/4/21)

4 Faculty of Intensive Care Medicine, Intensive Care Society, Association of Anaesthetists, Royal College of Anaesthetists. Anaesthesia and critical care: guidance for Clinical Directors on preparations for a possible second surge in COVID-19. September 2020. https://static1.squarespace.com/static/5e6613a1dc75b87df82b78e1/t/5f68ce9ccda1805270405136/1600704156814/Second-Surge-Guidance.pdf (accessed 06/04/2021)

5 Health Research Authority. HRA decision tools: defining research. 2017. http://www.hra-decisiontools.org.uk/research/docs/DefiningResearchTable_Oct2017-1.pdf (accessed 10/4/2021)

6 NAP7 Sites. National Audit Project. March 2020. http://www.nationalauditprojects.org.uk/NAP7-Sites (accessed 01/11/20)

7 NHS Digital. NHS Workforce Statistics, April 2020. July 2020. https://digital.nhs.uk/data-and-information/publications/statistical/nhs-workforce-statistics/april-2020 (accessed 01/11/20)

8 UK Government. Coronavirus (COVID-19) in the UK. Healthcare in United Kingdom. https://coronavirus.data.gov.uk/details/healthcare (accessed 10/4/21)

9 Frampton D, Rampling T, Cross A et al. Genomic characteristics and clinical effect of the emergent SARS-CoV-2 B.1.1.7 lineage in London, UK: a whole-genome sequencing and hospital-based cohort study published as 'ePub ahead of print'. *Lancet Infectious Diseases* 2021 Apr 12; doi: 10.1016/S1473-3099(21)00170-5

10 Faculty of Intensive Care Medicine, Intensive Care Society, Association of Anaesthetists, Royal College of Anaesthetists. Restarting planned surgery in the context of the COVID-19 pandemic. May 2020. https://static1.squarespace.com/static/5e6613a1dc75b87df82b78e1/t/5eac2a173d65cd27933fca88/1588341272367/Restarting-Planned-Surgery.pdf (accessed 30/01/2021)

11 NHS Digital. NHS workforce statistics - December 2020. March 2021. https://digital.nhs.uk/data-and-information/publications/statistical/nhs-workforce-statistics/december-2020 (accessed 08/04/21)

12 Park N. Office for National Statistics. Estimates of the population for the UK, England and Wales, Scotland and Northern Ireland. June 2020 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland (accessed 10/4/21)

13 Sury MRJ, Palmer JHMG, Cook TM, Pandit JJ, Mahajan RP. The state of UK anaesthesia: a survey of National Health Service activity in 2013. *British Journal of Anaesthesia*, 2014; **113:** 575-584

14 British Medical Association. Rest, recover, restore: Getting UK health services back on track. 2021. https://www.bma.org.uk/media/3910/nhs-staff-recover-report-final.pdf (accessed 14/04/21)

15 Cook TM, Roberts JV. Impact of vaccination by priority group on UK deaths, hospital admissions and intensive care admissions from COVID-19. *Anaesthesia* 2021; **76:** 608-616

16 Price J, Sheraton T, Self R, Cook TM. The need for safe, stable and sustainable resumption of planned surgery in an era of COVID-19 published as 'ePub ahead of print'. *Anaesthesia* 28 2021 March 28 doi: 10.1111/anae.15470

17 Batchelor G. Revealed: huge regional variation in NHS' ability to meet coronavirus demand. *Health Service Journal.* March 2020. https://www.hsj.co.uk/quality-and-performance/revealed-huge-regional-variation-in-nhs-ability-to-meet-coronavirus-demand/7027153.article (accessed 18/4/21)

18 Intensive Care National Audit & Research Centre. Table appendix, 26 March 2021. https://www.icnarc.org/Our-Audit/Audits/Cmp/Reports (accessed 8/4/21)

19 NHS Digital. Critical Care Bed Capacity and Urgent Operations Cancelled 2019-20 Data. March 2020. Available from https://www.england.nhs.uk/statistics/statistical-work-areas/critical-care-capacity/critical-care-bed-capacity-and-urgent-operations-cancelled-2019-20-data/ (Accessed 20/4/21)

20 Story DA, Tait AR. Survey research. *Anesthesiology* 2019; **130**: 192-202

Figure 1 Timing of the surveys and number of hospital admissions due to COVID-19 in the UK. The grey areas represent the timeline for October 2020 (R1), December 2020 (R2) and January 2021 (R3). Data adapted from [9].

Figure 2 Proportion of respondents (%) that have reported red (not able to resume planned surgery), amber (nearly able to resume planned surgery) or green (able to resume planned surgery) for 'Space, Staff, Stuff (equipment) and Systems' categories for R1 (October 2020), R2 (December 2020), R3 (January 2021). 'Overall hospital status' indicates the proportion of respondents reporting at least one of staff, space, stuff or systems red (red), no red and at least one amber (amber), all green (green).

Figure 3 Proportion of respondents (%) that have reported the state of the responding hospitals' ICUs as per Staged Resurgence Plan (SRP) stages for R2 (December 2020) and R3 (January 2021), across the UK and within the different nations. SRP1 (green) represents an endemic level of COVID-19 activity; SRP2 (yellow) increased demand but met within established capacity; SRP3 (orange) demand exceeds the established capacity and requires expansion; SRP4 (red) high likelihood of occupying maximum expanded capacity; SRP5 (black) there is a need to transfer to external local or regional networks as part of mutual aid.

Figure 4 Impact on anaesthesia and critical care staffing levels. Total number of anaesthetists and/or intensivists off work or redeployed to ICU activities as a result of COVID-19, in R1 (October 2020, light blue), R2 (December 2020, mid blue) and R3 (January 2021, dark blue) from responding hospital sites.

Figure 5 UK and regional variations of the average (mean) proportion of operating theatres closed (%) compared to the same period the previous year, at R1 (October 2020, light blue), R2 (December 2020, mid blue) and R3 (January 2021, dark blue).

Figure 6 Proportion of respondents (%) reporting theatre productivity in theatres that are open/working, compared to the same period the previous year, at R1 (October 2020, light blue), R2 (December 2020, mid blue) and R3 (January 2021, dark blue).

Figure 7 Average UK percentage of surgical activity at R1 (October 2020, light blue), R2 (December 2020, mid blue) and R3 (January 2021, dark blue) compared to the corresponding previous year's activity.

Figure 8 Proportion of operations (%) completed over a 24-hour period from responding hospital sites compared to the previous year, at R1 (October 2020), R2 (December 2020) and R3 (January 2021). Blue area denotes the proportion (%) of active surgical cases completed and pink area the proportion (%) of lost surgical cases that were completed on the same date the previous year.