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Prospective Cohort Study

A cohort study of 30 day mortality after NON-EMERGENCY surgery in a COVID-19 cold site

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ABSTRACT

Background: Two million non-emergency surgeries are being cancelled globally every week due to the COVID-19 pandemic, which will have a major impact on patients and healthcare systems.
Methods: During the peak of the pandemic in the United Kingdom, we set up a multicentre cancer network amongst 14 National Health Service institutions, performing urological, thoracic, gynaecological and general surgical urgent and cancer operations at a central COVID-19 cold site. This is a cohort study of 500 consecutive patients undergoing surgery in this network.
The primary outcome was 30-day mortality from COVID-19. Secondary outcomes included all-cause mortality and post-operative complications at 30-days.
Results: 500 patients underwent surgery with median age 62.5 (IQR 51–71). 65% were male, 60% had a known diagnosis of cancer and 61% of surgeries were considered complex or major. No patient died from COVID-19 at 30-days. 30-day all-cause mortality was 3/500 (1%). 10 (2%) patients were diagnosed with COVID-19, 4 (1%) with confirmed laboratory diagnosis and 6 (1%) with probable COVID-19. 33/500 (7%) of patients developed Clavien-Dindo grade 3 or higher complications, with 1/33 (3%) occurring in a patient with COVID-19.
Conclusion: It is safe to continue cancer and urgent surgery during the COVID-19 pandemic with appropriate service reconfiguration.

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1. Background

COVID-19 has led to most non-emergency surgery in regions affected by the COVID-19 pandemic being halted [1] in an effort to divert resources and staff to managing patients with COVID-19 and to reduce the impact of COVID-19 on patients undergoing surgery. Globally, it is estimated that over 2 million non-emergency operations are being cancelled each week due to COVID-19 [2]. This will have a profoundly detrimental long-term effect on patients and healthcare systems. Patients' quality of life and survival can be reduced by delayed surgery and there are significant health economic consequences to the population [3–6].

An international cohort study reported a concerning 19% 30-day mortality in 278 patients undergoing non-emergency surgery who had COVID-19 diagnosed peri-operatively [7]. There are a number of mechanisms by which surgery may result in worse outcomes for those infected with COVID-19. Surgery is known to impair immune function [8], can lead to a dysregulated inflammatory response [9] and can lead to a high incidence of respiratory complications [7,10]. Furthermore, patients with cancer have been shown to have a higher risk of needing intensive care unit (ITU) admission and ventilation and have higher mortality if they develop COVID-19 [11].

The UK is globally one of the worst-affected countries from COVID-19, with over 310,250 confirmed cases and 43,514 deaths as of the June 28, 2020 [12]. The first case in the UK was recorded on the January 30, 2020 and London is the UK region with the highest number of reported cases [12]. In order to continue to safely provide a surgical service to patients who would benefit from their urgent cancer surgery, we set up a multicentre surgical network based in the London area. The network took regional and national referrals for urgent and cancer surgery and performed these surgeries centrally at a site that was intended to be kept a COVID-free site during the COVID-19 pandemic. This was part of an approach coordinated by the Pan-London Cancer Alliances and NHS England.

We aimed to assess the 30-day mortality rate from COVID-19 in patients undergoing non-emergency surgery at our institution during the peak of the pandemic. We hoped to demonstrate that it can be both feasible and safe to continue with the conduct of non-emergency surgery.

2. Methods

2.1. Study design

This was a cohort study evaluating patients undergoing non-emergency surgery at a dedicated COVID-19 cold site (CCS), within a regional urgent and cancer surgery network of 14 National Health Service hospital trusts. Non-emergency surgery was defined as any surgery that did not need to be performed within 24 h of diagnosis. This could include urgent surgery which was of a pressing nature but did not need to be performed within 24 h and cancer surgery, which was surgery to treat cancer and routine non-urgent, non-cancer surgery. The study is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines and the Strengthening the Reporting of Cohort Studies in Surgery [13,14].

2.2. Setting

Our institution consists of a number of geographically separate sites located within a 2-mile distance in London, the region with the highest number of confirmed cases in the UK [12]. We converted one of these sites, which was a high volume urological and thoracic cancer centre, into a dedicated CCS. This CCS has 7 operating theatres, 84 inpatient beds and a level-1 surgical ITU with 9 beds. The aim of the service restructuring within our institutional sites was to maximise the chances of keeping the dedicated CCS COVID-19 free and keep urgent cross-speciality surgery going (Table 1) [15].

2.3. Patients

The first 500 consecutive patients having non-emergency surgery at the CCS from the March 5, 2020 (the date of first case of COVID-19 in our institution) to April 22, 2020 were included. On the March 26, 2020 a regional cancer and urgent surgery network was set up with representation from urology, thoracic, gynaecology and general surgery (Fig. 1). This allowed patients from other institutions and other specialities in the network with the greatest need for urgent cancer surgery to have this at the CCS. In urological surgery, non-urgent and non-cancer surgery stopped after inception of the regional network. Patients were prioritised, influenced by national guidelines, on basis of their individual cancer risk and potential benefit of having surgery [3,16] judged against patient risk for serious complications of COVID-19 [17]. In thoracic surgery, due to the urgent nature of the surgery, elective cancer and urgent surgery continued unabated. Elective surgery at other sites other than the CCS was stopped.

2.4. Primary outcome

The primary outcome was the proportion of patients who died from COVID-19 within 30-days of surgery. Cause of death was assessed by the clinical care team and were extracted from death certificates, following national guidelines [18].

2.5. Secondary outcomes

Secondary outcomes included the proportion of patients who died from any cause within 30-days, the proportion of patients developing confirmed or probable COVID-19 within 30-days and the 30-day post-operative complication profile.

The date of onset of COVID-19 was defined as the date on which the first related symptoms appeared. In patients undergoing testing, the presence of COVID-19 RNA was assessed with a real-time reverse transcriptase polymerase chain reaction technique on a nasopharyngeal and oropharyngeal swab collected according to World Health Organisation (WHO) recommendations [19], utilizing the Hologic Panther Fusion assay.

In line with WHO guidelines, a diagnosis of confirmed COVID-19 was given to patients with laboratory confirmation of COVID-19 infection, irrespective of clinical signs and symptoms [20]. A diagnosis of probable COVID-19 was given to patients who did not undergo laboratory testing or whose laboratory testing was inconclusive, but who had fever and at least one sign of acute respiratory illness (persistent cough, shortness of breath, sore throat, loss of smell, loss of taste or vomiting). The proportion of patients with a chest CT with the typical appearances of COVID-19 pneumonia according to the Radiological Society of North America was also reported [21]. Surgical complications were graded according to the Clavien-Dindo classification [22].

2.6. Surgical precautions

Patients were called prior to the day of their operation and were only asked to attend for surgery if they remained asymptomatic. Where feasible, patients were asked to self-isolate for 14 days prior to their surgery.

From April 6, 2020, in line with national recommendations, staff wore personal protective equipment (PPE) and took precautions assuming as default that the patient had unrecognised COVID-19 infection [23] (Table 1).

From April 18, 2020, at the discretion of their treating clinician, patients underwent COVID-19 viral swab testing and CT of the chest 48 h before their surgery if they were planned for ITU admission post-operatively or were deemed by their clinical team to be high risk for

Table 1
Healthcare service restructuring in response to COVID-19.

Type of restructuring	Description
Regional referral network	• Organisation of cancer and urgent surgery network consisting of 14 UK National Health Service Trusts (University College London Hospital NHS Foundation Trust, Royal Free London NHS Foundation Trust, North Middlesex University Hospital NHS Trust, Barts Health NHS Trust, Whittington Health NHS Trust, Cambridge University Hospitals NHS Foundation Trust, United Lincolnshire Hospitals NHS Trust, University Hospital Southampton NHS Foundation Trust, Barking, Havering and Redbridge University Hospitals NHS Trust, The Princess Alexandra Hospital NHS Trust, Homerton University Hospital NHS Foundation Trust, Bedfordshire Hospitals NHS Foundation Trust, Ashford and St Peter's Hospital NHS Foundation Trust and the Royal Brompton and Harefield NHS Foundation Trust) • Network arranged into Hub-and-Spoke organisational design (15) where the anchor site and hub for conducting the major urological, thoracic, gynaecological and general surgery was a dedicated COVID-19 cold site • Patients with an urgent need for surgery from the remaining regional and national network sites (spokes) were referred for surgery at the dedicated COVID-19 cold site hub. • Surgeons from local referring institutions were set up with operating rights at the cold site hub and could perform surgery on the patients they had referred.
Reconfiguration across institutional sites	• Creation of COVID-19 hot and cold sites within our institution. Unwell patients with suspected COVID-19 were admitted only to hot sites. Conversion of one of our institutional sites into a dedicated COVID-19 cold site. Non-emergency surgery that would typically occur prior to the COVID-19 pandemic in the hot sites were diverted to the cold site during the pandemic. • No emergency admissions or direct patient transfers were accepted at the COVID-19 cold site during the COVID-19 period for urological, gynaecological or general surgery. It was mandated that any transfers or emergencies in these specialties were admitted directly to the hot sites. • Though the clinicians managing these patients at hot sites were based in the cold site, a dedicated sub-team attended the hot site evaluating and managing and the patients admitted there. • In thoracic surgery due to the urgent nature of the pathology, urgent transfers were accepted to the cold site, but only if they had a negative COVID-19 viral swab prior to transfer.
Reconfiguration at hub COVID-19 cold site where surgery was performed	• Staff were set up with remote access to the electronic record system • Outpatient services were converted from face-to-face appointments to telephone appointments where feasible • Administrative and clinical staff worked from home where feasible • Multi-disciplinary team meetings were carried out by web conferences, with a restriction placed on the maximum numbers of attendees for essential face-to-face meetings to 5 people • Staff treating inpatients on the wards were required to wear a surgical mask, an apron and a pair of gloves for each patient • Family members were not allowed to visit inpatients • Patients were called before surgery to ensure they were asymptomatic • Patients were asked to self-isolate, where feasible, 14 days prior to and after their surgery
Reconfiguration of the theatre environment	• Full personal protective equipment worn by each member of staff included an apron, surgical gown, two pairs of gloves, F95 mask, face visor and theatre hat. • Dedicated areas for donning and doffing were created, training was provided on performing these manoeuvres, and a dedicated donning team assisted each member of staff. • The patient would be intubated and extubated in theatre with only the anaesthetist and operating department practitioner present. After intubation and extubation, other staff did not enter the theatre for 20 min to minimise risk of exposure to aerosolised airway secretions. • During surgery the number of staff in theatre was kept to the minimum required. • The number of planned cases on each theatre list was reduced in order to facilitate longer turnaround time between cases. • During robotic surgery, a smoke evacuation device was used for all cases to minimise the putative risk of transmission of COVID-19 virus particles into the theatre environment.

complications of COVID-19.

2.7. Post-operative management

Patients were evaluated on daily ward rounds during their inpatient stay. If patients presented with symptoms consistent with COVID-19 they were isolated in a side room and tested for COVID-19 with a viral swab and chest CT.

Patients were discharged when they had appropriately recovered from surgery and it was clinically safe to do so. Once discharged, patients were instructed to self-isolate for 14 days where feasible. A phone call at or shortly after 30 days was carried out to determine their clinical status based on a dedicated questionnaire.

2.8. Data collection

We reviewed electronic medical records with a standardised case report form. We assessed baseline demographics, operation notes, radiological test results, laboratory test results and post-operative clinical encounters. Data entry was verified independently by two data collectors to ensure accuracy.

2.9. Statistical analysis

Continuous data were presented with mean and standard deviation or median and interquartile range. Categorical data were presented with the number of patients and percentage in each category. All analyses were performed using STATA (version 14.2) software.

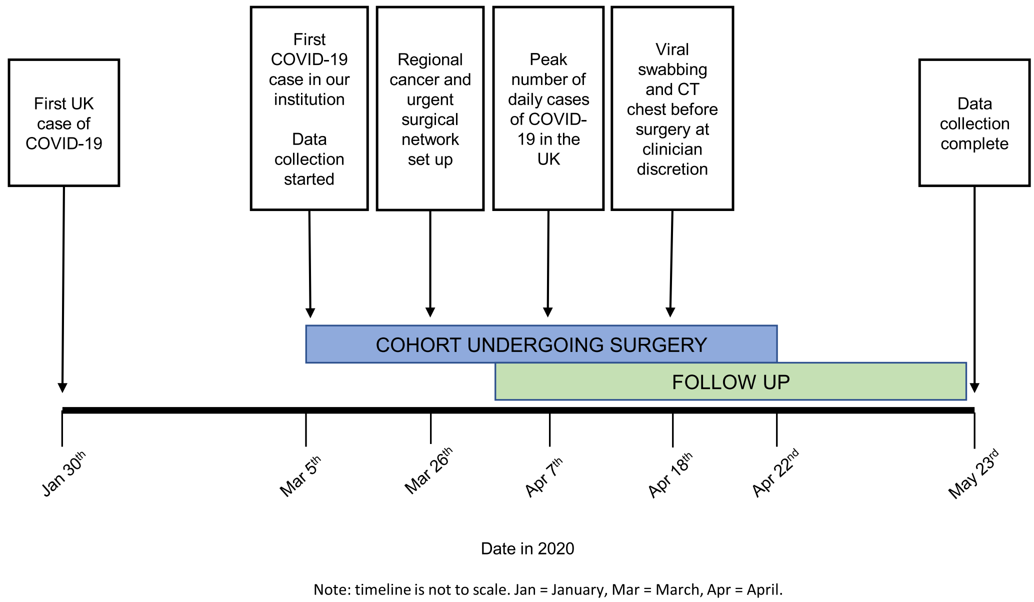

Fig. 1. Title: Timeline of key events during the studyNote: timeline is not to scale. Jan = January, Mar = March, Apr = April.

2.10. Ethics

The institutional review board at University College London Hospital deemed this work exempt from ethical approval.

3. Results

The first confirmed case of COVID-19 in our institution was on March 5, 2020. 500 patients underwent non-emergency surgery at the dedicated CCS between the March 5, 2020 and April 22, 2020. The date of follow up for the final patient was on the May 23, 2020. There was no loss to follow up. In this time period, across all of our institutional sites, there were 788 confirmed cases of COVID-19.

The median hospital inpatient stay was 1 night. Patients were of median age 62.5 and 65% were male (Table 2). 350/500 (70%) of operations were performed for the diagnosis or treatment of cancer and 150/500 (30%) were done for urgent non-cancer conditions (Table 3).

220/500 (44%) of operations were performed with robotic or endoscopic assistance, with the remaining performed via an open, percutaneous or natural orifice approach. 305/500 (61%) were classified as major or complex surgery, 110/500 (22%) as intermediate and 85/500 (17%) as minor [24]. 440/500 (88%) procedures were performed under general anaesthetic, 31/500 (6%) were performed under sedation and 29/500 (6%) were performed under local anaesthetic. Pre-operatively, 72/500 (14%) patients underwent pre-operative viral swabs and 22/500 (4%) underwent pre-operative chest CT. Of these none had a laboratory confirmed test result positive for COVID-19 though one patient had changes with typical appearances of COVID-19 on chest CT. This patient was asymptomatic and had probable COVID-19 infection one month prior. In light of the CT changes, this patient's surgery was deferred by two weeks but was performed during the study.

No patient died from COVID-19 at 30-days. The all cause 30-day mortality was 3/500 (1%). Causes of death included aspiration pneumonia secondary to small bowel obstruction, myocardial infarction in a patient with underlying ischaemic heart disease and metastatic breast cancer. The latter two deaths occurred after the patients had been discharged home. 10/500 (2%) patients were diagnosed with confirmed or probable COVID-19 (Table 2), of whom 4/500 (1%) were confirmed on a viral swab (Table 4). These four patients had their first symptom at 1, 3, 8 and 30-days post operatively. 6/500 (1%) patients were diagnosed with probable COVID-19, with fever and at least one sign of acute

Table 2
Baseline demographics of all patients undergoing surgery, patients diagnosed with COVID-19 and patients who did not develop COVID-19.

Characteristic	Total population n = 500	Patients with COVID-19[a] n = 10	Patients without COVID-19 n = 490
Age	62.5, [IQR 51–71]	50, [IQR 43–63]	63, [IQR 51–71]
Sex			
Female	173/500 (35%)	5/10 (50%)	168/490 (34%)
Male	327/500 (65%)	5/10 (50%)	322/490 (66%)
BMI	27.0, [IQR 23.3–30.3]	31.3, [IQR 29–34.7]	26.7, [23.3–30.0]
Hypertension	165/500 (33%)	2/10 (20%)	163/490 (33%)
Ischaemic Heart Disease	28/500 (6%)	1/10 (10%)	27/490 (6%)
Previous stroke or transient Ischaemic attack	20/500 (5%)	0/10 (0%)	20/490 (4%)
Congestive heart failure	7/500 (1%)	0/10 (0%)	7/490 (1%)
Type II Diabetes Mellitus	63/500 (13%)	1/10 (10%)	62/490 (13%)
Chronic obstructive lung disease	32/500 (6%)	0/10 (0%)	32/490 (7%)
Asthma	56/500 (11%)	2/10 (20%)	54/490 (11%)
Smoker	66/500 (13%)	1/10 (10%)	65/490 (13%)
Autoimmune disorder	31/500 (6%)	2/10 (20%)	29/490 (6%)
Existing diagnosis of cancer	301/500 (60%)	4/10 (40%)	297/490 (61%)
American Society of Anesthesiologists (ASA) Classification			
ASA 1	33/500 (7%)	0/10 (0%)	33/490 (7%)
ASA 2	293/500 (59%)	6/10 (60%)	287/490 (59%)
ASA 3	168/500 (34%)	4/10 (40%)	164/490 (34%)
ASA 4	6/500 (1%)	0/10 (0%)	6/490 (1%)

Where variable is continuous, mean±standard deviation or median±interquartile range [IQR] is presented. Where variable is categorical, the number and proportion of the patients with that characteristic is presented.

[a] Confirmed or probable COVID-19 defined as per World Health Organisation guidelines for diagnosing COVID-19 [20].

Table 3
A table showing the surgeries performed classified by speciality, complexity and number performed.

Speciality and operation, stratified by complexity of surgery[a]	Number performed (%) N = 500
Urology	N = 333/500 (67%)
Major or complex	n = 160
Excision of penile/perineal lesion and graft	3
Glansectomy±graft for penile cancer	3
Insertion of artificial urethral sphincter	5
Insertion or removal of penile prosthesis	3
Radical nephrectomy or nephroureterectomy	13
Radical cystectomy and/or urinary diversion	19
Radical prostatectomy	45
Radical penectomy	3
Urethroplasty	5
Transurethral resection of bladder tumour	13
Ureterorenoscopy±procedure	26
Other major surgery	22
Intermediate	n = 95
Cryotherapy to prostate	10
High intensity focal ultrasound of the prostate	10
Insertion or exchange of nephrostomy	10
Radical orchidectomy	1
Rigid cystoscopy±procedure	56
Other intermediate surgery	8
Minor	n = 78
Circumcision for penile cancer	11
Flexible cystoscopy±procedure	18
Insertion of suprapubic catheter	5
Penile biopsy	1
Transperineal prostate biopsy	31
Other minor surgery	12
Thoracics	N = 117/500 (23%)
Major or complex	n = 107
Lobectomy	26
Excision of lung lesion	38
Video assisted thoracoscopic procedure	39
Other major surgery	4
Intermediate	n = 10
Bronchoscopy	3
Mediastinoscopy	4
Insertion of chest drain	3
Gynaecology	N = 45/500 (9%)
Major or complex	n = 34
Total abdominal hysterectomy±bilateral salpingoopherectomy	31
Other major surgery	3
Intermediate	n = 5
Evacuation of retained products of conception	4
Loop excision of transformation zone	1
Minor	n = 6
Hysteroscopy	2
Other minor surgery	4
General surgery	N = 5/500 (1%)
Major	n = 4
Adrenalectomy	1
Bowel resection	1
Haemorrhoidectomy	1
Thyroidectomy	1
Minor	n = 1
Examination of rectum under anaesthesia	1

[a] Complexity as per NICE guidelines [NG45]: Routine preoperative tests for elective surgery (24).

Table 4
The diagnosis of COVID-19 in 500 patients undergoing surgery at a dedicated COVID-19 cold site.

Characteristic	Summary measure
Pre-operative	
Number of patients with pre-operative viral swab sent off for COVID-19	72/500 (14%)
Number of patients with a pre-operative viral swab positive for COVID-19	0/72 (0%)
Number of patients with pre-operative CT chest	22/500 (3%)
Number of patients with pre-operative CT chest with changes typical of COVID-19[a]	1/22 (5%)
Post-operative	
Number of patients with post-operative viral swabs sent off for COVID-19	41/500 (8%)
Number of viral swabs sent off post-operatively for COVID-19	44
Median number of days from surgery to post-operative viral swab for COVID-19 (median, IQR)	5 [IQR 2–12]
Number of patients undergoing post-operative chest CT	19/500 (4%)
Median number of days from surgery to post-operative chest CT (median, IQR)	5.5 [IQR 3–13]
Number of patients with confirmed COVID-19 from a post-operative viral swab	4/41 (10%)
Median number of days from surgery to first symptom in those with confirmed COVID-19	5.5 [IQR 2–19]
Number of patients with chest CT showing typical changes of COVID-19[a]	2/19 (11%)
Number of patients experiencing at least one clinical symptom that may be associated with COVID-19	47/500 (9%)
Cough	21
Fever	29
Shortness of breath	25
Muscle pain	11
Fatigue	14
Joint pain	6
Sore throat	1
Loss of smell	3
Loss of taste	1
Vomiting	1
Chest pain	1
Loss of appetite	2
Number of patients with probable COVID-19[b]	
Number of patients with fever and at least one sign of acute respiratory illness	6/500 (1%)
Median number of days from surgery to diagnosis of probable COVID-19 (median, IQR)	14 ([IQR 7–26]
Number of patients with confirmed or probable COVID-19	10/500 (2%)

[a] CT Chest with the typical appearances of COVID-19 pneumonia according to the Radiological Society of North America [21].
[b] A diagnosis of probable COVID-19 was given to patients who did not undergo laboratory testing or in whom laboratory testing was inconclusive, but who had fever and at least one sign of acute respiratory illness [20].

respiratory illness. None of the ten patients with probable or confirmed COVID-19 had a pre-operative viral swab sent, though one patient had a pre-operative CT which did not show signs suggestive of COVID-19.

There were 92/500 (18%) grade 1–5 Clavien-Dindo complications, of which 33/500 (7%) were grade 3a or above (Table 5). The majority of these complications (32/33, 97%) were in patients without confirmed or probable COVID-19. One of these complications occurred in a patient with probable COVID-19. This was a grade 4b complication following an infected implant which required admission to ITU for management of septic shock and hypoxia. The patient was discharged home well on the 12th post-operative day and developed probable COVID-19 on the 30th post-operative day. They recovered fully at home without any treatment (see Table 6).

4. Discussion

The principle finding of this study was that it is feasible and safe to continue with high-volume urgent and cancer surgery during the

Table 5
Description of complications occurring within 30-days for Clavien-Dindo Grade 3 or above complications for 500 patients undergoing surgery.

Clavien Dindo grade[a]	Complication	Frequency (n, %)
IIIa		n = 14 (3%)
Requires surgical, endoscopic or radiological intervention under local anaesthetic	Anastomotic leak requiring urethral catheter	1
	Urinary retention requiring catheterisation	11
	Knee swelling requiring aspiration	1
	Additional suture to improve seal of drain	1
IIIb		n = 2 (1%)
Requires surgical, endoscopic or radiological intervention under general anaesthetic	Return to theatre due to post-operative bleeding	2
IVa		n = 9 (2%)
Life-threatening complication requiring ITU management with single organ dysfunction	Admission to ITU for respiratory support following respiratory failure	3
	Admission to ITU for cardiovascular support following post-operative bleed and/or hypotension	3
	Admission to ITU for treatment of severe hyponatraemia	1
	Admission to ITU for management of fast atrial fibrillation and haemodynamic compromise	1
	Admission ITU for cardiac support following bradycardia and hypotension	1
IVb		n = 5 (1%)
Life-threatening complication requiring ITU management with multi organ dysfunction	Admission to ITU for vasopressors for hypotension, intubated and ventilated for respiratory failure and treated for hyperkalaemia following acute kidney injury.	1
	Admission to ITU for cardiac support for right ventricular failure following cardiac arrest and respiratory support with non-invasive ventilation.	1
	Admitted to ITU for intubation and ventilation after airway compromise from surgical emphysema and for vasopressors	1
	Admission to ITU for respiratory support following hypoxia and supportive treatment for hepatic failure.	1
	Admission to ITU for vasopressors for hypotension and high flow oxygen for hypoxia.	1
V		n = 3 (1%)
Death	Aspiration pneumonia	1
	Coronary atheroma due to underlying ischaemic heart disease	1
	Metastatic breast cancer	1

Table 6
Primary operation and disease pathology in patients with probable or confirmed diagnoses of COVD-19.

Patient operation	Primary disease pathology
For patients with confirmed COVID-19:	
Thymectomy	Myasthenia gravis
Rigid cystoscopy	Lower urinary tract symptoms
Nephrectomy	Renal cancer
Video-assisted thoracoscopic procedure	Pleural effusion
For patients with probable COVID-19:	
Radical prostatectomy	Prostate cancer
Focal cryotherapy to prostate	Prostate cancer
Lobectomy	Lung cancer
Flexible cystoscopy	Lower urinary tract symptoms
Sacral nerve modulator insertion	Lower urinary tract symptoms
Sacral nerve modulator insertion	Lower urinary tract symptoms

COVID-19 pandemic. No patient died from COVID-19 despite being in the peak of the pandemic in the worst affected region of the UK, which is a country with one of the highest number of cases and deaths from COVID-19 in the world [12,25]. The prevalence of COVID-19 in our region was high with 788 confirmed cases of COVID-19 across our institutional sites in the study period. With an estimated 2 million surgeries being cancelled each week globally because of uncertainties associated with COVID-19 [2], patients with cancer are at risk of poorer survival outcomes and poorer quality of life [4–6]. This study has significant implications in supporting the continued provision of surgical cancer services during the pandemic and the recovery phases following the pandemic. It provides a model for institutions wishing to continue performing surgery to follow and has implications for the surgical management of patients in future pandemics.

The 30-day mortality and complications from COVID-19 were much lower than those seen in previous landmark studies, where mortality rates of 19–21% have been reported [7,26]. It is likely that these results reflect selection bias from only including patients with COVID-19 and being more likely to include patients with serious complications of COVID-19 than ones who recover without complication. Our study demonstrates results consistent with data from more recent studies where patients underwent surgery without pre-operative suspicion of COVID-19 [27]. Overall the mortality in a large cohort study of over 9000 patients undergoing elective cancer surgery was 1.5% [27]. However, a limitation of this work is that each centre included an average of 21 patients and the authors themselves acknowledge the risk of associated ascertainment bias. There was no verification of source data in this study to assess this and no confirmation that the centres carried out surgery during the peak of the pandemic in their regions. We overcome selection bias by strictly including consecutive patients from when the first case was confirmed in our institution during the peak of the pandemic in our region and had a second investigator independently verify the results from the source data. Furthermore, since there are a wide range of centres included in the previous work, there is variation in practice but no granular detail on how organisations can actually restructure their service to achieve these results. In contrast, we provide granular detail on the measures taken to reduce COVID-19 transmission.

Ten (2%) of the patients in the current cohort had probable or confirmed COVID-19 and none of these patients died from COVID-19. Overall a 7% Clavien-Dindo grade 3a or higher complication rate is a low rate of complications given the nature of surgeries being performed. This may reflect expertise at a high-volume tertiary cancer centre and patient selection. Patients were chosen who would benefit the most from surgery, balanced by their risk of serious complications from COVID-19. Importantly, developing confirmed or probable COVID-19 infection did not appear to influence the likelihood of developing a complication. In comparison to the COVIDSurg cohort study [7], patients in our cohort had a higher prevalence of cancer (60% vs 17%), a similar prevalence of smokers (13% vs 10%), but lower prevalence of chronic obstructive lung disease (6% vs 10%), diabetes (13% vs 25%), hypertension (33% vs 50%) and congestive heart failure (1% vs 7%). These differences may contribute to the outcomes seen, though are not likely to be enough on their own to explain the difference in mortality.

Service reconfiguration was important in achieving the outcomes demonstrated. A hub-and-spoke model of practice was set up, with efforts on preserving the hub's status as a COVID cold site, which is likely to be one of the key drivers in the observed outcomes. The hub accepted referrals from a multicentre surgical cancer network, allowing the cases with the highest risk disease across different specialities within the network, who would benefit most from surgery, to be prioritised. Important local adjustments included diverting the majority of patient transfers or emergencies to an alternative geographically separate site within the institution. Footfall within the hospital was reduced by enabling staff to work from home when possible and for patient consultations to become telephone based. The use of telemedicine has become extremely important during the COVID-19 pandemic for patient contact and multidisciplinary team working [28].

PPE measures were introduced with the rationale of increasing the safety of staff and patients. Though some recommend universal operating room respiratory precautions in the pandemic [23] and this is what our institution adopted, there are uncertainties over this practice. For example, intubation and extubation during a general anaesthetic are aerosol-generating procedures that carry a higher risk of transmission of COVID-19, though there is less certainty over transmission risk from laparoscopy and from the production of a smoke plume from coagulating instruments. Performing surgery in full PPE is challenging, particularly during major and complex surgery, which comprised a large proportion of our cases. The impact on increasing the operative time and turnaround time between cases is not insignificant, meaning only a reduced surgical workload is feasible. Typically for each case, an additional 40 min turnaround time was required due to additional time allowed before the full theatre team could re-enter theatre following intubation and extubation. In addition, the surgical procedure itself typically took longer, though this varied by complexity of the surgical procedure. As an example, prior to the COVID-10 pandemic we typically performed 6–7 transperineal prostate biopsies in a 9-h theatre list, but we typically reduced this to 4 biopsy procedures during the COVID-19 pandemic. Institutions should consider the implication that adopting these measures has on their ability to offer surgery during the peaks and recovery phases of the pandemic and further evidence to support the influence of these measures on risk of transmission of COVID-19 is warranted.

It is worth noting that measures such as pre-operative viral swabs and pre-operative CT chest testing were only introduced towards the end of this series, and despite this, the COVID-specific mortality rate remained low. This may suggest that other measures such as striving to maintain a COVID-free site, checking patients remained asymptomatic prior to their surgery and patient isolation pre and post-surgery could be the principle drivers of the observed outcomes.

There are a number of limitations in this study. First, not all of the patients were tested with a viral swab. This may underestimate the number of patients with confirmed laboratory diagnoses of COVID-19, though this may be mitigated by our assessment of patients for probable COVID-19 on the basis of their symptoms and in line with WHO guidelines [20]. Testing everyone in the community is not feasible in countries such as the UK, where testing capacity was limited, and government policy meant that testing was typically reserved for patients admitted to hospital.

Second, this service reconfiguration approach may not be feasible in all healthcare settings. At other institutions, particularly those based in one building, it may not be possible to keep the site COVID-free. However, we would strongly recommend that neighbouring institutions work together to designate cold COVID sites amongst a group of institutions during these unprecedented times.

Third, we should acknowledge the ethical dilemmas surrounding resource allocation at a time of limited resources and with uncertainty about where resources are best used [29]. The ability to offer such a service is dependent on local resources and the specific clinical situation, though models have been developed to allow planning for resource allocation during a pandemic [30]. It is ultimately down to the judgment of the regional healthcare system leaders whether it is appropriate and safe to offer the described approach. Fourth, we were not able to study the impact that this service reconfiguration had on COVID-19 infections in staff members, though understanding the factors contributing to this is complex and could be the subject of future research.

5. Conclusion

This study has demonstrated that it is feasible and safe to carry out cancer and urgent surgery during the COVID pandemic providing appropriate service reconfiguration takes place to facilitate this.

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Conflicts of interest

The authors have no relevant conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijsu.2020.10.019.

References

[1] K. Soreide, J. Hallet, J.B. Matthews, A.A. Schnitzbauer, P.D. Line, P.B.S. Lai, et al., Immediate and long-term impact of the COVID-19 pandemic on delivery of surgical services, Br. J. Surg. 30 (10) (2020) 1250–1261.
[2] Collaborative C, Nepogodiev D, Bhangu A. Elective surgery cancellations due to the COVID-19 pandemic: global predictive modelling to inform surgical recovery plans. BJS (British Journal of Surgery).n/a(n/a). 107(11), 1440-1449.
[3] A. Sud, M.E. Jones, J. Broggio, C. Loveday, B. Torr, A. Garrett, et al., Collateral damage: the impact on cancer outcomes of the COVID-19 pandemic, medRxiv (2020) 2020, 04.21.20073833.
[4] A.T. Chu, S.K. Holt, J.L. Wright, J.D. Ramos, P. Grivas, E.Y. Yu, et al., Delays in radical cystectomy for muscle-invasive bladder cancer, Cancer 125 (12) (2019) 2011–2017.
[5] M.M. AlHilli, P. Elson, L. Rybicki, A.A. Khorana, P.G. Rose, Time to surgery and its impact on survival in patients with endometrial cancer: a National cancer database study, Gynecol. Oncol. 153 (3) (2019) 511–516.
[6] P.J.J. Herrod, A. Adiamah, H. Boyd-Carson, P. Daliya, A.M. El-Sharkawy, P. B. Sarmah, et al., Winter cancellations of elective surgical procedures in the UK: a questionnaire survey of patients on the economic and psychological impact, BMJ Open 9 (9) (2019), e028753.
[7] Nepogodiev D, Glasbey JC, Li E, Omar OM, Simoes JFF, Abbott TEF, et al. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. Lancet. 10243(396), 27-38.
[8] G. Amodeo, D. Bugada, S. Franchi, G. Moschetti, S. Grimaldi, A. Panerai, et al., Immune function after major surgical interventions: the effect of postoperative pain treatment, J. Pain Res. 11 (2018) 1297–1305.
[9] C.J. Allen, A.J. Griswold, C.I. Schulman, D. Sleeman, J.U. Levi, A.S. Livingstone, et al., Global gene expression change induced by major thoracoabdominal surgery, Ann. Surg. 266 (6) (2017) 981–987.
[10] Epidemiology, practice of ventilation and outcome for patients at increased risk of postoperative pulmonary complications: LAS VEGAS - an observational study in 29 countries, Eur. J. Anaesthesiol. 34 (8) (2017) 492–507.
[11] W. Liang, W. Guan, R. Chen, W. Wang, J. Li, K. Xu, et al., Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China, Lancet Oncol. 21 (3) (2020) 335–337.
[12] Coronavirus (COVID-19) in the UK. UK government data. https://coronavirus.data.gov.uk. Accessed on 28th June 2020.
[13] Elm Ev, D.G. Altman, M. Egger, S.J. Pocock, P.C. Gøtzsche, J.P. Vandenbroucke, Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies, BMJ 335 (7624) (2007) 806–808.
[14] R. Agha, A. Abdall-Razak, E. Crossley, N. Dowlut, C. Iosifidis, G. Mathew, et al., STROCSS 2019 Guideline: Strengthening the reporting of cohort studies in surgery, Int. J. Surg. 72 (2019) 156–165.
[15] J.K. Elrod, J.L. Fortenberry, The hub-and-spoke organization design: an avenue for serving patients well, BMC Health Serv. Res. 17 (1) (2017) 457.
[16] The Royal College of Surgeons of England Clinical Guide to Surgical Prioritisation, 2020. https://www.rcseng.ac.uk/coronavirus/. Accessed on 5th May.
[17] W-j Guan, W-h Liang, Y. Zhao, H-r Liang, Z-s Chen, Y-m Li, et al., Comorbidity and its impact on 1590 patients with covid-19 in China: a nationwide analysis, Eur. Respir. J. (2020) 2000547.
[18] Completing a Medical Certificate of Cause of Death, UK Government guidance, 2020. https://www.gov.uk/government/publications/guidance-notes-for-completing-a-medical-certificate-of-cause-of-death. Accessed on 5th May.
[19] World Health Organisation Guidelines on Laboratory Testing for 2019 Novel Coronavirus (2019-nCoV) in Suspected Human Cases, 2020. https://www.who.int/publications-detail/laboratory-testing-for-2019-novel-coronavirus-in-suspected-human-cases-20200117. Accessed on 5th May.
[20] World Health Organisation Guidance on Global Surveillance for COVID-19 Caused by Human Infection with COVID-19 Virus: Interim Guidance, 20 March 2020. https://apps.who.int/iris/handle/10665/331506. Accessed on 5th May 2020.
[21] S. Simpson, F.U. Kay, S. Abbara, S. Bhalla, J.H. Chung, M. Chung, et al., Radiological society of North America expert consensus statement on reporting chest CT findings related to COVID-19. Endorsed by the society of thoracic radiology, the American College of radiology, and RSNA, Radiology: Cardiothoracic Imaging 2 (2) (2020), e200152.
[22] P.A. Clavien, J. Barkun, M.L. de Oliveira, J.N. Vauthey, D. Dindo, R.D. Schulick, et al., The Clavien-Dindo classification of surgical complications: five-year experience, Ann. Surg. 250 (2) (2009) 187–196.
[23] E.H. Livingston, Surgery in a time of uncertainty: a need for universal respiratory precautions in the operating room, J. Am. Med. Assoc. 323 (22) (2020) 2254–2255.
[24] National Institute for Health and Care Excellence guideline, Routine preoperative tests for elective surgery (NG45) published 5th April 2016. https://www.nice.org.uk/guidance/NG45. Accessed on 17th May 2020.
[25] The world health orgnisation COVID-19 information dashboard. https://covid19.who.int. Accessed on 28th June 2020.
[26] S. Lei, F. Jiang, W. Su, C. Chen, J. Chen, W. Mei, et al., Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection, EClinicalMedicine (2020) 100331.
[27] J.C. Glasbey, A. Bhangu, Collaborative obotC, Elective cancer surgery in COVID-19–free surgical pathways during the SARS-CoV-2 pandemic: an international, multicenter, comparative cohort study, J. Clin. Oncol. (2020) publication online ahead of print. JCO2001933.
[28] S. Tolone, C. Gambardella, L. Brusciano, G. Del Genio, F.S. Lucido, L. Docimo, Telephonic triage before surgical ward admission and telemedicine during COVID-19 outbreak in Italy. Effective and easy procedures to reduce in-hospital positivity, Int. J. Surg. 78 (2020) 123–125.
[29] E.J. Emanuel, G. Persad, R. Upshur, B. Thome, M. Parker, A. Glickman, et al., Fair allocation of scarce medical resources in the time of covid-19, N. Engl. J. Med. 382 (2020) 2049–2055.
[30] G.E. Weissman, A. Crane-Droesch, C. Chivers, T. Luong, A. Hanish, M.Z. Levy, et al., Locally informed simulation to predict hospital capacity needs during the COVID-19 pandemic, Ann. Intern. Med. 173 (1) (2020) 21–28.