
Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

ORIGINAL ARTICLE

# Impact of SARS-CoV-2 pandemic on pancreatic cancer services and treatment pathways: United Kingdom experience

Siobhan C. McKay[1,2], Samir Pathak[3,4], Richard J.W. Wilkin[2], Sivesh K. Kamarajah[5], Stephen J. Wigmore[6], Jonathan Rees[3], Declan F.J. Dunne[7], Giuseppe Garcea[8], Jawad Ahmad[9], Nicola de Liguori Carino[10], Asma Sultana[11], Mike Silva[12], Pavlos Lykoudis[13], David Nasralla[14], James Milburn[15], Nehal Shah[16], Hemant M. Kocher[17], Ricky Bhogal[18,19], Ryan D. Baron[7], Alex Navarro[20], James Halle-Smith[1], Bilal Al-Sarireh[21], Gourab Sen[5], Nigel B. Jamieson[22,23], Christopher Briggs[24], David Stell[24], Somaiah Aroori[24], Matthew Bowles[24], Aditya Kanwar[24], Simon Harper[25], Krishna Menon[26], Andreas Prachalias[26], Parthi Srinivasan[26], Adam E. Frampton[27,28], Claire Jones[29], Ali Arshad[30], Iain Tait[31], Duncan Spalding[32,33], Alastair L. Young[34], Damien Durkin[35], Manijeh Ghods-Ghorbani[2], Robert P. Sutcliffe[1] & Keith J. Roberts[1]

[1]The Liver Unit, Queen Elizabeth Hospital Birmingham, [2]Academic Department of Surgery, University of Birmingham, Birmingham, [3]University Hospitals Bristol NHS Foundation Trust, Bristol, BS2 8HW, [4]Centre for Surgical Research, University of Bristol, Canynge Hall, 39, Whatley Road, Bristol, BS8 2PS, [5]Department of Hepatobiliary, Pancreatic and Transplant Surgery, The Freeman Hospital, Newcastle Upon Tyne, Tyne and Wear, [6]Department of Clinical Surgery, University of Edinburgh, Royal Infirmary of Edinburgh, EH16 4SA, [7]Department of Pancreatobiliary Surgery, Royal Liverpool University Hospital, L7 8XP, [8]Department of HPB Surgery, University Hospitals of Leicester, Gwendolen Road, Leicester, LE5 4PW, [9]University Hospitals Coventry and Warwickshire, Clifford Bridge Rd, Coventry, CV2 2DX, [10]Department of HPB Surgery, Manchester Royal Infirmary, University of Manchester, Manchester, M13 9WL, [11]Department of HPB Surgery, East Lancashire Teaching Hospitals NHS Trust, Haslingden Road, Blackburn, BB2 3HH, [12]Oxford University Hospitals NHS FT, Headley Way, Headington, Oxford, OX3 9DU, [13]Hull University Teaching Hospitals, Hull, HU3 2JZ, [14]Department of HPB Surgery, The Royal Free Hospital, Pond Street, London, NW3 2QG, [15]HPB Surgical Unit, Aberdeen Royal Infirmary, Aberdeen, AB25 2ZN, [16]Department of HPB Surgery. Sheffield University Teaching Hospital. Sheffield, S5 7AU, [17]Barts Cancer Institute, Queen Mary University of London, Charterhouse Square, London, EC1M 6BQ, [18]The Royal Marsden Hospital NHS Foundation Trust, Fulham Road, London, SW3 6JJ, [19]Institute for Cancer Research, 123 Old Brompton Road, South Kensington, London, SW7 3RP, [20]Nottingham University Hospitals, Derby Rd, Lenton, Nottingham, NG7 2UH, [21]Morriston Hospital, Heol Maes Eglwys, Morriston, Cwmrhydyceirw, Swansea, SA6 6NL, [22]West of Scotland Pancreatic Unit, Glasgow Royal Infirmary, 84 Castle St, Glasgow, G4 0SF, [23]Wolfson Wohl Cancer Research Centre, Institute of Cancer Sciences, University of Glasgow, G61 1BD, [24]University Hospitals Plymouth NHS Trust, Derriford Road, Crownhill, Plymouth, Devon, PL6 8DH, [25]Addenbrookes Hospital, Hills Rd, Cambridge, CB2 0QQ, [26]King's College Hospital, Denmark Hill, Brixton, London, SE5 9RS, [27]HPB Surgical Unit, Royal Surrey County Hospital NHS Foundation Trust, Guildford, Surrey, GU2 7XX, [28]Department of Clinical and Experimental Medicine, Faculty of Health and Medical Sciences, University of Surrey, Guildford, Surrey, GU2 7WG, [29]Mater Hospital, 45-51 Crumlin Rd, Belfast, BT14 6AB, [30]University Hospital Southampton, Tremona Road, Southampton, Hampshire, SO16 6YD, [31]Ward 11, Ninewells Hospital and Medical School Dundee, DD1 9SY, [32]Department HPB Surgery, Hammersmith Hospital, DuCane Road, London, W12 0HS, [33]Department of Surgery and Cancer, Imperial College London, London, [34]Department of Pancreatic Surgery, St James's University Hospital, Leeds, LS9 7TF, and [35]Royal Stoke NHS Trust, Newcastle Road, Stoke-on-Trent, ST4 6QG, UK

## Abstract

**Introduction:** The SARS-CoV-2 pandemic presented healthcare providers with an extreme challenge to provide cancer services. The impact upon the diagnostic and treatment capacity to treat pancreatic cancer is unclear. This study aimed to identify national variation in treatment pathways during the pandemic.

**Methods:** A survey was distributed to all United Kingdom pancreatic specialist centres, to assess diagnostic, therapeutic and interventional services availability, and alterations in treatment pathways. A repeating methodology enabled assessment over time as the pandemic evolved.

**Results:** Responses were received from all 29 centres. Over the first six weeks of the pandemic, less than a quarter of centres had normal availability of diagnostic pathways and a fifth of centres had no capacity whatsoever to undertake surgery. As the pandemic progressed services have gradually improved though most centres remain constrained to some degree. One third of centres changed their standard resectable pathway from surgery-first to neoadjuvant chemotherapy. Elderly patients, and those with COPD were less likely to be offered treatment during the pandemic.

**Conclusion:** The COVID-19 pandemic has affected the capacity of the NHS to provide diagnostic and staging investigations for pancreatic cancer. The impact of revised treatment pathways has yet to be realised.

 

Received 22 August 2020; accepted 9 March 2021

## Correspondence

Siobhan C. McKay, The Liver Unit, Queen Elizabeth Hospital Birmingham, UK. E-mail: Siobhan.mckay@uhb.nhs.uk

drsamirpathak@gmail.com (S. Pathak), richardwilkin@doctors.net.uk (R.J.W. Wilkin), siveshkk93@gmail.com (S.K. Kamarajah), s.wigmore@ed.ac.uk (S.J. Wigmore), Jonathan.Rees@bristol.ac.uk (J. Rees), declan.dunne@rlbuht.nhs.uk (D.F.J. Dunne), giuseppe.garcea@uhl-tr.nhs.uk (G. Garcea), jawad.ahmad@uhcw.nhs.uk (J. Ahmad), nicola.deliguoricari0@mft.nhs.uk (N. de Liguori Carino), asma.sultana@elht.nhs.uk (A. Sultana), mikesilva10@gmail.com (M. Silva), pavlos.lykoudis@hey.nhs.uk (P. Lykoudis), David.nasralla@nhs.net (D. Nasralla), j.milburn@nhs.net (J. Milburn), nehal.shah@nhs.net (N. Shah), h.kocher@qmul.ac.uk (H.M. Kocher), ricky.bhogal@rmh.nhs.uk (R. Bhogal), Ryan.baron@liverpoolft.nhs.uk (R.D. Baron), alexnavarro1978@gmail.com (A. Navarro), James.Halle-Smith@uhb.nhs.uk (J. Halle-Smith), Bilal.al-sarireh@wales.nhs.uk (B. Al-Sarireh), gourab.sen@nhs.net (G. Sen), nigel.jamieson@glasgow.ac.uk (N.B. Jamieson), christopherbriggs@nhs.net (C. Briggs), David.Stell@nhs.net (D. Stell), Somaiah.Aroori@nhs.net (S. Aroori), Matthew.Bowles@nhs.net (M. Bowles), Aditya.Kanwar@nhs.net (A. Kanwar), simon.harper@addenbrookes.nhs.uk (S. Harper), krishna.menon@nhs.net (K. Menon), Andreas.Prachalias@nhs.net (A. Prachalias), Parthi.Srinivasan@nhs.net (P. Srinivasan), aframpton@nhs.net (A.E. Frampton), claire.jones@belfasttrust.hscni.net (C. Jones), Ali.Arshad@uhs.nhs.uk (A. Arshad), itait@nhs.net (I. Tait), d.spalding@imperial.ac.uk (D. Spalding), alistair.young@nhs.net (A.L. Young), ddurkin@doctors.org.uk (D. Durkin), Manijeh.Ghods-Ghorbani@uhb.nhs.uk (M. Ghods-Ghorbani), robert.sutcliffe@uhb.nhs.uk (R.P. Sutcliffe), Keith.Roberts@uhb.nhs.uk (K.J. Roberts)

## Introduction

The World Health Organisation declared SARS-CoV-2 infection a global pandemic on 11th March 2020.[1] With rapid global spread of the virus, and a higher death rate than that observed with seasonal flu,[2] healthcare systems mobilised an organisation-wide response to cope with the influx of patients to hospitals.[3,4] In order to cope with actual and anticipated need for widespread multi-organ support, and in particular ventilation, NHS trusts reorganised their acute and elective care pathways and systems, with prioritisation of emergency care.[5,6] This included the conversion of operating theatres into intensive care units and moving of staff normally required to deliver anaesthesia and perioperative care to intensive care units.[7]

Pancreatic cancer is a rapidly progressive disease where delays in treatment are associated with disease progression and adverse outcomes.[8] There has been a lack of national directive by the NHS as to how individual cancer types should be managed, other than to say that cancer care should continue. Early in the pandemic specialist societies issued guidelines for the treatment of patients with potentially resectable pancreatic cancer, suggesting biliary stenting should be performed for jaundiced patients, and surgery undertaken if appropriate level 2 or 3 care is available (HDU offering single organ support, and ITU offering two or more organ support).[5,9] These also include advising careful patient selection for treatment, providing surgery at 'clean sites', and to provide neoadjuvant chemotherapy as an alternative to surgery when surgery is not available.[4,5,10]

It is imperative to establish the effect of the current pandemic on the reorganisation of healthcare services for pancreatic cancer pathways and care. The aim of this study was to perform a national survey of specialist pancreatic cancer centres, to evaluate diagnostic, interventional, and operative service availability and capacity, and changes to treatment pathways during the initial wave of the SARS-CoV-2 pandemic in the United Kingdom. This information will help guide ongoing care pathways during the pandemic should a second surge occur, or high-incidence local breakouts, to provide a valuable reference point for care pathways when longer term outcome data becomes available.

## Methods

The survey was designed to assess the impact of SARS-CoV-2 on pancreatic cancer diagnostic, interventional and therapeutic services, and assess potential changes to treatment pathways for pancreatic cancer patients. It was created using the REDCap electronic data capture tool, a secure web-based software platform hosted by the Birmingham Surgical Trials Consortium (BiSTC) at Birmingham University, UK. Survey content was reviewed and supported by the Association of Upper Gastrointestinal Surgery (AUGIS), the Royal College of

 

Surgeons of England (RCS Eng), the Pancreatic Society of Great Britain and Ireland, and Pancreatic Cancer UK (PCUK).

The survey captured baseline information about each resectional centre, including operative case load and normal treatment pathways for resectable pancreatic ductal adenocarcinoma (PDAC), and borderline PDAC with venous involvement (Supplementary file 1). A SARS-CoV-2 pandemic specific element of the survey repeated every two weeks to assess changes in services and decision making over the course of the pandemic (Supplementary file 2). The repeating element assessed how many pancreatic resections had been performed in the preceding two weeks and the COVID-status of the operative site used, availability of diagnostic and interventional procedures, decision-making and treatment options offered to patients. Clinical vignettes were used to assess any changes to treatment offered to patients stratified by age and respiratory co-morbidity. Respondents were asked if a patient with resectable pancreatic cancer would be offered treatment or not, according to age (40, 63, 82 year old), and with or without respiratory co-morbidity (chronic obstructive pulmonary disease (COPD)) for each respective age group at each timepoint throughout the pandemic. The SARS-CoV-2 status of the hospital was classified as 'hot' or 'cold'. 'Hot' sites were hospitals with SARS-CoV-2 positive patients and no defined 'clean' pathway for surgery or peri-operative care. 'Cold' sites were defined as hospitals with no SARS-CoV-2 positive patients.

Dissemination of the survey was to consultants at each specialist pancreatic centre in the United Kingdom (UK) via the AUGIS/RCS(Eng) Specialty Surgical Lead for Pancreatic Cancer research network, personal contacts, and social media. The survey started as the number of SARS-CoV-2 cases in the UK greatly increased, the week after the UK government increased the national strategy from the 'contain' to 'delay' phase,[11] with weeks 1–2 from 16th-29th March 2020 with 2546 daily confirmed new cases,[12] repeating fortnightly until weeks 17–18 from 6th–19th July 2020 when the number of reported SARS-CoV-2 cases reduced to 827 daily confirmed new cases in the UK.[13]

## Results

### Baseline characteristics

All Twenty-nine specialist pancreatic centres in the UK responded. Prior to the pandemic, the median annual case volume per centre was 90 pancreatic resections per year (IQR: 60–120). Surgery followed by adjuvant chemotherapy was the standard pathway for resectable pancreatic cancer at 28/29 centres (96.6%) with the remaining centre offering neoadjuvant therapy. For borderline resectable PDAC with venous involvement standard treatment was surgery followed by adjuvant chemotherapy in 13/21 centres (n = 8 missing data), neoadjuvant chemotherapy followed by surgery in 6/21 centres, and neoadjuvant chemo-radiotherapy followed by surgery in 2/21 centres. 96.6% of centres (28/29) had patients being treated for SARS-CoV-2 at their institutions at the beginning of the study period.

### Diagnostic, staging and management of jaundice

Fig. 1 demonstrates the changing availability of routine diagnostic and staging investigations as well as interventions to treat jaundice between each centre during the pandemic. The ability of centres to undertake invasive procedures (EUS, ERCP, PTC or staging laparoscopy) was affected much more than cross sectional imaging (CT or CT-PET). Availability of CT returned to normal within 6 weeks and CT-PET by week 13. The ability to undertake PTC or ERCP returned to normal by week 11 or 18 respectively. At the final review, 22% and 11% of centres still had limited ability to undertake EUS and diagnostic laparoscopy respectively.

Furthermore, at the beginning of the pandemic capacity to run a normal Multi-Disciplinary Team (MDT) meeting service was reduced in 5/21 centres (missing n = 8), with one centre having suspended their MDT service. MDT provision returned to normal in all centres by weeks 13–15.

### Surgical and oncology capacity

Fig. 2 demonstrates that capacity for treatment of pancreatic cancer during the pandemic was drastically reduced across both surgical and oncology modalities. One fifth of centres had no capacity for pancreatic resectional surgery in the first 6 weeks of the pandemic (5/26 week 1–2; 5/28 week 5–6), with only half of the centres returning to normal surgical capacity by weeks 15–16 (11/22) (Fig. 2). Oncology service availability was similarly compromised, with a reduction in capacity for adjuvant therapy, neoadjuvant therapy, and palliative therapy. Chemotherapy services broadly were affected throughout the pandemic, recovering as the pandemic progressed. In the first two weeks there was a drastic reduction in the normal capacity to deliver chemotherapy, with palliative chemotherapy available at normal capacity in only one fifth of centres (5/22), adjuvant chemotherapy in 10 of 26 centres, and less than half of centres for neoadjuvant chemotherapy (12/26).

The reduction in reported surgical capacity was also demonstrated by a reduction in median number of pancreatic operations (resections and attempted resections) compared to the 2019 baseline figures (Fig. 3A). Over the whole period the median operative activity was −40% compared to the annual 2019 baseline, and was most severely affected during weeks 7–8 (median −60%, IQR -20% to −100%). Although there was a trend towards recovery, the impact on operating was not fully recovered nationally, with −16% operations at 17–18 weeks (IQR 30% to −56%). In 2019 the national median bypass rate was 6.9% (IQR 3.7–15.2%). During the pandemic there was a significant increase in the bypass rate to 29.2% (IQR 26.6–30.3%, p 0.0005) (Fig. 3B).

### Patient selection

In the initial phase of the pandemic (weeks 1–6) 96.2% of clinicians believed that the post-operative consequence of acquiring SARS-CoV-2 infection for their patients would be a higher mortality (25/26; missing n = 3), and all clinicians were

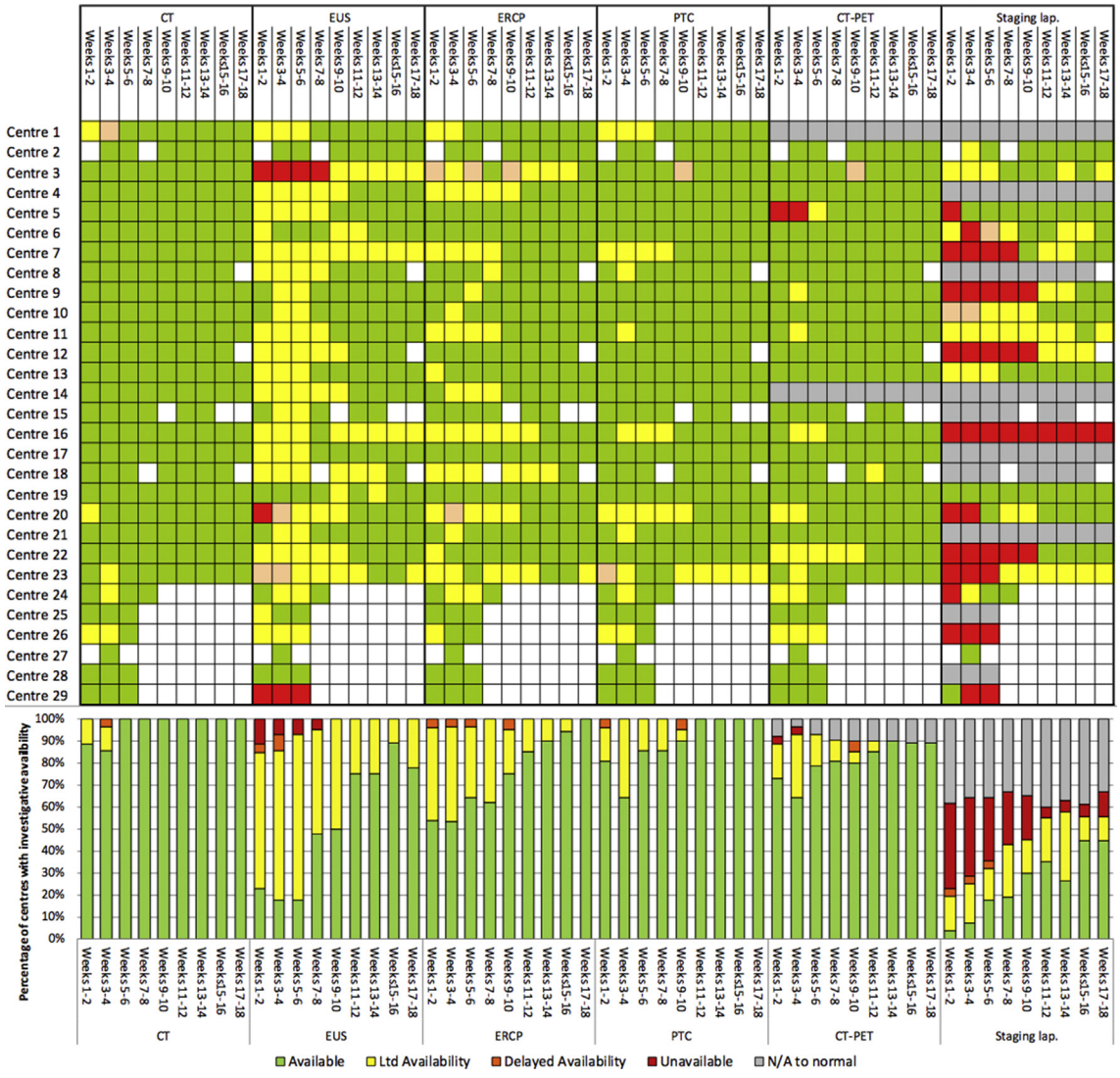


**Figure 1** Change in availability of diagnostic investigations and therapeutic interventions during SARS-CoV-2 pandemic per centre (EUS, endoscopic ultrasound; ERCP, endoscopic retrograde cholangiopancreatography; PTC, percutaneous transhepatic cholangiography; CT-PET, computer tomography positron emission tomography; Ltd availability, limited availability; N/A to normal pathway, not applicable to normal pathway)

discussing the uncertainty and potential risks associated with surgery during the pandemic with their patients.[14]

By using clinical vignettes, the survey demonstrated that within the constrained healthcare service surgery would be rationed based upon patient age and comorbidity (Fig. 4). Young patients (in the vignette, 40- and 63-years old) continued to enter curative pathways regardless of the pandemic. However, elderly patients (in the vignette an 82-years old) were initially much less likely to be offered curative treatment with only 44% of centres offering this. By the end of the study period this had improved close to 100%.

The presence of respiratory co-morbidity strongly affected the selection of patients to treatment (in the vignettes this was COPD). During the peak of the pandemic curative treatment would be offered at the majority of centres for young patients with COPD (93%), but one fifth wouldn't offer treatment to 63-year olds, and 91% of centres would not offer treatment to 82-year olds with COPD. By the end of the study this returned to pre-pandemic levels.

## Changes to treatment

Approximately one third of centres changed their treatment pathway for resectable and borderline resectable PDAC during the pandemic, as demonstrated in Fig. 5A and B. For resectable disease a surgery-first approach was changed to neoadjuvant therapy (chemotherapy or chemoradiotherapy) in a quarter of

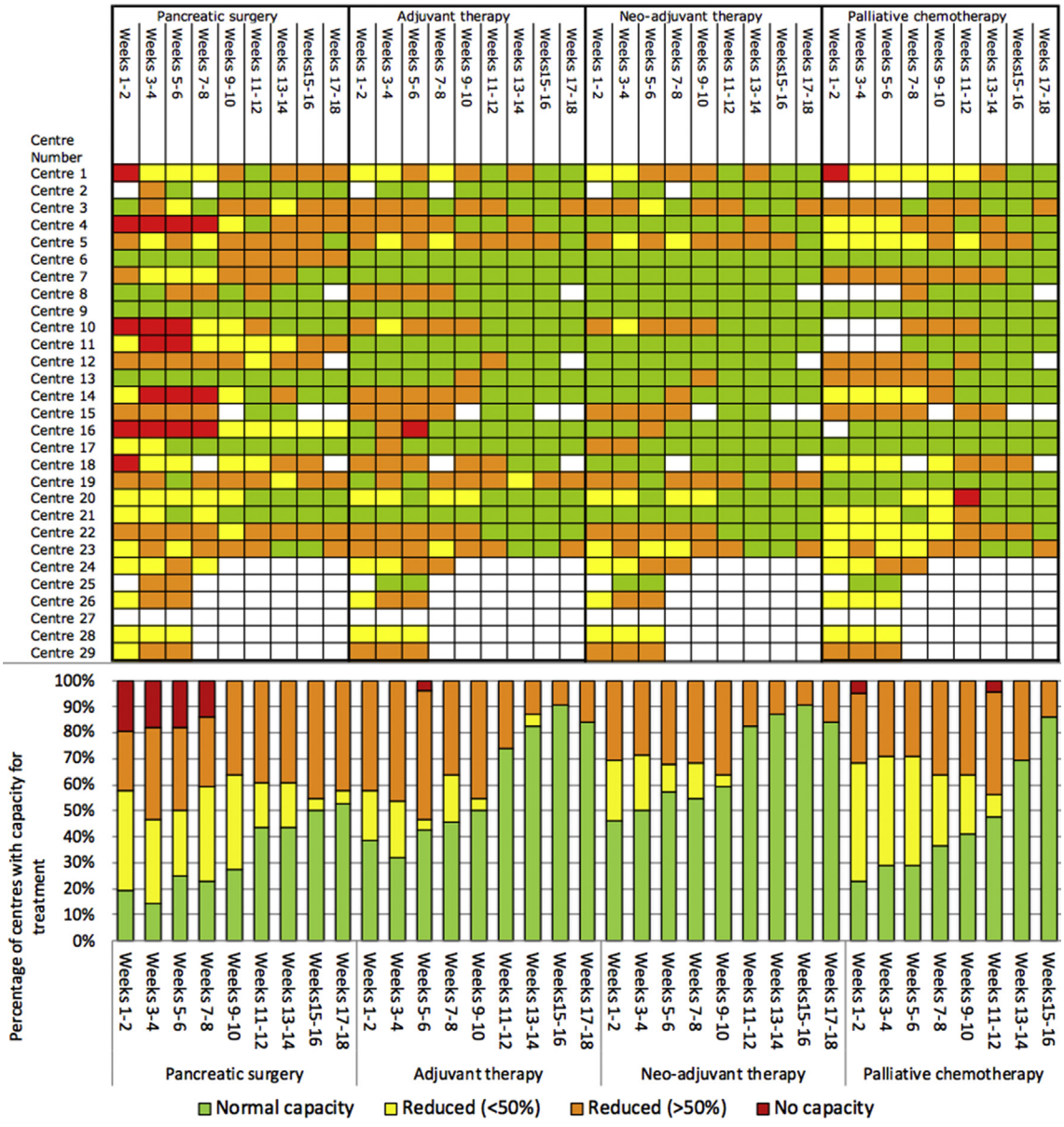


**Figure 2** Change in capacity for pancreatic cancer treatment during SARS-CoV-2 pandemic per centre

centres, returning back to the standard treatment pathway by weeks 11–12 (Fig. 5A). For borderline resectable PDAC with venous involvement one third of centres changed from a surgery-first approach to neoadjuvant therapy in week 3–4, trending toward a resumption of the standard pathway in the final 8 weeks of the study. The split between neoadjuvant chemotherapy and chemoradiotherapy was evenly offered nationally.

### Emerging strategies to treat pancreatic cancer during SARS-CoV-2 pandemic

There was a reduction in operating at 'hot' NHS sites throughout the pandemic, mirrored by an increase in operating at 'cold' NHS sites (Fig. 6). There was also a modest increase in the use of alternative clean sites for surgery during the pandemic, provided as a result of local service reorganisation, utilising dedicated cancer hubs, and the independent sector healthcare providers for operating. In addition, up to 45.5% centres were developing pathways to send post-operative patients directly to the ward, however this reduced to 15.5% of centres at the end of the study.

## Discussion

This study from UK specialist pancreatic centres, together with clinical vignettes, aimed to quantify the effect of the SARS-CoV-2 pandemic upon the delivery of treatment to patients with potentially resectable and borderline resectable pancreatic cancer

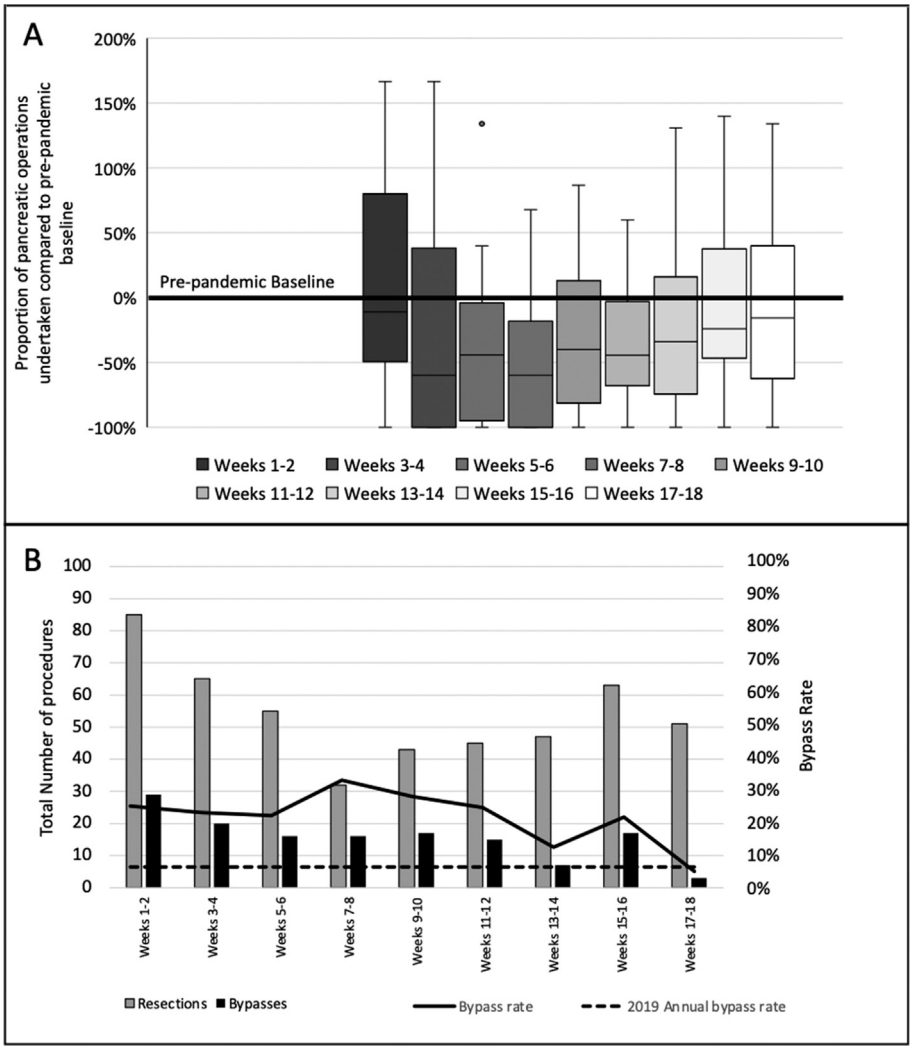


**Figure 3** **a-b: (a)** Box-plot demonstrating change in number of pancreatic resections from during SARS-CoV-2 pandemic per centre compared to pre-pandemic baseline. **(b)** National number of pancreatic resections, bypasses, and bypass rate nationally during SARS-CoV-2 pandemic

across the UK during the first phase of the pandemic. The main finding was a broad reduction in the ability to undertake diagnostic and staging investigations, with dramatic changes in treatment pathways, resulting in a reduction in the capacity for surgical and oncological treatments for pancreatic cancer. There was a marked reduction in the availability of endoscopic services. This is in line with national guidance released by the British Society of Gastroenterology advising that all endoscopy except emergency and essential procedures should stop immediately as it is an aerosol generating procedure with high risk of transmission of SARS-CoV-2.[15] Endoscopic diagnostic tests for malignancy were classified as requiring individual case-by-case assessment of risk associated with postponing the procedure in view of limited PPE provision available and risk of transmission to endoscopy staff, rather than being classified as an essential procedure.

There was an overall reduction in operated cases during the pandemic, and a reported reduced organisational capacity to undertake surgery. The reduction in operated cases is likely to be multifactorial, due to societal advice recommending risk stratification and neoadjuvant surgery, constraints on HDU and ITU availability due to the SARS-CoV-2 response, a reduction in 2 week-wait referrals from general practice, and reduced number of patients referred to regional MDT's from local MDT's. Throughout the pandemic the operative bypass rate was markedly higher than the pre-pandemic 2019 rate of 6.9%. This could represent patients with occult advanced stage of disease as a consequence of diagnostic delays due to reduced capacity for

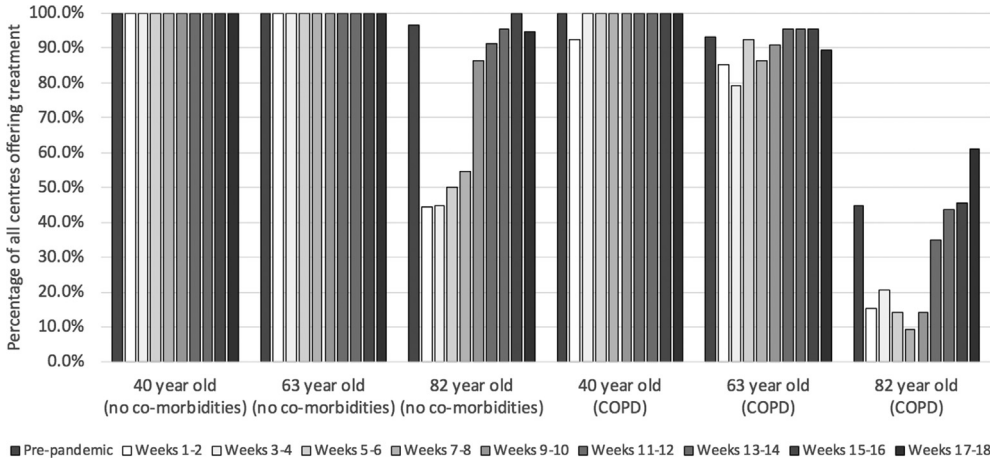


**Figure 4** Use of clinical vignettes to determine treatment variation during COVID pandemic: proportion of centres offering treatment for resectable pancreatic cancer stratified by age and COPD, prior to, and during the pandemic (COPD, chronic obstructive pulmonary disease)

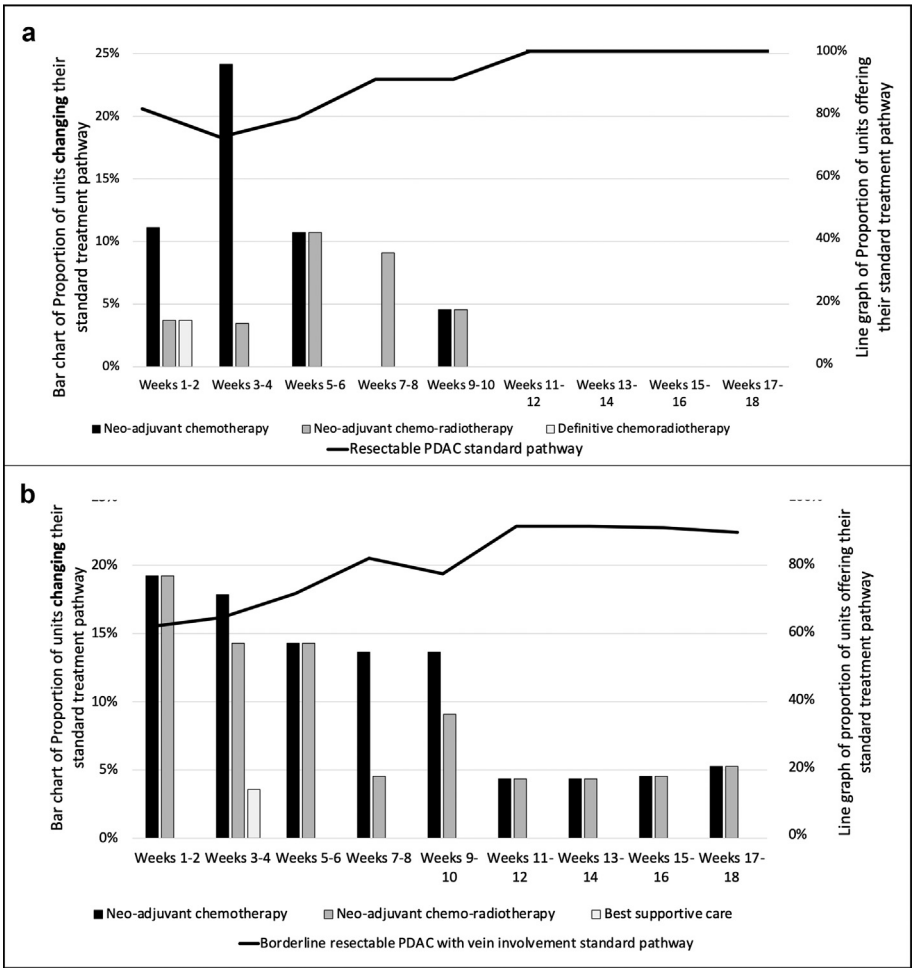


**Figure 5** **A-B:** Changes to standard treatment offered by centres for (A) resectable PDAC, (B) borderline resectable PDAC with vein involvement

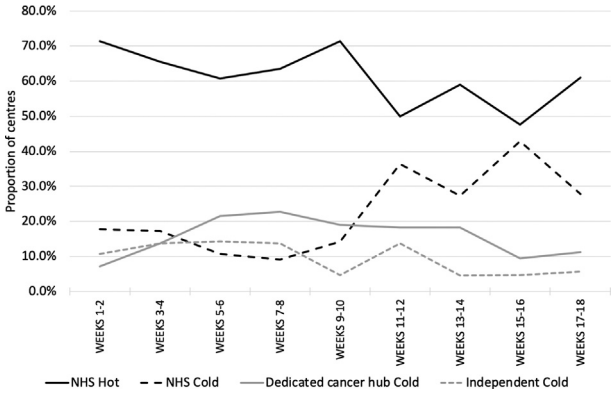


**Figure 6** COVID-status and type of centre pancreatic resections undertaken in during the SARS-CoV-2 pandemic

investigation, a risk with pathway delays in rapidly progressive tumour types such as pancreatic cancer, where even a few additional weeks can be catastrophic. However, with the effect being so early in the pandemic it is more likely to represent a more cautious surgical strategy at a time when HDU and ITU resources were scarce.

There was an increase in the use of alternative destinations to ITU for immediate post-operative care. This may represent a cohort of younger less co-morbid patients being risk stratified for elective surgery during the pandemic that did not require higher levels of care, or may represent a safe change in practice that the pandemic facilitated to be instituted. Alternatively, patients requiring more complex resections with vascular resection and reconstruction may have been avoided during the pandemic, reducing the requirement for level 3 (ITU) care. Given that there may be further exacerbations of SARS-CoV-2 within populations, and that ventilated patients require prolonged periods of care on ITU, it is reasonable to assume that capacity is unlikely to return completely to normal over the coming months, and risk stratification, and assessment of the safety of alternative peri-operative pathways will become increasingly important.

As teams look to reopen pathways, desire to offer treatment needs to be considered in the broader context of this public health crisis. Without an effective treatment or herd immunity, there is concern over possible exacerbations of SARS-CoV-2. Postoperative mortality rates appear very high among patients who contract SARS-CoV-2 in the perioperative period.[14] Thus, developing 'clean' sites for surgery is gaining worldwide appeal, and is a strategy being pursued by specialist pancreatic centres in the UK, as shown by this study.[16] However, it remains to be seen whether the full spectrum of surgery will be provided at these sites. Complex resections requiring vascular resection and reconstruction may not be well served by performing them away from large volume tertiary centres. The volume–outcome relationship in pancreatic surgery is clear; and careful audit of outcomes will be required when surgery is undertaken at both SARS-CoV-2 positive or clean sites.[17]

There is growing evidence to support neo-adjuvant chemotherapy in resectable PDAC, however the current standard of care remains a surgery first approach.[18–20] During the pandemic a third of centres changed their pathway from a surgery-first approach to neoadjuvant therapy, demonstrating the pragmatic treatment alterations required in response to the SARS-CoV-2 pandemic, in line with the practice identified from a global survey of pancreatic cancer management during the pandemic [10 21]. A move away from surgery-first treatment is multifactorial, to reduce the peri-operative risk to patients of SARS-CoV-2 infection and associated morbidity and mortality, and respond to the strain on HDU and ITU services. In centres where neoadjuvant treatments were being offered as standard for borderline resectable patients, the switch for resectable patients to neoadjuvant therapy was logistically simpler as established protocols could be followed. The accepted caveat is the risk of progression on treatment and missing the surgical window for resection, however, on balance may represent a lesser risk than potentially considerable unknown delays to the surgery-first pathway during the pandemic and uncertainty on perioperative risk. To counter this benefit, delaying surgery by using a neoadjuvant pathway may create further problems as when surgical capacity is largely restored, due to the large number of patients completing neoadjuvant treatment in addition to new presentations of patients with resectable disease who will require resections. Extra capacity will need to be found or there will be ongoing delays in access to surgery. Currently patients completing neoadjuvant treatments have a small, optimal surgical window after which surgery becomes considerably more challenging and hazardous. According to NHSE guidance these patients should be prioritised, but have a high need for ITU care particularly if vascular resections are required and so these patients may be delayed because of concerns regarding perioperative risk.[21] Extending the period of chemotherapy is one strategy to mitigate this, however this again defers surgery to a time when capacity is unlikely to be sufficient and so services need to look ahead to plan how to deliver the additional surgery required.

Patients undergoing pancreaticoduodenectomy have a higher than standard complication rate, with a need for HDU and ITU care to rescue patients. Undertaking such operations when HDU and ITU resources are under strain brings concern that there may be an increased rate of failure to rescue these elective patients due to resource constraints, and an organisation level strategy to prioritise less complex cases. Offering a neoadjuvant treatment pathway assumes that those patients will actually receive chemotherapy. However, there is concern from oncologists about SARS-CoV-2 infection among patients receiving chemotherapy.[22] There is a possibility that concern over the immunosuppressive effects of chemotherapy increasing risk from SARS-CoV-2 infection, will lead to patients being offered 'milder' regimens. Logistical priorities to reduce inpatient treatment regimens, and risk of SARS-CoV-2

exposure with inpatient treatment may lead to the administration of less effective therapy, and potential poorer long term outcome. Therefore, it is essential to monitor these patients to quantify both treatment delivery and the impact of SARS-CoV-2. It is possible that patients may receive no therapy or milder regimens than would normally be provided, with a considerable risk of tumour progression and becoming unresectable at re-staging, with a concern that the elderly population will be disproportionately affected, being classified to receive milder or no treatment, reflected in this survey.[23] Due to the aggressive tumour biology underlying pancreatic cancer, there is a high risk of progression without optimal treatment, with a shorter safe postponement period compared to other cancer types of only 3 weeks, and there is concern that a large cohort of pancreatic cancer patients may become unresectable, and be secondary casualties of the SARS-CoV-2 pandemic.[24]

This is a study of treatment pathways and service availability, however the clinical outcomes associated with these changes are presently unclear. Prospective patient-level data collection is required to fully map the changes to treatment, and the short- and long-term outcomes. Data from registries such as CovidSurg-Cancer (https://globalsurg.org/covidsurg/) will define the impact of this pandemic upon cancer patients, and will provide evidence to guide care and service reorganisation should a second surge of the pandemic occur.

## Conclusions and recommendations

The COVID-19 pandemic has affected the capacity of the NHS to provide diagnostic and staging investigations for pancreatic cancer. The impact of revised treatment pathways has yet to be realised, but the majority of centres have reported a reduction in the number of patients being treated by standard pathways for pancreatic cancer, and elderly and co-morbid patients being less likely to be offered treatment.

It is vital that we learn from the experience of service constraints and treatment pathway changes during the pandemic, to enable proactive service planning for a second surge, or high-incidence local breakouts. It should not be acceptable to deny patients treatment based on age and co-morbidity, however this may be challenging to achieve if services are stretched and both surgical on oncology resources are limited. If clean pathways to surgery with appropriate screening can be developed, and move to operating within clean sites, or within dedicated clean pathways within 'hot' sites, there may be more capacity for surgical treatment. Thorough audit of the safety of using direct to ward pathways post-surgery as utilised during the pandemic is necessary, to assess if this strategy can continue to be utilised moving forwards, reducing the burden on HDU and ICU capacity should a second surge occur. The use of HDU and ICU beds will remain necessary for patients requiring complex resections and for those with major co-morbidity, and these patients should not be denied treatment, but treated within COVID-free environments to reduce the risk of peri-operative SARS-CoV-2 associated morbidity and mortality.

### Acknowledgments

We would like to thank the Association of Upper Gastrointestinal Surgery (AUGIS), the Royal College of Surgeons of England (RCS Eng), the Pancreatic Society of Great Britain and Ireland (PSGBI), and Pancreatic Cancer UK (PCUK) for their help. We also thank the Birmingham Surgical Trials Consortium (BiSTC) for their assistance with administration of the surveys.

### Funding

This research received no external funding.

### Conflicts of interest

None declared.

### References

1. WHO. (2020) *WHO director general's opening remarks at the media briefing on COVID-19 11th March 2020*. Available from: https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—-11-march-2020. [Accessed 29 April 2020].
2. Organisation WH. (2020) *WHO Coronavirus disease 2019 (COVID-19) situation report – 52*. 2020. Available from: https://www.who.int/docs/default-source/coronaviruse/20200312-sitrep-52-covid-19.pdf?sfvrsn=e2bfc9c0_2. [Accessed 29 March 2020].
3. Qiu H, Tong Z, Ma P, Hu H, Peng Z, Wu W *et al*. (2020) Intensive care during the coronavirus epidemic. *Intensive Care Med* 46:576–578. https://doi.org/10.1007/s00134-020-05966-y [published Online First: 2020/02/23].
4. Neil M, Ferguson DL, Gemma Nedjati-Gilani, Natsuko Imai, Kylie Ainslie, Marc Baguelin *et al*. (2020) *Report 9: impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand*. London: Imperial College.
5. Association of Upper Gastrointestinal Surgery of Great Britain and Ireland. (2020) *Statement from AUGIS re Hepatobiliary and Pancreas cancer*.
6. COVIDSurg Collaborative. (2020) Global guidance for surgical care during the COVID-19 pandemic. *Br J Surg*. https://doi.org/10.1002/bjs.11646 [published Online First: 2020/04/16].
7. Zangrillo A, Beretta L, Silvani P, Colombo S, Scandroglio AM, Dell'Acqua A *et al*. (2020) Fast reshaping of intensive care unit facilities in a large metropolitan hospital in Milan, Italy: facing the COVID-19 pandemic emergency. *Crit Care Resusc* 22:91–94 [published Online First: 2020/04/02].
8. Lukács G, Kovács A, Csanádi M, Moizs M, Repa I, Kaló Z *et al*. (2019) Benefits of timely care In Pancreatic Cancer: A systematic review to navigate through the contradictory evidence. *Canc Manag Res*, vol. 11:9849–9861. https://doi.org/10.2147/CMAR.S221427 [published Online First: 2019/12/11].
9. Internsive Care Society. (2009) *Levels of critical care for adult patients*.
10. Oba A, Stoop TF, Löhr M, Hackert T, Zyromski N, Nealon WH *et al*. (2020) Global survey on pancreatic surgery during the COVID-19 pandemic. *Ann Surg* 272:e87–e93. https://doi.org/10.1097/SLA.0000000000004006 [published Online First: 2020/07/18].
11. Press release. (2020) *Government announces further measures on social distancing. Released 20/02/2020*. 2020. Available from: https://

www.gov.uk/government/news/government-announces-further-measures-on-social-distancing. [Accessed 29 March 2020].
12. WHO. (2020) *WHO coronavirus disease 2019 (COVID-19) situation report – 69*. 2020. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200329-sitrep-69-covid-19.pdf?sfvrsn=8d6620fa_8. [Accessed 9 August 2020].
13. WHO. (2020) *WHO coronavirus disease (COVID-19) situation report – 181*. 2020. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200719-covid-19-sitrep-181.pdf?sfvrsn=82352496_2. [Accessed 9 August 2020].
14. Lei S, Jiang F, Su W, Chen C, Chen J, Mei W *et al*. (2020) Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. *EClinicalMedicine*, 100331. https://doi.org/10.1016/j.eclinm.2020.100331 [published Online First: 2020/04/16].
15. BSG. (2020) *GI endoscopy activity and COVID-19: next steps*, p. 2020.
16. Abu Hilal M, Besselink MG, Lemmers DHL, Taylor MA, Triboldi A. (2020) Early look at the future of healthcare during the COVID-19 pandemic. *Br J Surg* 107:e197. https://doi.org/10.1002/bjs.11666 [published Online First: 2020/05/10].
17. Liu Z, Peneva IS, Evison F, Sahdra S, Mirza DF, Charnley RM *et al*. (2018) Ninety day mortality following pancreatoduodenectomy in England: has the optimum centre volume been identified? *HPB* 20: 1012–1020. https://doi.org/10.1016/j.hpb.2018.04.008 [published Online First: 2018/06/14].
18. NICE. (2018) *NICE guideline [NG85]: pancreatic cancer in adults: diagnosis and management*. 2018. Available from: https://www.nice.org.uk/guidance/ng85. [Accessed 29 April 2020].
19. Versteijne E, Suker M, Groothuis K, Akkermans-Vogelaar JM, Besselink MG, Bonsing BA *et al*. (2020) Preoperative chemoradiotherapy versus immediate surgery for resectable and borderline resectable pancreatic cancer: results of the Dutch randomized phase III PREOPANC trial. *J Clin Oncol* 38:1763–1773. https://doi.org/10.1200/JCO.19.02274 [published Online First: 2020/02/28].
20. Paula Ghaneh DHP, Cicconi Silvia, Halloran Christopher, Psarelli Eftychia Eirini, Rawcliffe Charlotte Louise, Sripadam Rajaram *et al*. (2020) ESPAC-5F: four-arm, prospective, multicenter, international randomized phase II trial of immediate surgery compared with neoadjuvant gemcitabine plus capecitabine (GEMCAP) or FOLFIRINOX or chemoradiotherapy (CRT) in patients with borderline resectable pancreatic cancer. *J Clin Oncol* 38:4505. https://doi.org/10.1200/JCO.2020.38.15_suppl.4505.
21. NHSE. (2020) *Clinical guide for the management of non- coronavirus patients requiring acute treatment: cancer*. 2020. Available from: https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/specialty-guide-acute-treatment-cancer-23-march-2020.pdf. [Accessed 29 April 2020].
22. Patel R, Saif MW. (2020) Management of pancreatic cancer during COVID-19 pandemic: to treat or not to treat? *JOP* 21:27–28 [published Online First: 2020/05/08].
23. Farrell TW, Francis L, Brown T, Ferrante LE, Widera E, Rhodes R *et al*. (2020) Rationing limited healthcare resources in the COVID-19 era and beyond: ethical considerations regarding older adults. *J Am Geriatr Soc* 68:1143–1149. https://doi.org/10.1111/jgs.16539 [published Online First: 2020/05/07].
24. Turaga KK, Girotra S. (2020) Are we harming cancer patients by delaying their cancer surgery during the COVID-19 pandemic? *Ann Surg*. https://doi.org/10.1097/SLA.0000000000003967 [published Online First: 2020/06/04].

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.hpb.2021.03.003.