A Best Practice Guideline for Backlog Modelling to Inform Policy Decisions During a Pandemic and Beyond

Conflicts of interest:

- Moderator / Karin Cerri: KC is a full-time employee of Johnson and Johnson Medical
- Speaker 1 / James Kinross: JK reports grants from H2020—ITN grant, grants from NIHR—i4i grant, grants from CRUK fellowship and grants from J+J Educational grant, personal fees from Verb Robotics/Ethicon(Johnson and Johnson Medical) and Medtronic, outside the submitted work, and others from Cerulean Health, OneWelbeck and LNC Therapeutics.
- Speaker 2 / Jonathan Clarke: JC reports no conflicts.
- Speaker 3 / Alexander Carter: AC reports no conflicts.
- This research project was funded by Johnson and Johnson Medical. Speakers ISPOR EU 2021 registration fees were covered by Johnson and Johnson Medical. **Slides including a "*" illustrate Johnson and Johnson Medical funded research project, other slides are representing speaker experience and opinion.**

A Best Practice Guideline for Backlog Modelling to Inform Policy Decisions During a Pandemic and Beyond

Affiliations:

- Moderator / **Karin Cerri, PhD**: Head, Health Economics and Market Access EMEA, Johnson and Johnson Medical, Diegem, Belgium
- Speaker 1 / **James Kinross, Sc(Hons), MBBS, PhD, FRCS(Gen):** Senior lecturer in colorectal surgery and consultant surgeon Division of Surgery, Department of Surgery and cancer, Faculty of Medicine, Imperial College London, London, UK
- Speaker 2 / **Jonathan Clarke, MA(Cantab), MB, BChir, MRCS(Eng), MPH, PhD, FRSA** : Postdoctoral Fellow, Department of Mathematics, Imperial College London, London, UK
- Speaker 3 / **Alexander Carter, BSc(Hons), MSc:** Senior lecturer, Department of Health Policy, London School of Economics & Political Science, London, UK

Poll Question

What is your job?

Introduction *

As of August 31, 2021, the World Health Organization (WHO) declared over 215 million confirmed cases of COVID-19 and approximately 4.5 million deaths globally[1]

Modelling estimations predicted that 28 million medical operations would be cancelled globally over 12-week peak disruption caused by COVID-19[2]

Policy strategy[3]

1) increase supply
2) reduce demand
3) provide regional/national strategies

Supply constraints during the pandemic raised important questions about the use of capacity modelling to inform policy:

- As with cost-effectiveness modelling, should capacity modelling address trade-offs between resources/costs and outcomes?
- What is the quality of published capacity models, and how do they fare against modelling-based checklists and guidance documents?

ISPOR objectives *

Objectives

The panel will answer these questions in four steps

- Assess the backlog in elective surgery due to COVID19 and its impact on patients and healthcare systems,
- Review existing policies and outcomes of efforts to resolve hospital backlogs,
- Summarize methods and results from published capacity (backlog) models, and
- Recommend approaches to improving the quality of capacity models for policy shaping.

Poll Question

Should cancer be automatically prioritised over chronic surgical disease when managing the elective backlog?

The impact of COVID on hospital backlog *

Reallocation of resources to treat patients severely affected by COVID 19, including deprioritization of non-urgent care and provision of "essential services", created a backlog in cases across multiple specialty areas.

Colorectal cancer

Upper gastrointestinal cancer and benign disease

Total hip and knee arthroplasty

Obesity Surgery (2021) 31:1745–1754
https://doi.org/10.1007/s11695-020-04919-0

REVIEW

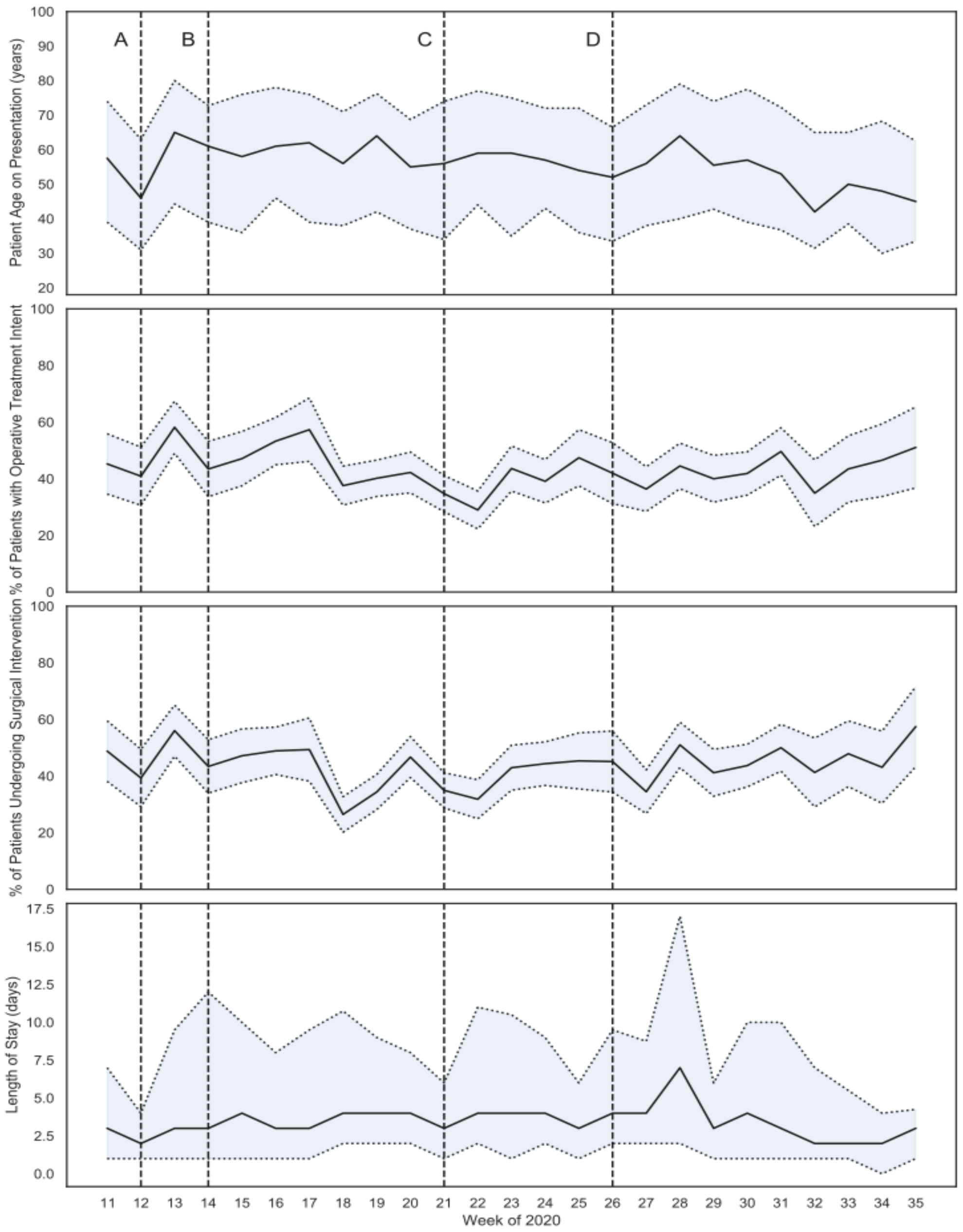
SARS-CoV-2 and Obesity: "CoVesity"—a Pandemic Within a Pandemic

Kimberley Zakka[1] · Swathikan Chidambaram[2] · Sami Mansour[3] · Kamal Mahawar[4] · Paulina Salminen[5] · Ramos Almino[6] · Philip Schauer[7] · James Kinross[3] · Sanjay Purkayastha[3] · on behalf of the PanSurg Collaborative

Received: 25 June 2020 / Revised: 9 August 2020 / Accepted: 11 August 2020 / Published online: 22 January 2021

Surgical outcomes during COVID

- **The first surge was associated with significantly higher in-hospital mortality (IHM) for all emergency surgical patients**
- Overall **IHM was 3·6% and was not significantly increased by surgical intervention (p=0·11).**
- **Higher Clinical Frailty Scale (CFS >7 aOR 30·83, CI 7·56-125·76)** greatest predictor of IHM.



Annals of Surgery • Volume 274, Number 6, December 2021

PanSurg PREDICT

- 5300 patients
- 54 global institutions
- 24 countries

The impact of COVID on hospital backlog *

Colorectal cancer

- **Diagnostic services** (initial months of the pandemic): **48% to 72% decrease** in new cancer diagnoses in 2020[5,6,7].
- **Care pathways** disruption: **486,563 surgeries cancelled over 12 weeks** in 2020 representing **35.9%** of the global overall surgical volume[2] (modelling).

- **4-month treatment delay: survival reduction of ≥20% for Stage 3 patients**, regardless of age[9];
- **Some localities reported the following implications on the need for emergency interventions**:
  - 2020 vs 2019 : **twice as many** patients with large bowel obstructions, increasing the need for emergency surgeries[5];
  - **emergency operations:** higher rates of complications and postoperative morbidity and mortality than in the **elective setting.**[5,10]

Predicting endoscopic activity recovery in England after COVID-19: a national analysis

Kai Man Alexander Ho, Amitava Banerjee, Mark Lawler, Matthew D Rutter, Laurence B Lovat

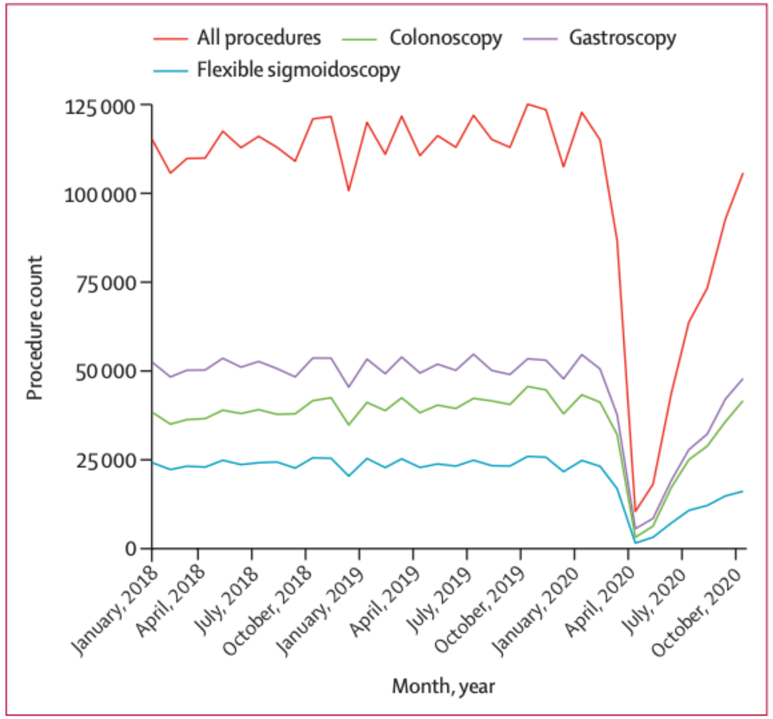


Figure 2: Trends in number of endoscopy procedures from January, 2018, to October, 2020

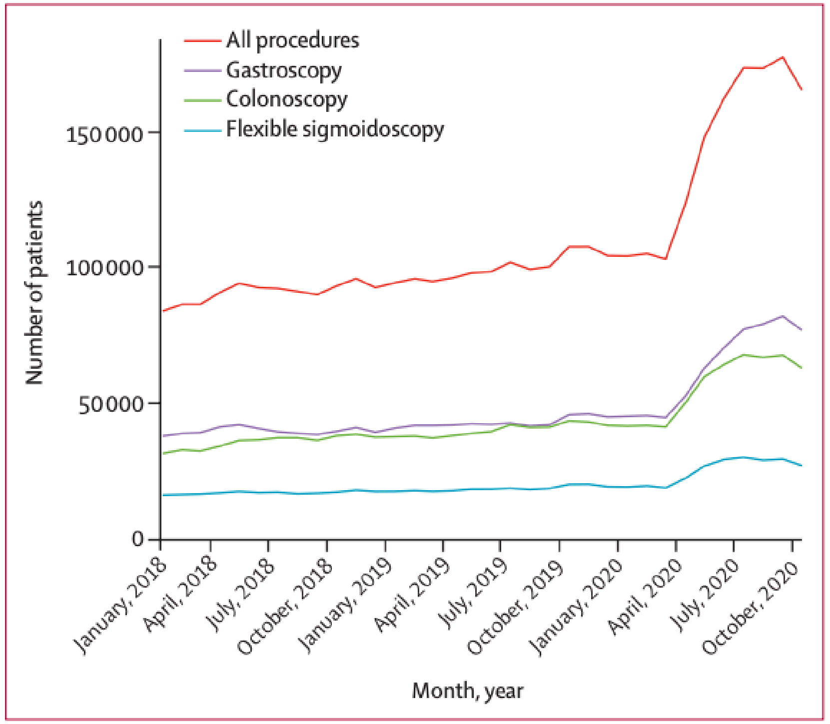
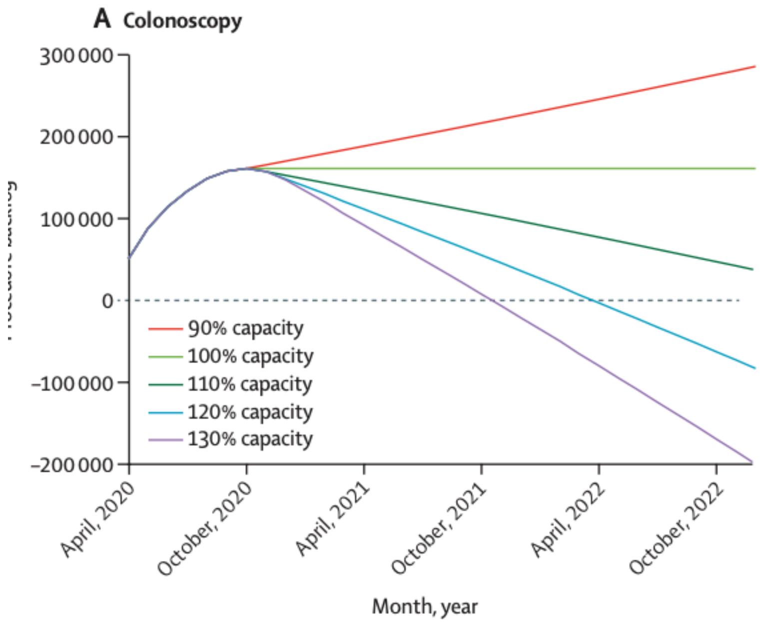


Figure 3: Number of patients on procedure waiting lists at the end of the month from January, 2018, to October, 2020



Backlog

	January, 2021	January, 2022	January, 2023
90%	176 387 (156 522 to 196 251)	233 239 (208 668 to 257 809)	293 682 (262 641 to 324 723)
100%	162 735 (143 775 to 181 695)	162 735 (143 775 to 181 695)	162 735 (143 775 to 181 695)
110%	149 736 (132 568 to 166 904)	92 884 (80 422 to 105 347)	32 441 (26 450 to 38 433)
120%	140 610 (124 057 to 157 163)	26 906 (19 764 to 34 048)	Backlog cleared
130%	134 880 (119 927 to 149 833)	Backlog cleared	Backlog cleared

Lancet Gastroenterol Hepatol
2021; 6: 381–90

Global Change in Elective Colorectal Cancer Practice due to COVID-19

Mason SE, ***PLoS One.*** 2020;15(10):e0240397

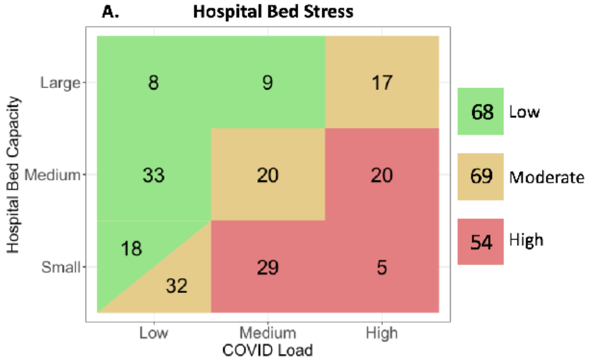

Global Reach

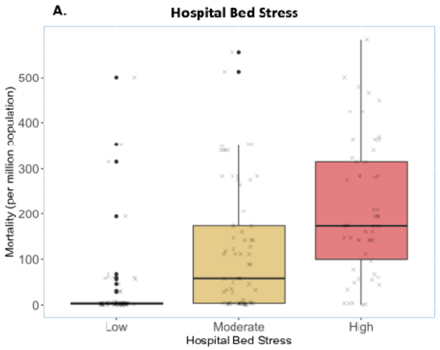
191
surgeons

159
hospitals

46
countries

High Bed Stress Associated with National Mortality

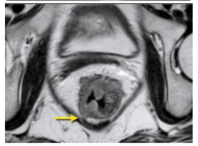




Diagnostics Change

74% Limited
19% Stopped

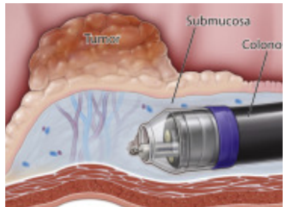
40% Limited



41% Limited

Non-Surgical Rx

Increased use of rectal CRT when resections cease or extended delay to surgery



52% Limited
19% Stopped

Surgical Technique

7% of centers ceased operating

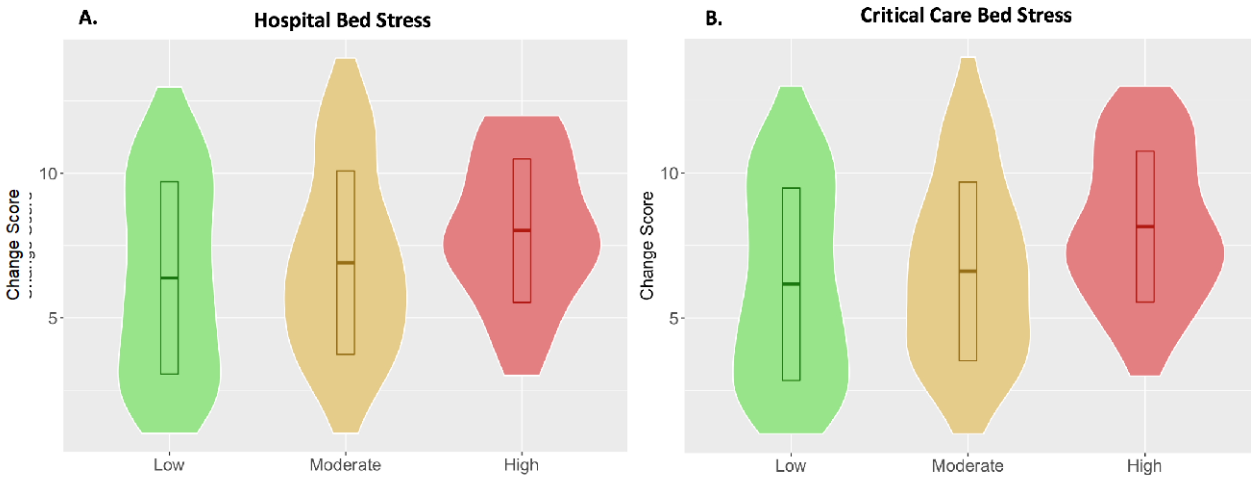
29% Decreased
19% Stopped

54% Increase
on left side

Global Change in Elective Colorectal Cancer Practice due to COVID-19

Mason SE, ***PLoS One.*** 2020;15(10):e0240397

Predictors of Practice Change



Degree of practice change significantly associated with increasing hospital and critical care bed stresses

Low stress hospitals still markedly limiting services, with rising critical care stress the biggest risk factor for complete service cessation

Hospital or critical care bed stresses, mortality and national guidelines unable to fully account for variation

Change Score Domains

Diagnostic endoscopy
CT
MRI
PET
Therapeutic endoscopy
Rectal NeoAdj Rx
Colon NeoAdj Rx
Surgical delays
Operator seniority
Laparoscopy use
Stoma formation rates

The impact of COVID on hospital backlog *

Upper gastrointestinal cancer

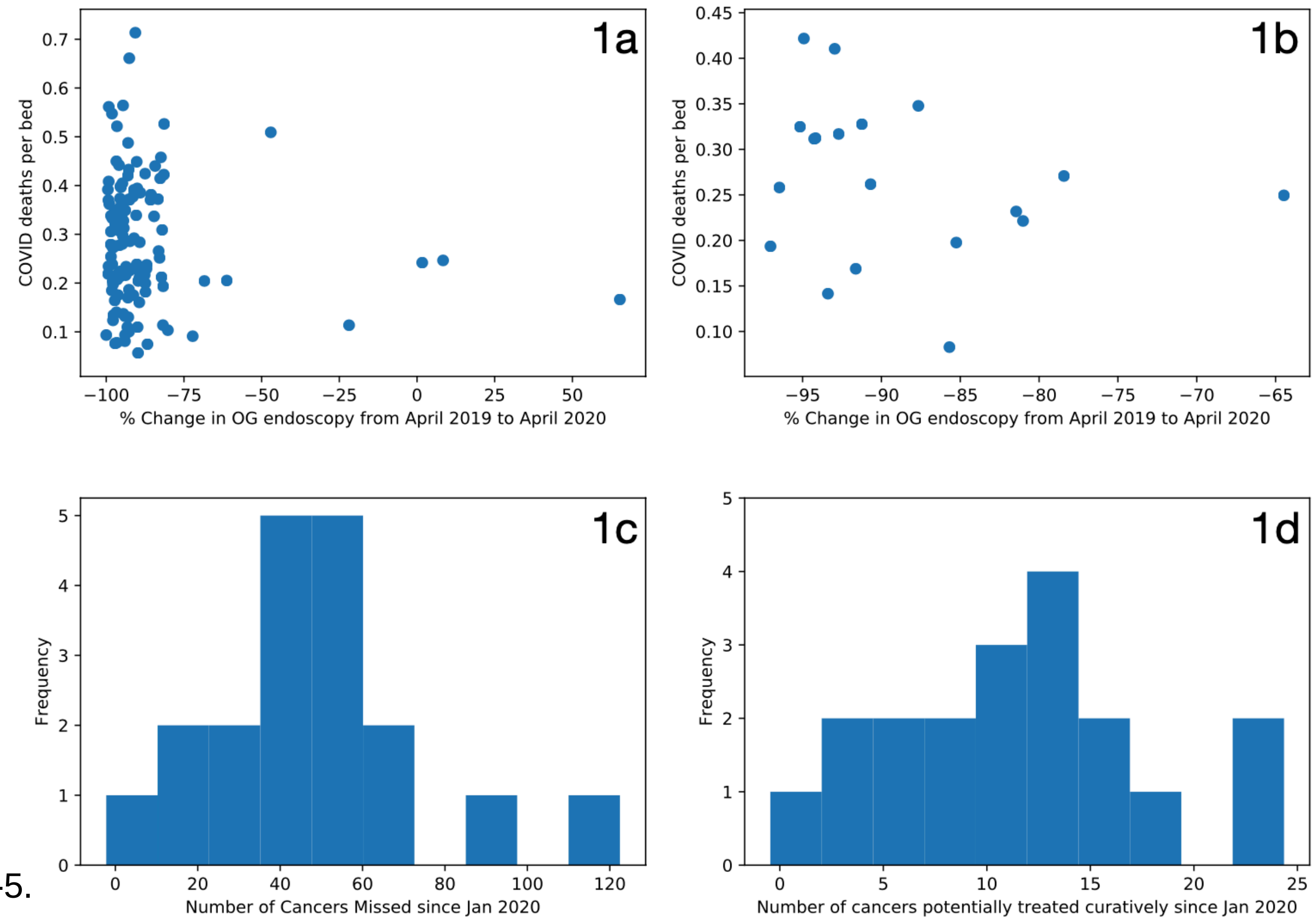
- 394 fewer new cancers were detected per week in the UK[8]**,** representing **52% increase in missed** cases[7];
- **Canceled surgeries** globally over 12 weeks **: 498,885, representing 39.6% of the overall surgical volume**[2] (modelling)
- **Diagnostic endoscopies** decreased by 28% during the initial COVID-19 outbreak in England and reached a low of 20% of prior year volume.[33]

There is mixed evidence on whether **time** to surgery **impacts overall survival or disease-free survival** in patients with early or advanced stages of **gastric cancer** [11, 34].

Global Change in endoscopic cancer diagnostics during COVID-19 in England

- Nationally – OGD activity fell by 88.7% in April 2020.
- (49877 vs 5638 in April 2019).

- 750 oesophageal and gastric cancers undiagnosed across England between Jan and April 2020
- Of these 213 would have been treated curatively



Markar SR, Lancet Gastroenterol Hepatol. 2020;5(9):804-5.

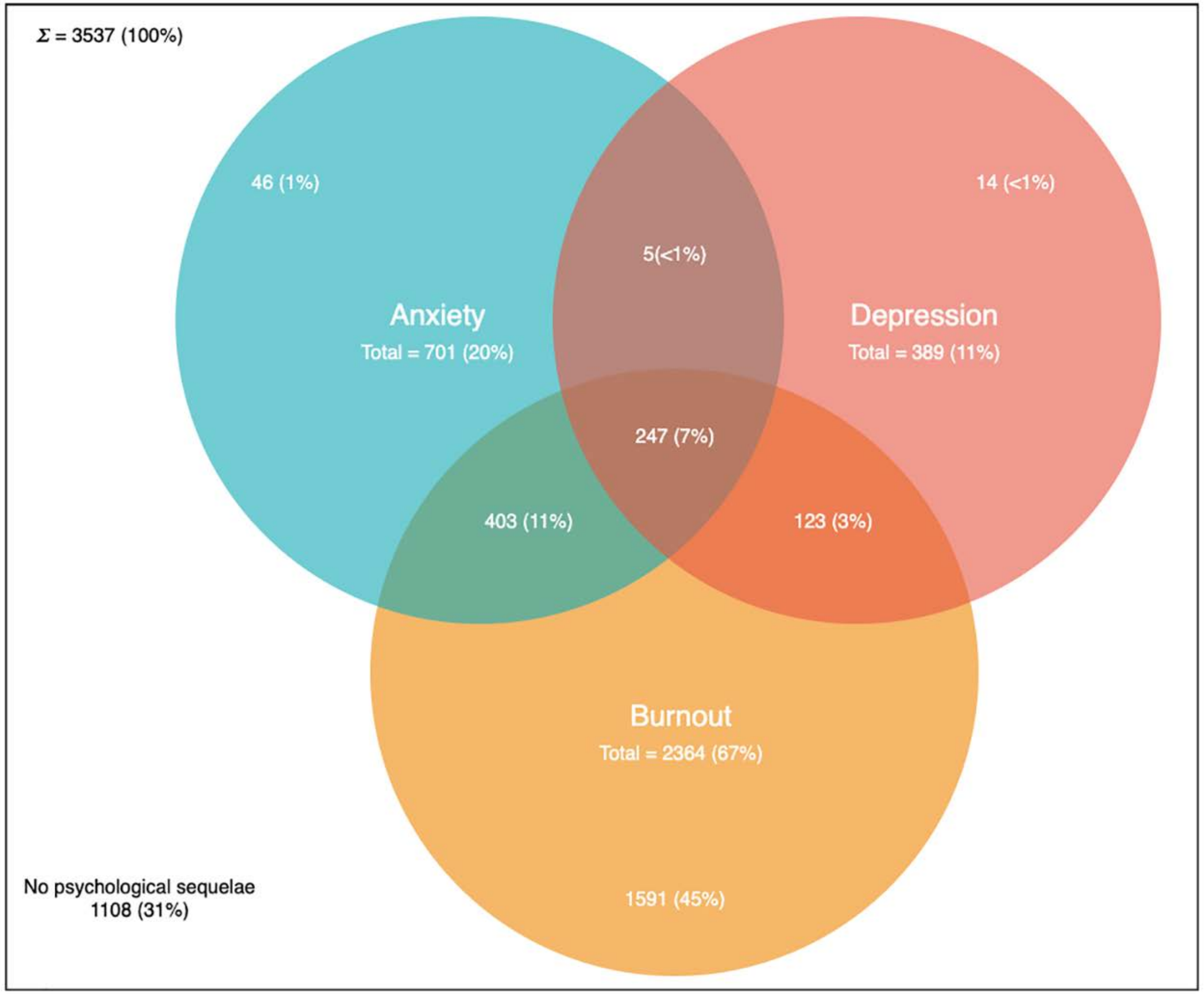
The impact of COVID on hospital backlog *

Total hip and knee arthroplasty

- Patients **awaiting surgery**: **885,286 to 1,028,733** in England as of November 2020[12].
- Global cancellation of **elective orthopedic surgeries**: **at least 6 million** during the 12 weeks, representing **82%** of the standard surgical volume[2].

Reports in the literature suggested that delayed surgery may:

- Prolong and intensify **pain**[13];
- Induce higher **morbidity** and **mortality** rates for **hip** surgery[13] ;
- Induce **muscle wasting** from decreased mobility and increase **pain** for **knee** surgery [13,24];
- Increase **anxiety** and **emotional distress**[15]**.**



Determinants of burnout and other aspects of psychological well-being in healthcare workers during the Covid-19 pandemic: A multinational cross-sectional study

Max Denning, Ee Teng Goh, Benjamin Tan, Abhiram Kanneganti, Melanie Almonte, Alasdair Scott, Guy Martin, Jonathan Clarke, Viknesh Sounderajah, Sheraz Markar, Jan Przybylowicz, Yiong Huak Chan, Ching-Hui Sia, [...], James Kinross [view all]

Published: April 16, 2021 • https://doi.org/10.1371/journal.pone.0238666

Significant predictors of burnout:
- Patient-facing roles
- Redeployment
- Bottom quartile SAQ score
- Anxiety and depression.

Significant factors inversely correlated with burnout included:
- Tested for SARS-CoV-2
- Top quartile SAQ score

93,000 NHS vacancies

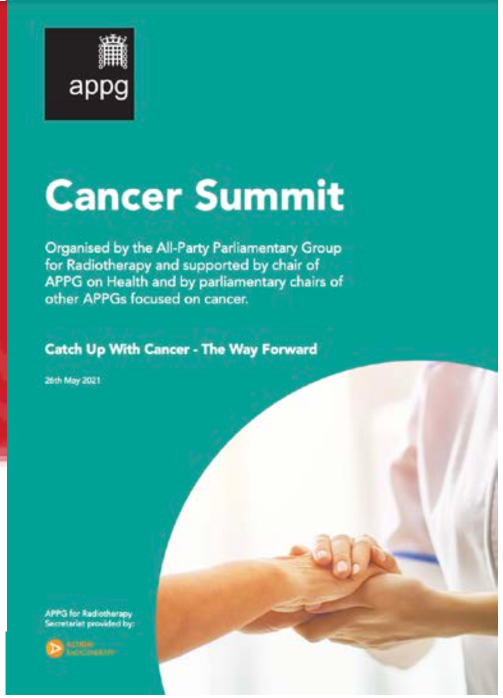

PanSurg: The COVID-19 Aftershock Report

PanSurg

The PanSurg Collaborative

Imperial College London

In proud partnership with: Johnson&Johnson MEDICAL DEVICES COMPANIES


appg

Cancer Summit

Organised by the All-Party Parliamentary Group for Radiotherapy and supported by chair of APPG on Health and by parliamentary chairs of other APPGs focused on cancer.

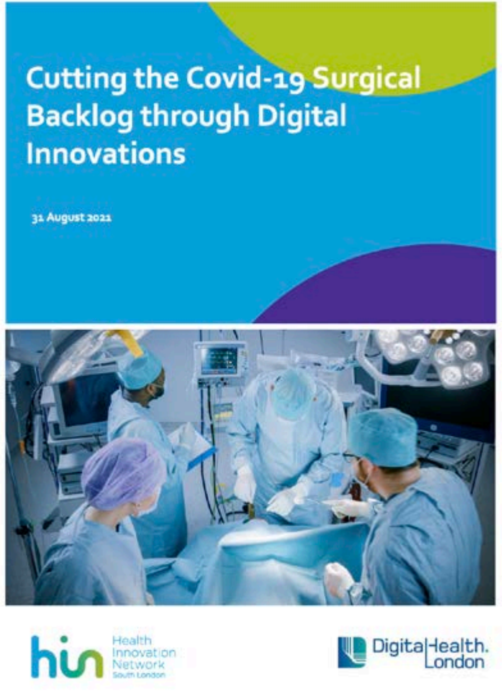
Catch Up With Cancer - The Way Forward

26th May 2021

APPG for Radiotherapy Secretariat provided by:


Royal College of Surgeons of England

A NEW DEAL FOR SURGERY


Cutting the Covid-19 Surgical Backlog through Digital Innovations

31 August 2021

Health Innovation Network South London

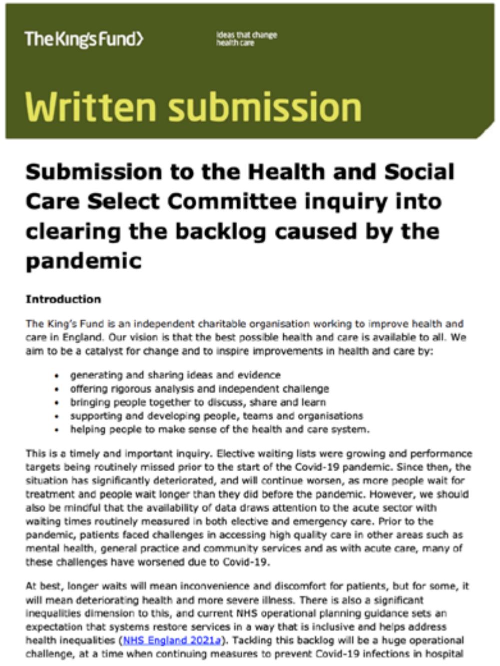
DigitalHealth.London


Future COVID-19 Surgical Pathways

PanSurg

"The strategy has been to prioritise patients with COVID-19 over non-COVID patients and this may not have been the best call"

Mr. Mike Farrar


The King's Fund>

Ideas that change health care

Written submission

Submission to the Health and Social Care Select Committee inquiry into clearing the backlog caused by the pandemic

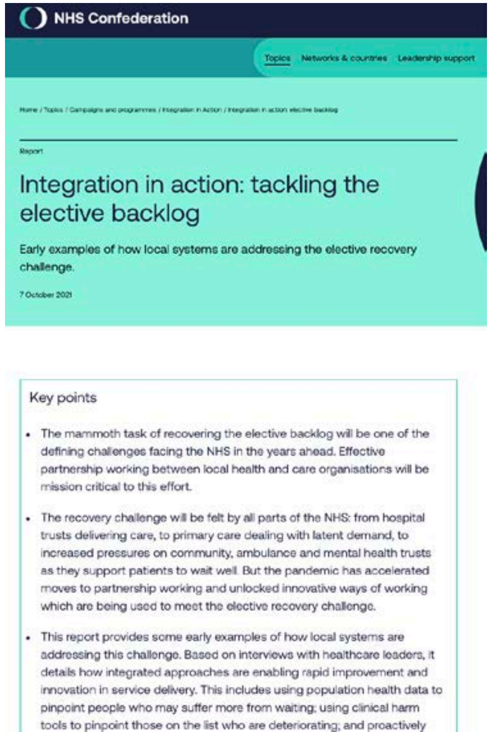
Introduction

The King's Fund is an independent charitable organisation working to improve health and care in England. Our vision is that the best possible health and care is available to all. We aim to be a catalyst for change and to inspire improvements in health and care by:

- generating and sharing ideas and evidence
- offering rigorous analysis and independent challenge
- bringing people together to discuss, share and learn
- supporting and developing people, teams and organisations
- helping people to make sense of the health and care system.

This is a timely and important inquiry. Elective waiting lists were growing and performance targets being routinely missed prior to the start of the Covid-19 pandemic. Since then, the situation has significantly deteriorated, and will continue worsen, as more people wait for treatment and people wait longer than they did before the pandemic. However, we should also be mindful that the availability of data draws attention to the acute sector with waiting times routinely measured in both elective and emergency care. Prior to the pandemic, patients faced challenges in accessing high quality care in other areas such as mental health, general practice and community services and as with acute care, many of these challenges have worsened due to Covid-19.

At best, longer waits will mean inconvenience and discomfort for patients, but for some, it will mean deteriorating health and more severe illness. There is also a significant inequalities dimension to this, and current NHS operational planning guidance sets an expectation that systems restore services in a way that is inclusive and helps address health inequalities (NHS England 2021a). Tackling this backlog will be a huge operational challenge, at a time when continuing measures to prevent Covid-19 infections in hospital


NHS Confederation

Topics Networks & countries Leadership support

Home / Topics / Campaigns and programmes / Integration in Action / Integration in action elective backlog

Report

Integration in action: tackling the elective backlog

Early examples of how local systems are addressing the elective recovery challenge.

7 October 2021

Key points

- The mammoth task of recovering the elective backlog will be one of the defining challenges facing the NHS in the years ahead. Effective partnership working between local health and care organisations will be mission critical to this effort.
- The recovery challenge will be felt by all parts of the NHS: from hospital trusts delivering care, to primary care dealing with latent demand, to increased pressures on community, ambulance and mental health trusts as they support patients to wait well. But the pandemic has accelerated moves to partnership working and unlocked innovative ways of working which are being used to meet the elective recovery challenge.
- This report provides some early examples of how local systems are addressing this challenge. Based on interviews with healthcare leaders, it details how integrated approaches are enabling rapid improvement and innovation in service delivery. This includes using population health data to pinpoint people who may suffer more from waiting; using clinical harm tools to pinpoint those on the list who are deteriorating; and proactively


Institute for Public Policy Research

IPPR

BUILDING BACK CANCER SERVICES IN ENGLAND

Parth Patel and Chris Thomas

September 2021

The progressive policy think tank

DIAGNOSTICS: RECOVERY AND RENEWAL

Report of the Independent Review of Diagnostic Services for NHS England

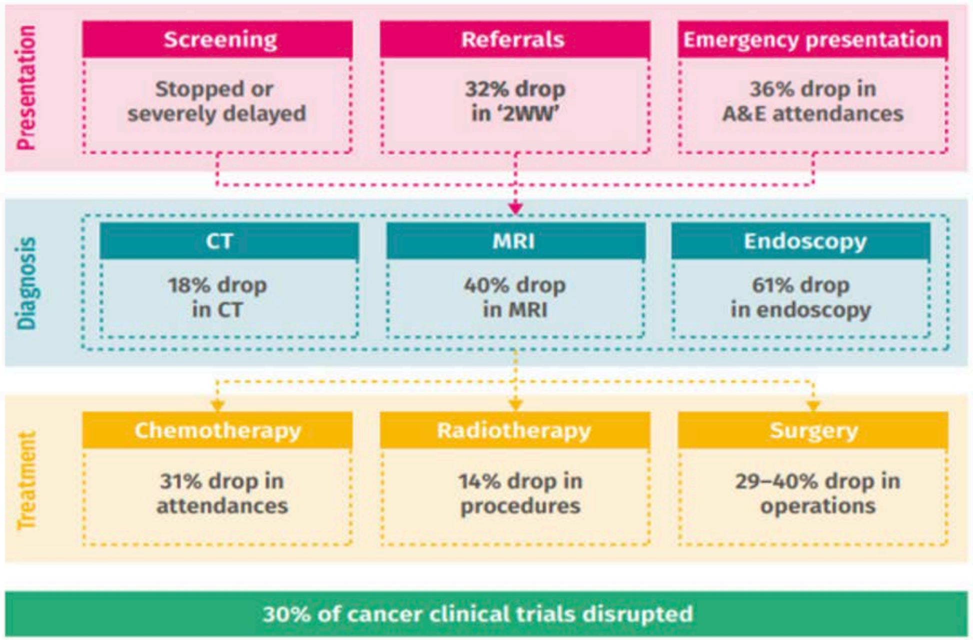
October 2020

Publication approval reference: PAR242

3.54. The NHS provides an excellent testbed for assessing new innovations, but such assessments have not always been done as quickly as they could be. The NHS needs to prepare for implementation of these developments right now.

FIGURE 2.1

Disruptions to cancer services in 2020 due to the Covid-19 pandemic



IPPR March 2021

Policy interventions to resolve backlog*

The frameworks for **resuming elective services** and **attenuating the backlog of case volume** in **oncology** and **orthopedics** share some commonalities: deploy pre-COVID strategies to shorten the waiting lists for elective care, adopt policy strategies **to increase the supply** and **reduce the demand of services**[18]**.**

Increase supply[18]

- Paying for increased activity;
- Increasing capacity through the private sector, using existing capacity more efficiently;
- Giving patients a choice to redirect to a different hospital to reduce waiting lists.

Reduce demand[3]

- Short term - prioritization or triage schemes, eliminating waste (unnecessary tests and treatments);
- Short term - Setting mandatory targets with direct incentives for meeting them;
- Medium-long term - investing in health promotion and primary care to prevent the need for treatment;
- Medium-long term - encouraging hospital competition.

Poll Question

Did the appropriate backlog models come too late to inform policy decisions to prevent/battle backlogs early on?

Modelling-based approaches to managing hospital backlog

In early 2020, healthcare organizations globally sought to understand the implications of the COVID-19 pandemic on their clinical pathways.

At Imperial College London we undertook several early analyses to support local decision making

Case study 1:

How should hospitals manage the backlog of patients awaiting surgery following the COVID-19 pandemic? A demand modelling simulation case study for carotid endarterectomy

Guy Martin, Jonathan Clarke, Sheraz Markar, Alexander W. Carter, Sam Mason, Sanjay Purkayastha, Ara Darzi, James Kinross

doi: https://doi.org/10.1101/2020.04.29.20085183

Case study 2:

Observational Study > BMJ Open. 2020 Oct 31;10(10):e042392.
doi: 10.1136/bmjopen-2020-042392.

New geographic model of care to manage the post-COVID-19 elective surgery aftershock in England: a retrospective observational study

Jonathan Clarke [#] [1], Alice Murray [#] [2], Sheraz Rehan Markar [2], Mauricio Barahona [3], James Kinross [2], PanSurg Collaborative

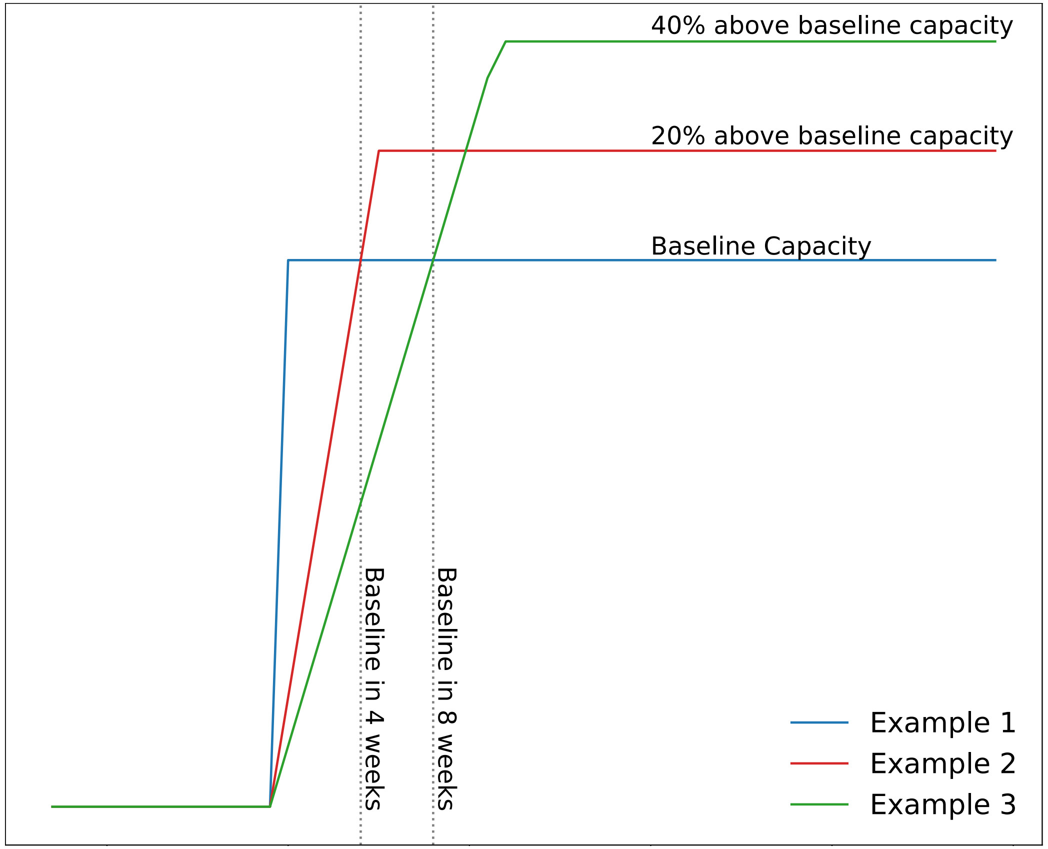
Modelling-based approaches to managing hospital backlog

Case Study 1: How should hospitals manage the backlog of patients awaiting surgery following the COVID-19 pandemic? A demand modelling simulation case study for carotid endarterectomy

- **Aim:**
  - To better understand the tradeoff between cessation of Carotid endarterectomy (CEA) surgical services and the required expansion of capacity after resumption of services.
- **Setting:**
  - CEA surgical pathways in the UK in the first wave of the COVID-19 pandemic.
- **Rationale:**
  - CEA is a time-sensitive surgical procedure, which is most effective if delivered within 2 weeks of a cerebrovascular accident and is not effective after 12 weeks.
  - Redeployment of surgical teams and use of operating theatres as ICUs reduced capacity for CEA surgery.

Modelling-based approaches to managing hospital backlog

Case Study 1: How should hospitals manage the backlog of patients awaiting surgery following the COVID-19 pandemic? A demand modelling simulation case study for carotid endarterectomy



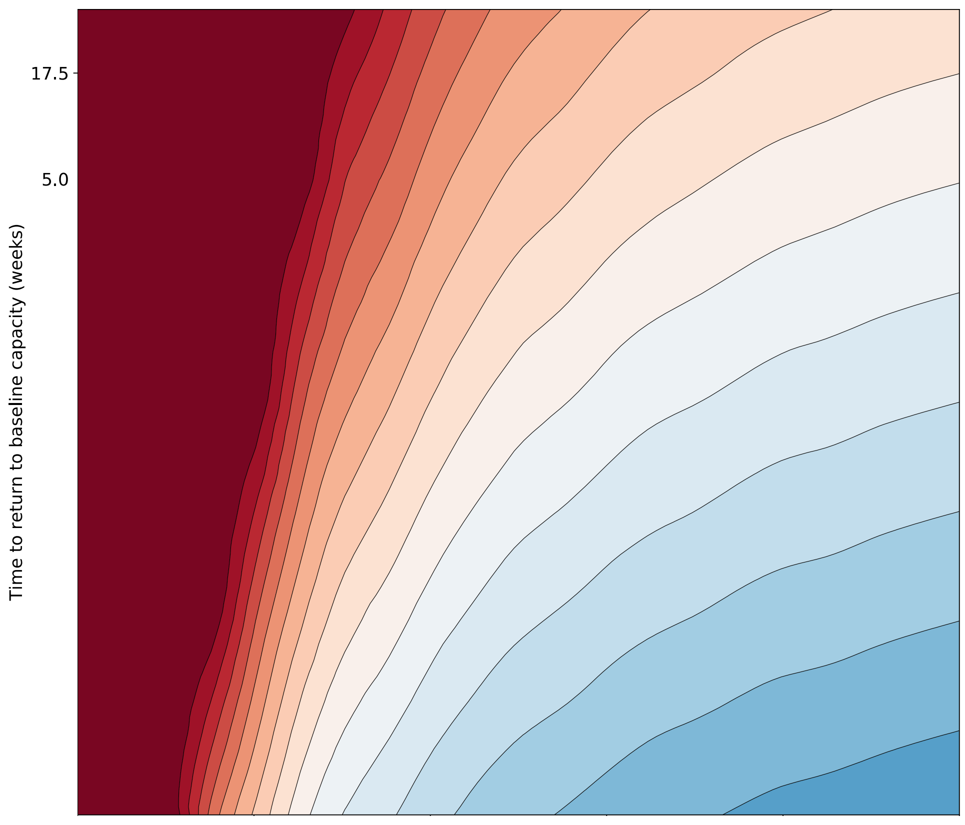
Compartmental model based on:
- No change in daily rate of patients requiring CEA (74/week
- 3 month total cessation of CEA procedures

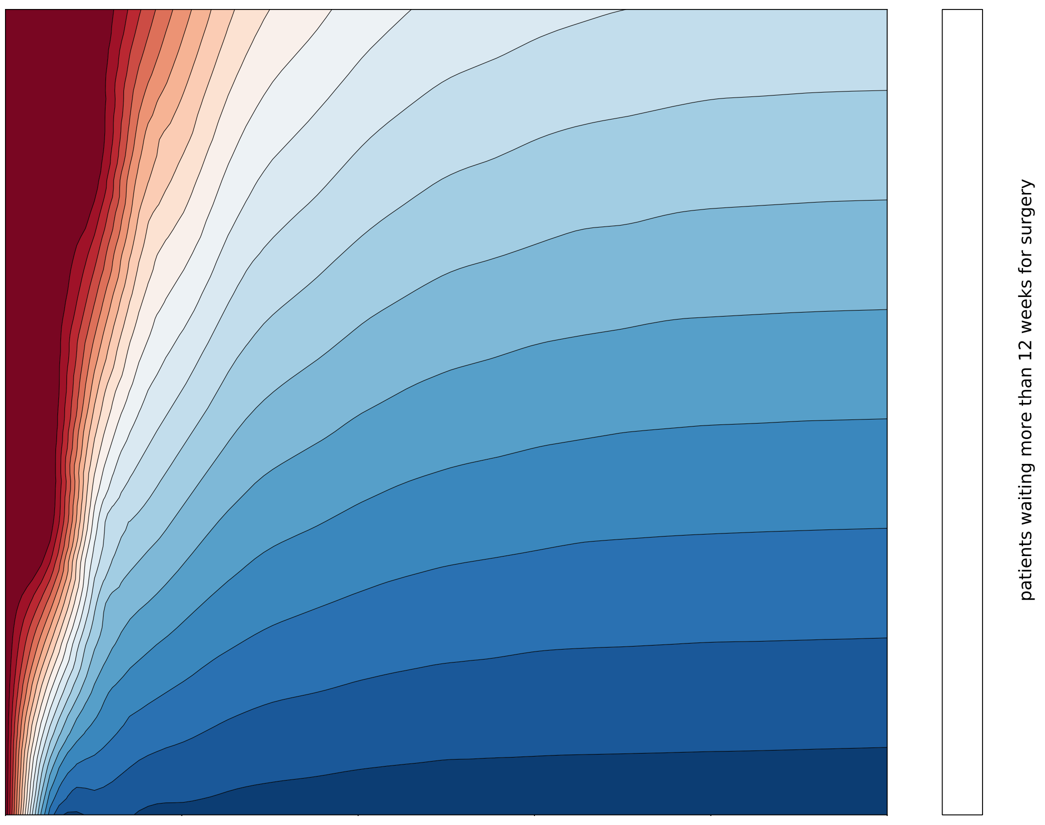
Two varying parameters:
- Time taken to return to baseline capacity
  - Range: 0-19 weeks
- Increase above baseline capacity to resolve backlog
  - Range: 0– 100%

Outcomes:
- % of patients receiving surgery within 2 weeks
- % of patients receiving surgery within 12 weeks

Modelling-based approaches to managing hospital backlog

Case Study 1: How should hospitals manage the backlog of patients awaiting surgery following the COVID-19 pandemic? A demand modelling simulation case study for carotid endarterectomy





Modelling-based approaches to managing hospital backlog

Case Study 1: How should hospitals manage the backlog of patients awaiting surgery following the COVID-19 pandemic? A demand modelling simulation case study for carotid endarterectomy

- **Conclusions:**
  - Simple compartmental model to support important clinical tradeoffs
  - Framed around actions and outcomes relevant to clinicians
  - Does not propose a single optimum
  - Gives an idea of the scale of the potential backlog and the relative impact of different actions

Modelling-based approaches to managing hospital backlog

Case Study 2: New geographic model of care to manage the post-COVID-19 elective surgery aftershock in England

- **Aim:**
    - To identify the extent to which collaboration between surgical centres may be used to reduce backlog in planned surgical care
- **Setting:**
    - Planned surgical care for common, low-risk procedures in the National Health Service in England.
- **Rationale:**
    - Much of the surgical backlog involves a small number of low-risk procedures
    - Pooling of resources between surgical centres may allow for surgical capacity to be maintained while providing COVID-19 care

Modelling-based approaches to managing hospital backlog

Case Study 2: New geographic model of care to manage the post-COVID-19 elective surgery aftershock in England

Table 2 The 28 procedures accounting for more than half of all elective surgical activities in England

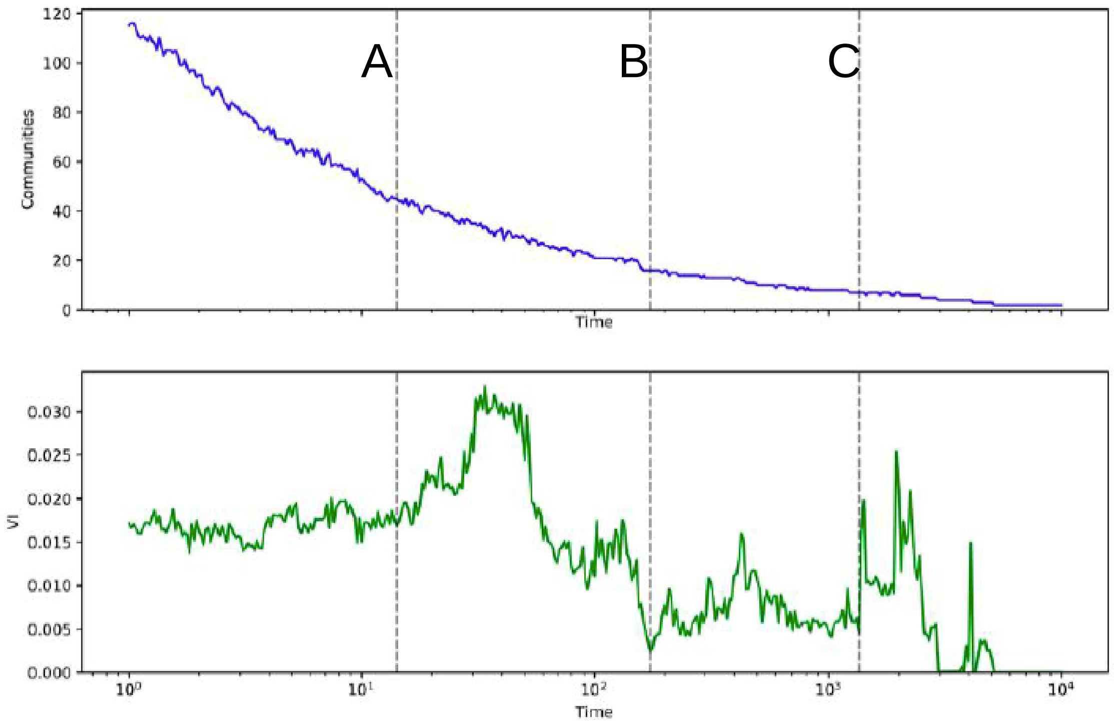
Procedure	Total number of cases	Patient risk: Low risk (%)	Patient risk: Medium risk (%)	Patient risk: High risk (%)	Mean distance travelled (km)
Lower GI endoscopy	937 616	74.8	17.9	7.3	9.8
Upper GI endoscopy	650 133	66.9	22.1	10.9	9.4
Lens extraction+ replacement	395 445	33.5	46.5	20.0	10.9
Excision of skin lesion	215 608	55.0	29.5	15.5	12.7
Injection/aspiration joint	142 562	71.6	20.9	7.5	12.6
Vitrectomy	132 938	39.9	44.1	16.1	13.2
Cystoscopy	130 114	56.4	26.2	17.4	11.8
Insertion of central venous catheter	109 864	24.3	38.3	37.4	14.0
Coronary angiography	105 620	56.2	30.0	13.8	13.9
Dental extraction	101 435	91.6	5.8	2.5	11.5
Knee replacement	78 773	53.3	34.4	12.3	13.4
Bladder catheterisation or irrigation	71 552	42.5	32.7	24.8	12.8
Injection to bladder	67 167	34.3	29.8	35.9	11.5
Spinal facet joint injection	64 154	70.4	21.9	7.7	14.0
Cholecystectomy	61 790	80.5	13.8	5.7	11.8
Lymph node biopsy	60 674	34.8	34.4	30.8	14.9
Epidural or spinal injection	60 656	69.2	22.6	8.1	12.9
Inguinal hernia repair	58 943	72.6	19.9	7.5	10.9
Spinal nerve root injection	58 212	77.0	17.5	5.5	16.2
Knee meniscectomy/ meniscal repair	57 871	93.2	5.9	0.8	12.4
Hysteroscopy	52 360	90.9	6.4	2.7	9.9
Carpal tunnel release	48 245	70.7	22.2	7.1	11.0
Application/ removal of internal fixation of bone	46 771	84.6	11.9	3.5	15.7
Dental clearance	43 463	82.3	11.7	5.9	11.1
Partial breast excision	41 827	50.1	31.4	18.5	11.5
Bone marrow biopsy	38 369	39.8	34.8	25.5	15.6
Primary joint resurfacing	37 854	59.3	30.1	10.5	14.0
Cystoscopy+ resection of bladder lesion	37 458	17.7	29.8	52.5	11.2

- Examined 7,811,891 planned surgical admissions
- April 2017 – March 2018
- 26 procedures accounted for > 50% of all operations
- 61.7% of operations were in ‘low-risk’ individuals
- Patients travelled an average of 11.7km for surgery

Modelling-based approaches to managing hospital backlog

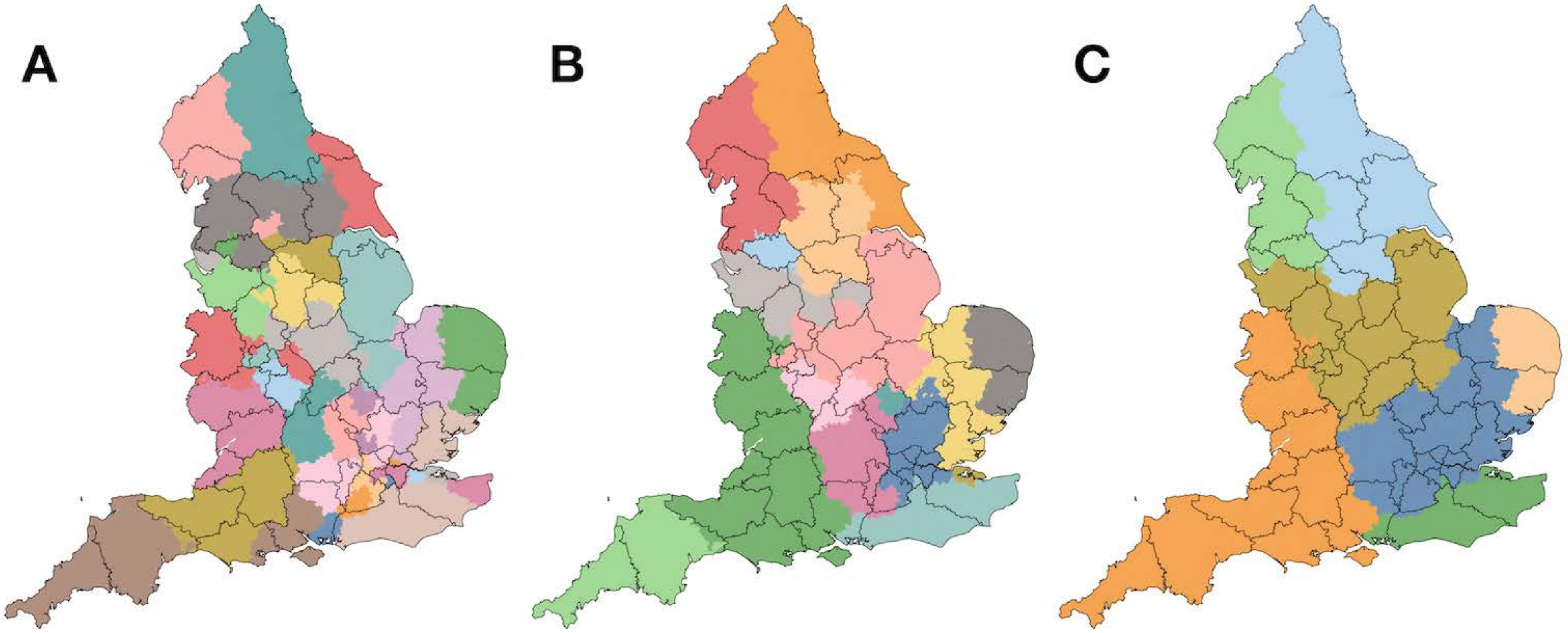
Case Study 2: New geographic model of care to manage the post-COVID-19 elective surgery aftershock in England

- Markov Multiscale Community Detection applied to an LSOA similarity matrix
- Three stable partitions identified over different scales



Modelling-based approaches to managing hospital backlog

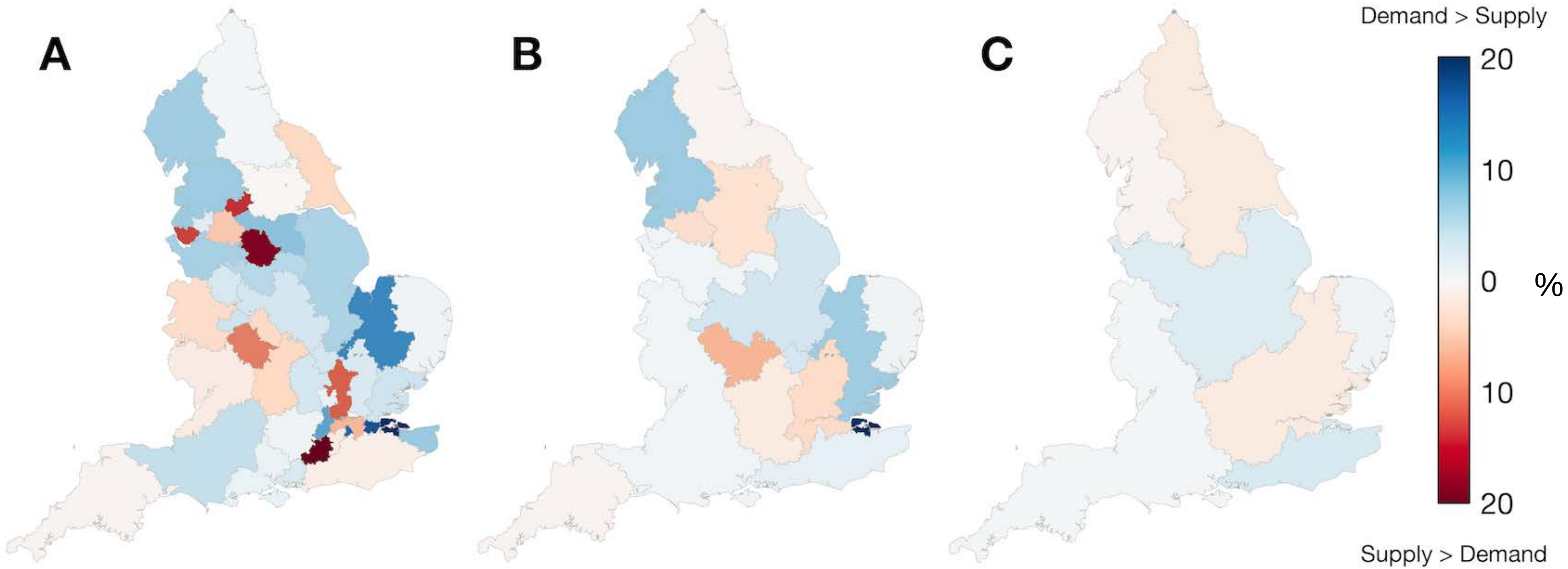
Case Study 2: New geographic model of care to manage the post-COVID-19 elective surgery aftershock in England



Division of England into 45 (panel A), 16 (panel B) and 7 (panel C) surgical communities (in colour), according to Markov stability. Sustainability and transformation partnership (STP) boundaries are overlaid (black lines).

Modelling-based approaches to managing hospital backlog

Case Study 2: New geographic model of care to manage the post-COVID-19 elective surgery aftershock in England



The absolute percentage difference between the number of patients undergoing surgery resident within a surgical community (demand) and the number of procedures performed by hospitals within the community (supply) for configurations of 45 (panel A), 16 (panel B) and 7 (panel C) surgical communities. Areas in blue represent those surgical communities where procedures performed on patients outnumber those performed by the local providers.

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- **Conclusions:**
  - Many planned surgical procedures involve low-risk patients, and are provided close to a patient's home
  - Provision of planned surgical services through collaboration between providers may help to reduce the backlog
  - Disagreement exist between 'data driven' communities and administrative boundaries which may inform the collaboration between providers.
  - Mismatches between supply and demand within localities indicates larger surgical communities may be more effective

Modelling-based approaches to managing hospital backlog*

A literature search was conducted to **identify mathematical models** to optimize hospital backlog. Models were **assessed using a checklist from the ISPOR task force**[30] on optimization methods emerging good practices, which focuses on constrained optimization methods in health services research

Modelling

- Problem structuring
- Mathematical formulation
- Model development
- Model validation

Optimization

- Optimization method
- Optimization/sensitivity analyses
- Reporting of results
- Decision making

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STAGE	STEP	DESCRIPTION
MODELLING[30]	**Problem structuring**	Specify the objective(s) and constraints, identify decision variables and parameters, and list and appraise model assumptions
	Mathematical formulation	Present the objective function(s) and constraints in mathematical notation using decision variables and parameters
	Model development	Program the model in software to estimate the objective function(s) and constraints using decision variables and parameters as inputs
	Model validation	Ensure the model is appropriate for evaluating different combinations of decision variables and parameters

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STAGE	STEP	DESCRIPTION
OPTIMIZATION[30]	**Select optimization method**	Choose an appropriate optimization method and algorithm based on the characteristics of the problem.
	Perform optimization/sensitivity analysis	Use the optimization algorithm to search for the optimal solution and examine the performance of the optimal solution for reasonable sets of parameters
	Report results	Report the results of the optimal solution and sensitivity analyses
	Decision making	Interpret the optimal solution and use it for decision making

Overview of model review: modelling checklist *

The identified **13 models** are a mix of optimization and forecasting models; an overview of results from the **modelling checklist for these publications is as follows:**

Problem structuring

1. Narrative description: **5/13** [20-24]
2. Narrative description, objective and decision variables: **1/13** [25]
3. Full overview of the problem structure:**2/13**[26,27]
4. Complete overview of problem structure, separate overview of variables, input parameters, and assumptions: **5/13**[4,28-31]

Mathematical formulation

1. Mathematical notation for the variables, parameters, and the model itself: **2/13**[28,30]
2. Narrative description of the model: **11/13**[4,21-27,31]

Model validation

1. Not perform or report validation: **6/13**[20-25]
2. Internal validation: **2/13**[28,26]
3. Both internal and external validation: **5/13** [4,27,29-31]

Overview of model review: optimization checklist *

The optimization/forecasting method

As the model builders had more insights into the available data and the purpose of the model, it was not possible to assess the suitability of the method choice.

Forecasting models

Supply and demand modelling, wherein differences between supply and demand resulted in backlog per cycle[20,21,25,26,31];

Linear regression models that used national data sets to forecast expected surgical volume over time, with introduction of backlog scenarios to quantify postponed surgeries[22,23];

Linear forecasting was used in one study, combined multiple operational/supply constraints to predict the total financial impact of delayed surgeries[27].

Overview of model review: optimization checklist *

The optimization/forecasting method

As the model builders had more insights into the available data and the purpose of the model, it was not possible to assess the suitability of the method choice.

Optimization models

- Discrete event simulation to model the workflow in an ambulatory center[3];
- Machine learning models/tools to maximize efficiency of operation room time and/or predict surgical resource requirements[24,30]; and
- State-transition models (cohort or individual-patient) to quantify disability-adjusted life years (DALYs) or due to delayed surgeries[28,29].

Overview of model review: optimization checklist *

Performing an optimization/sensitivity analysis

Sensitivity analysis was inconsistently reported and not routinely robust

- **4/13** studies do **not** report any form of **sensitivity analysis**[20, 23-25] **;**
- **3/13** studies did **not run a stochastic sensitivity** analysis; however, they did perform **scenario analyses**[22,27,30]**;**
- **4/13** models ran a **complete stochastic sensitivity analysis**[4,21,26,29]**;**
- **2/13** models reported **both stochastic sensitivity analysis and different scenarios**[28,31]**.**

Overview of model review: optimization checklist *

Decision making

Finally, each model describes the optimal solution or forecast and interprets how this can be used for decision-making. When assessing how each model is used for decision-making, there are two different approaches.

First approach: the model is built for **a specific problem** and gives a practical application, such as *optimizing the operating room workflow* or *surgical demand forecasting,* and evaluates model performance/validity after its implementation [20,24-26,30];

Second approach: takes a **broader approach** to model structure, allowing consideration of a broad set of policy challenges, where the model allows for different scenarios to assess those policies[4,20-23,28,29,31].

Policy recommendations for future model development *

Further policy recommendations for developing these mathematical models: based on the evaluation of existing models for optimal backlog management due to COVID-19 and using the current ISPOR task force on optimization methods.

Model the flow of patients across settings

Consistent with other models in health economics, it is possible to model current treatment methods versus new policies and / or treatment methods. There are clear similarities between modelling methods.

Mathematic notations to describe the model

Provide mathematic notations to describe the model, because currently only two out of the thirteen models use mathematical notation to describe their model, which limits reproducibility [28,29]

Internal and external validation of models

Validation encompasses essential steps in model development and some improvement can be made in this domain – only six out of thirteen models reported validation methods and findings [20-25]

Policy recommendations for future model development *

Conduct sensitivity analyses to test the robustness of a model

Ideally, both stochastic and scenario analyses should be performed—this was done within two of the assessed models [28,31].

Create consensus on outcomes to consider for optimizing hospital backlog

Currently, outcomes are varied and include reduction in hospital backlog over time and DALY minimization due to delayed surgeries[24,29]. The report of the ISPOR task force on best practice modelling suggests approaches for modelling disease pathways, as well as for comparing effects of different treatment options in terms of life years and costs[32]. Variation may be appropriate based on local health priority.

Standardize the objectives of hospital backlog models using defined, existing measures

As the goal of (elective) surgeries is to improve population health, patient-centered measures such as life years, quality-adjusted life years (QALY), or DALYs should be used when feasible, with consideration of financial constraints and/or assessment of incremental cost-effectiveness or cost-utility ratios (ICER or ICUR). These approaches would provide decision makers with outcomes in common units, thereby facilitating comparison across disparate specialty areas, provider organizations and/or geographies[30,23]. Additional measures which reflect broader societal burden may be considered, as needed.

Poll Question

What is the most appropriate output / outcome measure for backlog modelling?

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Conclusions*

The pandemic has caused a **massive increase in hospital backlog**, especially in **elective surgeries** where most were cancelled or delayed. This is likely to result in clinical, medical resource use and economic impact, as well as potential quality-of-life loss for patients whose surgery is postponed.

Future studies

Guidelines and consistency are required for hospital backlog modelling to be part of the solution and recognize these models in health care. The **ultimate goal** is to achieve what health economic modelling has done in payer decisions for the introduction of new medicines into markets, where the cost is set off against the gain in quality of life or more broadly by incorporating the patient perspective and evaluating the economic or societal impact.

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