


The 'hub and spoke model' for the management of surgical patients during the COVID-19 pandemic

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Abstract

During the on-going COVID-19 pandemic a number of key public health services have been severely impacted. These include elective surgical services due to the synergetic resources required to provide both perioperative surgical care whilst also treating acute COVID-19 patients and also the poor outcomes associated with surgical patients who develop COVID-19 in the perioperative period. This article discusses the important principles and concepts for providing important surgical services during the COVID-19 pandemic based on the model of the RMCancerSurgHub which is providing surgical cancer services for a population of approximately 2 million people across London during the pandemic. The model focusses on creating local and regional hub centres which provide urgent treatment for surgical patients in an environment that is relatively protected from the burden of COVID-19 illness. The model extensively utilises the extended multidisciplinary team to allow for a flexible approach with core services delivered in 'clean' sites which can adapt to viral surges. A key requirement is that of a clinical prioritisation process which

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allows for equity in access within and between specialties ensuring that patients are treated on the basis of greatest need, while at the same time protecting those whose conditions can safely wait from exposure to the virus. Importantly, this model has the ability to scale-up activity and lead units and networks into the recovery phase. The model discussed is also broadly applicable to providing surgical services during any viral pandemic.

KEYWORDS

cancer, COVID-19, hub and spoke, pandemic, surgery, virus

1 | INTRODUCTION

The COVID-19 pandemic has led to unprecedented pressure on the UK National Health Service (NHS). Hospitals have, at times, been overwhelmed by treating patients with COVID-19 and remain at risk from further surges in COVID-19 related activity, for an as yet undefined period. In addition, there is a significant need for urgent management of non-COVID-19-related services such as surgery. These activities form the core NHS service and it is essential that patients' needs are not sacrificed in a linear 'virus response'.¹

During pandemic surges, hospitals face two, often conflicting, issues. The first relates to constrained physical capacity and human resources depleted by staff illness, with hospital beds and intensive care units (ICU) overburdened with infected patients such that there is little or no resource to treat other, often equally critical, conditions. Second, is the additional morbidity and mortality of hospital patients resulting from concomitant viral infection. It is imperative that patients treated for non-pandemic conditions, and the staff treating them, are protected from infection to allow maintenance of service provision and minimise the excess mortality attributable to the crisis.

In this report, we outline the key concepts and procedures required for providing surgical services during the COVID-19 pandemic based on the model and experience of the RMCancerSurgHub. This was a collaboration of 14 UK NHS and 1 independent private sector hospital which across three main operating sites has been providing core surgical cancer services to a population of approximately 2 million people in South West London.

The RMCancerSurgHub model centres around the principles of the hub and spoke model for medical care.² From a surgical perspective, this focusses on creating local and regional hub centres to provide urgent treatment for surgical patients in an environment that is relatively protected from the burden of COVID illness. It extensively utilises the extended multidisciplinary team (MDT) to allow for a flexible approach with core NHS services delivered in 'clean' sites which can adapt to viral surges. A clinical prioritisation process allows for equity in access within and between specialties ensuring that patients are treated on the basis of greatest need, while at the same time protecting exposure to the virus to those whose conditions can safely wait. Importantly this model has the ability to scale-up activity and lead units and networks into the recovery phase. This model could also broadly be extrapolated to other viral pandemics. Whilst the purpose of this report is not to discuss the outcomes of the RMCancerSurgHub it has facilitated over 3000 cancer surgical procedures between March 2020 and December 2020 with provisional data showing no significant difference in standard surgical outcome metrics to prepandemic.

TABLE 1 NHS England tiers of surgical urgency³

Priority level 1	1a	Urgent operation needed within 24 h to save life
	1b	Urgent operation needed within 72 h (urgent emergency surgery/permanent injury)
Priority level 2		Elective surgery with the expectation of cure (within 4 weeks to save life)
Priority level 3		Elective surgery can be delayed for 10–12 weeks which will not have predicted negative outcome

2 | RATIONALE FOR A HUB AND SPOKE MODEL

In times of constrained resource, as exemplified by the COVID-19 pandemic, there are two questions which must be posed. First, 'can we?' and second, 'should we?' offer a service, either at all, or to a particular patient. In terms of surgery, NHS England (NHSE) introduced three broad tiers of surgical urgency (Table 1):

2.1 | Patients in Group 1

Patients in priority Group 1a are likely to be treated at the hospital they first present to since a time critical life-saving intervention is often required. An example of this includes a ruptured abdominal aneurysm or an ischaemic limb. Mortality and morbidity in such procedures are usually high. In the context of a viral pandemic where an operation is occurring in a potentially 'dirty' site where resources such as critical care and staff are already compromised outcomes are likely to be even worse. The time-critical nature of many of these conditions also precludes adequate viral screening processes which has significant implications for logistics, healthcare workers (HCW) and other patients.

Other reasons for surgical work to continue in 'dirty sites' is if systems are so overwhelmed 'clean sites' have no capacity or if a patient is too sick to transfer such as in palliative cases.

In Group 1b patients, consideration needs to be given whether it is in their best interests to transfer them to a clean 'green' site and or whether surgery itself is actually necessary. In some cases, such as acute appendicitis and acute cholecystitis a conservative nonsurgical approach may offer similar outcomes during a viral pandemic.^{3–5}

2.2 | Priority Groups 2 and 3

It is priority Groups 2 and 3 who form the largest surgical cohort affected by a viral pandemic. Defining these groups is extremely difficult and characterising the gap between categories 2 and 3 is challenging. The issue of 'should' a service be delivered hinges on an individual balance of risk; the risk of surgery in a constrained system with concomitant COVID risk versus the potential for harm to that individual from a delay in treatment.^{6,7}

These patients form the core patient group of the hub and spoke model (Figure 1). The concept of a surgical hub offers optimisation of resource, by providing a 'ring-fenced' facility to allow core surgical activity to continue in times of great systemic stress, but to do so in as 'clean' an environment as possible. Incidental perioperative COVID-19 infection has been associated with an unacceptable risk of perioperative mortality⁸ reinforcing the critical need to minimise the exposure of this cohort of patients to the virus.

3 | HOT/COLD SITES AND WORKFORCE LOGISTICS

An approach for surgical centres is to divide their facilities into 'hot' and 'cold' sites during viral pandemics. 'Hot' sites are areas in organisations where infected patients are treated. 'Cold' sites are where surgical services are

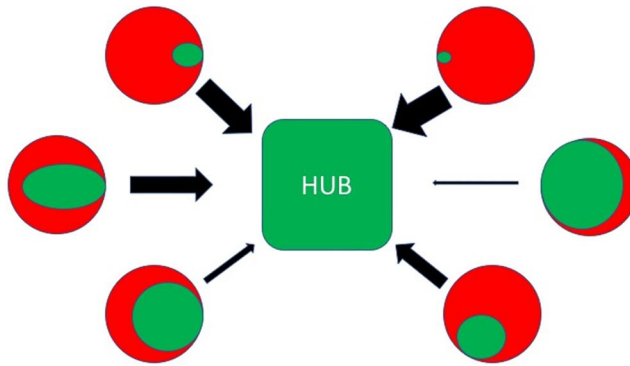


FIGURE 1 In circumstances where a hub can be maintained truly clean (green) and free from infection (red), spoke units, with varying proportions of 'clean' capacity, can refer into to the hub. The volume of referrals into the hub, demonstrated here by the width of the black arrows, will fluctuate during the pandemic and will be proportional to the residual 'clean' capacity in these spokes [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Key principles for the provision of surgical services at a 'cold site'

Key principles in provisions of surgical services in a 'cold site'

- Patient viral testing
- Staff viral testing
- Zones to demarcate where patients of differing COVID-19 status are treated
- A strategic plan for the flux in capacity between hot and cold sites
- Intensive care capacity
- Operating theatre (OT) logistics and PPE

delivered. These sites can be within the same hospital footprint, or in distinct geographical locations overseen by the same provider.⁵

Whilst surgical outcome data to support this approach is limited, its rationale relates to the perceived reduction in nosocomial infections. This is particularly important because during the perioperative period, due to immune dysfunction, patients are more vulnerable to the pathophysiological implications of an infections such as COVID-19.^{9,10} Recent data from elective surgical operating from around the world, during the current pandemic, report a postoperative mortality rate of 19.1% $n = 278$.⁷ Alongside the clinical advantages, centralising surgical care to a cold site leads to operational efficiencies with a focus on delivering optimal surgical care despite the ongoing pandemic response (Table 2).

3.1 | Healthcare workers

At one point during the early stages of the pandemic It has been estimated that 4%–19% of all cases of COVID-19 in Europe and China have been in HCWs.^{11,12} It has also been estimated that 25%–40% of infectious carriers are asymptomatic.¹³ To prevent cross infection of patients and staff it is essential to ensure, as far as possible, that HCWs are virus-free. To achieve this, clear testing protocols for HCWs, in line with national or local policy, must be followed. Routine weekly screening of all HCWs in the COVID-19 pandemic and appropriate isolation should be

considered by surgical hubs since evidence suggests it will significantly reduce infection both in the healthcare setting and wider community by up to 30%.¹⁴ In the longer-term widespread vaccination of HCW starting with the highest-priority staff first will be key to the continued maintenance of a virus free service.

During peaks of the COVID-19 pandemic it has been estimated that at any time 25% of all European HCWs were either unwell or self-isolating.¹⁵ In addition, there are 'at-risk' HCW groups who should be shielded from virus exposure in frontline areas. For some HCWs, work at a 'cold' site may be more appropriate. High levels of HCW stress, burnout, low morale and exhaustion have been described in viral pandemics¹⁶ and a strategy for HCW well-being is essential. These factors must be accounted for when staffing a cold site, which is likely to have a transitional workforce where versatility of roles is crucial.

3.2 | Zones of demarcation within a cold site

A 'cold' zone, either within a single site or spread across multiple geographical sites with distinct admission and treatment areas, is critical in minimising cross infection. Zoning needs to account for the location of existing inpatient groups such as immunosuppressed patients. A traffic light system can be used where 'green' refers to a zone for asymptomatic; confirmed virus negative patients; 'amber' for viral status unconfirmed and or mildly symptomatic patients and 'red' for symptomatic and/or virus positive patients.¹⁷ Where cold and hot sites are colocated, the green zone should include operating theatres (OTs) and surgical wards. Surgical patients who become infected should have a pathway for rapid transfer to a 'red zone'. Colocation of virus-negative and positive patients increases risk, mandating complex staff and patient flow systems.

3.3 | Flux between hot and cold sites

The 'hot' and 'cold' zones will be linked in terms of resource allocation with both operating in a constant state of flux (Figure 2). Pandemic surges will affect the ability to provide surgical services, with increased utilisation of ventilators, staff, medicines, critical care resources and surgical areas. Surge planning and defined escalation levels are essential to predict the likely implications for surgical services. Resources required to deliver the minimum essential surgical services for safe practice in the institution must be ring-fenced. This needs to be coordinated with the pandemic response team as these resources are required by both groups. The NHS South Central Operational Pressures Escalation System¹⁸ can be extrapolated and used to assist in modelling and resource allocation across all NHS services during crisis.

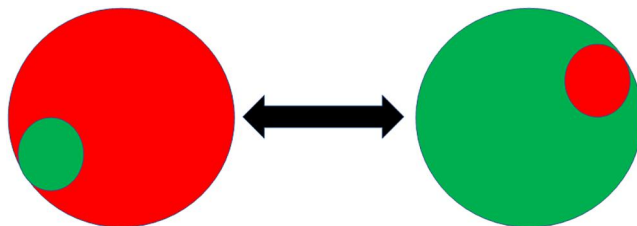


FIGURE 2 Flux required between clean (green) and dirty zones (red) during surges in a viral pandemic in a surgical hub. The key to flexibility in pandemic planning on a single site, when separating services, is to create a 'clean zone in an 'infected system', with the intention of transforming the services to an 'infected area' in a 'clean system'. To deal with peaks of viral activity there must be an ability to flex between these models [Colour figure can be viewed at wileyonlinelibrary.com]

3.4 | Intensive care capacity

During the surge period of a viral pandemic ICUs are likely to have constrained bed capacity. If the ICU also functions as the 'cold' surgical ICU this will impact surgical capacity. It may be that the surgical case-mix is adjusted to day case or short-stay surgery. Those requiring ICU care may be treated at ward level with intensivist oversight. There must be an appreciation that surgical patients admitted to an ICU, even if it is in a technically clean zone, are at risk of poor outcomes by virtue of their increased potential exposure to the virus.

3.5 | OT logistics and personal protective equipment

The practicalities of operating during a viral pandemic should focus on protecting staff and patients from infection, whilst also offering safe surgery. Many process changes are required to achieve this, and theatre efficiency will unlikely be at pre-pandemic levels. A number of authorities¹⁹ have made practical recommendations for operating during the COVID-19 pandemic which can be widely extrapolated to most viral pandemics (Table 3).

4 | PERSONAL PROTECTIVE EQUIPMENT

The current pandemic has highlighted the importance of appropriate personal protective equipment (PPE) in all clinical settings. Healthcare organisations need to adhere to evolving national recommendations for PPE, with appropriate training essential. Dedicated teams should be tasked to focus on the its procurement as stocks at a national level may be depleted. Healthcare organisations need to support staff in making difficult ethical decisions on whether to proceed with operating with their available PPE. HCWs. PPE can have impact on surgical operating including making communication more difficult and reducing visibility. Increased safety measures may need in the OT to facilitate surgery.²⁰

4.1 | Surgical technique

Surgical technique may need to be considered in a viral pandemic in order to minimise aerosol generation which could adversely affect HCW, patients and contaminate theatre environments. During the current COVID-19 outbreak, there was intense debate that occurred on the safety of using laparoscopic techniques during the most intense waves of the pandemic. There were more prudent attitudes in the UK and the European Union compared to the United States of America in terms of the avoidance of laparoscopic procedures.^{21,22}

TABLE 3 Key areas to focus on in terms of OT logistics

- Working in PPE—donning and doffing procedure; impact on communication
- Differing OT polices for patient flow—to reduce viral transmission in OT will be different from admission to discharge
- Differing anaesthetic and surgical techniques to reduce potential viral transmission—open or laparoscopic
- Continued staff education of new and evolving OT polices

4.1.1 | Preassessment process

The pre assessment process which assesses a patient's fitness for surgery to ensure safe perioperative care will need to adapt during a pandemic. Patients are likely to present for surgery at a later disease stage and may have poorly optimised chronic health conditions, having potentially encountered system delays and avoided health care providers due to the risk of infection. Within the current COVID-19 pandemic, physical distancing measures have been key to reducing transmission rates.²³ Telemedicine innovations are therefore important in the assessment process with telephone or video-linked communication between patients and HCWs replacing the traditional outpatient model of consultations. These clinics can be conducted with nurse-led triage escalated to remote anaesthetist assessment. Telemedicine can also be utilised for accessing external specialties in a rapid virtual consultation.²⁴ Functional assessment or invasive cardiological testing requiring outpatient attendance may be unavailable. The decision-making process for 'fitness for surgery' may therefore be less informed and decisions to postpone surgery on the basis of further investigation or optimisation must be put into context of the impact of the failure to operate in a capacity and resource limited health system. Shared decision making with patients is essential in this setting. In the hub and spoke model it is important that the pre-assessment process is standardised and that policies exist to prevent unwanted variation that could cause system delays.

Ensuring patients are not infected with the virus prior to surgery is crucial to the preassessment process. Clear preoperative isolation and viral-screening policies for all patients is essential to maintaining the safety of both patients and staff on cold sites. In the COVID-19 pandemic this has been achieved with a comprehensive multi-modal screening pathway adjusted to local infrastructures and resources (Table 4).

4.2 | Equity of healthcare delivery and the governance

Equity of access according to clinical need is key to the effective running of a surgical hub. Prioritisation within and between specialties is crucial when deciding who should be offered interventions. At times of extreme systemic stress, some high-risk/high-complexity interventions may be considered inappropriate. Structures are required to identify those in whom disease progression over a period of months is unlikely, and who should therefore enter a period of close monitoring. Criteria for prioritisation are based on the urgency of surgery with respect to disease progression and availability of alternative non-inferior nonoperative treatment options.

The final arbiters of aligning clinical need with capacity should be a Clinical Prioritisation Group (CPG) whose independence and probity, supported by strict outcome audit, are key to maintaining patients' trust and referring team engagement. The CPG should consist of a multidisciplinary team of healthcare professionals who

TABLE 4 Suggested preoperative COVID-19 screening policy

Testing modality	7–14 days before surgery	Within 48 h of surgery	Within 24 h of surgery
Screening questionnaire (see Appendix 1) (+ temperature check day of surgery)	✓		✓
RT-PCR SARS-CoV-2		✓	
Radiological imaging CXR or non-contrast computed tomography thorax*		✓	

The use of preoperative CT chest is controversial with UK National Bodies currently advising that its routine use is unnecessary.²⁵

conduct regular structured meetings, with clear governance and terms of reference to discuss prioritisation of patients for operations within the hub. The CPG stands removed from the competing interests of various specialties vying for limited resources. In maintaining an independent stature, an underlying ethos of the CPG is to respect the clinical decisions of local MDTs and to facilitate these decisions whilst providing a sense check for prioritisation.

When delay is clinically judged to be inadvisable, uniformity of perioperative processes including pre-assessment, optimisation and postoperative intensive care management ensures all patients deemed appropriate for surgery receive consistent care, irrespective of variations in extrinsic local factors. This allows appropriate allocation of theatre space within and between specialties and geographical sites.

5 | CONCLUSIONS

It is increasingly clear that the tail of the COVID-19 pandemic will likely be long and further surges will occur. Control is likely to require vaccine roll-out and subsequent widespread immunity of the population and HCWs²⁶ and until then some form of service separation is inevitable. For this reason, and to accommodate for further surges of pandemic infection rates, streaming of patients and the availability of surgical hub models will continue to be essential. The surgical hub model must also have the ability to reactivate as surgical services normalise but also repatriate services to base units as resource and safety allows.

RM Cancer Surg Hub

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CONFLICT OF INTERESTS

S. R. is the medical director of Humanity First, a WHO affiliated disaster organisation. A. C. and E. K. are in leadership roles in RM Partners West London Cancer Alliance hosted by The Royal Marsden NHS Foundation Trust which has provides oversight and strategy for all cancer care systems across west London.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request

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