

From the sidelines: The indirect repercussions of COVID-19 on the delivery of hospital surgical services

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Key words

COVID-19, pandemic, surgical activity, surgical outcomes.

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Accepted for publication 7 June 2021.

doi: 10.1111/ans.17016

Abstract

Background: Despite relatively few COVID-19 cases within New South Wales, the uncertainty surrounding the pandemic has prevented a return to business as usual for the delivery of surgical services. This study aims to describe the evolving impact of COVID-19 on surgical activity and patient outcomes at a major public tertiary referral hospital.

Methods: A retrospective cohort study involving adult surgical patients treated at a large public tertiary referral hospital in Sydney, Australia. Surgical activity, surgical outcomes and patient demographics were compared across two time periods, including the ‘first wave’ (February–May 2020 vs. February–May 2019) and the ‘perseverance phase’ (June–September 2020 vs. June–September 2019). Variables across both groups were compared using an independent *t* test or chi-squared test.

Results: A –32% reduction in surgical separations was observed in the ‘first wave’, including –20% emergency and –37% elective. In the ‘perseverance phase’, there was a –19% reduction in surgical activity, including 0% emergency and –27% elective. The average length of stay, intensive care admissions, postoperative complications and in-hospital costs significantly increased in the ‘first wave’. The proportion of public patients increased marginally (3%) in the ‘first wave’.

Conclusion: The impact of COVID-19 was most severely experienced in the initial months of the pandemic and observed in the number of patients treated. Although there was an initial effect on surgical outcomes, overall, the standard of care remained safe. The delivery of elective surgery remains a challenge and reflects the ongoing system-wide changes that are required to manage the COVID-19 pandemic.

Introduction

While the global COVID-19 pandemic is evolving differently across countries and indeed even within, what remains a universal experience has been the profound uncertainty and long-term disruption being caused to the delivery of healthcare services.¹ Even for those jurisdictions, such as the state of New South Wales, Australia, that have been fortunate to experience relatively low levels of community transmission of the virus and manageable second wave events thanks largely to the outstanding efforts of expert public health units,² the ever-present potential of the pandemic to escalate has prevented a return to business as usual. For elective surgical services, in particular, this has somewhat sidelined the discipline, with an ongoing reduction in surgical activity, closed face-to-face outpatient clinics and a considerable change to the health-seeking behaviours of patients.^{2–6}

Not unsurprisingly given the unique experience of encountering a global pandemic in a digital age, there has been an abundance of information published to share experiences, strategies and solutions, and to highlight areas of concern for surgical services in response to this extraordinary event.^{3,6–8} Initially, most of the COVID-19 publications were based on low-level evidence, including perspectives, editorials and other types of reports.⁹ As time has progressed, a growing number of publications have begun reporting on the indirect impact of COVID-19 on emergency and elective surgery worldwide. Despite differences in settings, country, surgical procedure and time-points analysed, the overall volume of emergency surgeries have decreased anywhere between 8% and 81%,^{10–13} whereas elective surgery has decreased between 33% and 62%.^{1,11,12} Although the road ahead still remains unclear, it is evident that contemporaneously demonstrating both the ongoing

repercussions of the COVID-19 pandemic and the organisational response on the delivery of hospital surgical services is important for contributing to the knowledge base and future decision making. As such, the aim of this study is to describe the impact of COVID-19 on surgical activity, surgical outcomes and patient demographics at a major public tertiary referral hospital in Sydney, Australia.

Methods

Study design and setting

This study is a retrospective cohort of routinely collected data from 1 February and 30 September 2019/2020 at Royal Prince Alfred Hospital (RPAH), a public teaching hospital in Sydney, Australia. Ethical approval was obtained from the Sydney Local Health District Human Research Ethics Committee (X20-0145 and 2020/ETH00895).

Patients

The population of interest for this study included all patients who underwent a surgical procedure (emergency or elective) within the following 16 specialties: breast (benign only), cardiothoracic, colorectal, ear, nose and throat (ENT), gynaecology (benign only), head and neck (predominantly benign), liver and renal transplant, melanoma, neurosurgery, ophthalmology, orthopaedic, plastic and reconstructive surgery, upper gastrointestinal (GIT), urology and vascular. Public patients under the management of RPAH surgeons but uniquely treated at another private hospital due to the pandemic pressures were excluded from the analysis due to limitations of data access. In addition, maternity and newborn, or patients with the urgency of admission unknown were also excluded.

Response to COVID-19

RPAH was established as a COVID-19 centre on 4 March 2020 and is a 900-bed teaching hospital located in metropolitan Sydney, which provides not only surgical care for the local community but also serves as a quaternary referral centre for complex surgical services including advanced gastrointestinal malignancy, complex cardiovascular and neurosurgery and renal and liver transplantation.⁴ Public patients with malignant breast, gynae-oncological or head and neck disease are treated in the co-located dedicated cancer hospital, within a unique public-private partnership. These patients were not included in the scope of this analysis.

Details regarding the measures implemented in response to the pandemic have previously been outlined,⁴ but in brief included conversion of the perioperative unit into a dedicated COVID-19 clinic, cancellation of all non-essential surgery and outpatient clinics, weekly scheduling of theatre lists, quarantining of surgical inpatient beds for COVID-19 patients and an expansion of intensive care beds into the day surgical unit.

Data sources and outcome measures

The data for this study were extracted from the NSW Health Information Exchange database by an experienced member of the SLHD

Performance Unit. This database contains routinely collected data on all patient separations including diagnoses and treatments through manual coding of patient's medical records using the International Classification of Diseases, 10th revision (ICD-10) coding system.

The following measures were collected:

(i) *Surgical Activity*: Surgical separations, which are defined as a completed episode of care for an admitted patient including those discharged and deceased,¹⁴ undertaken at RPAH by urgency (emergency or elective) and stay type (overnight or same day);

(ii) *Surgical Outcomes*: In-hospital mortality rate; hospital length of stay (days); intensive care admission; post-surgical complications (presence of T81–T87 ICD-10 codes indicating complications related to a procedure, prosthetic device, implant or graft, or a failed or rejected organ and/or tissue);¹⁵ re-admission to the hospital within 28 days (for the local health district); discharge at own risk; and National Weighted Activity Units (NWAU), which is an episode-based funding measure and a proxy measure for complexity; and.

(iii) *Patient Demographics*: This included insurance status (private, public or other) and place of residence (New South Wales, Interstate or Overseas).

Statistical analysis

Descriptive statistics have been used to summarise surgical activity, surgical outcomes and patient demographics. All categorical data are presented as frequencies (percentage), and continuous data as mean and standard deviation (SD). To measure the impact of COVID-19, surgical activity, surgical outcomes and patient demographics were compared between two key time periods in 2020 including the 'First Wave' (1 February to 31 May 2020) followed by the 'Perseverance Phase' (1 June–30 September 2020) compared to control periods at the same time in 2019. It should be noted that 2019 was a stable year for surgical activity in the hospital with only the anticipated small growth ($\approx 3\%$) in activity experienced compared to previous years.¹⁶ Pearson's chi-squared test have been used for categorical variables and independent *t* test was used for continuous variables. All statistical calculations were conducted using SPSS version 25.

Results

A total of 6784 surgical separations occurred between February and September 2020 compared to 9150 during the same time period in 2019 (-26%). In NSW, the first COVID-19 cases were diagnosed at the end of January 2020, with the peak of positive cases occurring between March and April 2020, with a sustained and relatively low number of new cases reported in NSW thereafter (Fig. 1).

Overall surgical activities

A significant reduction on surgical activities was observed in 2020 compared to 2019. A decrease of 32% (1498 cases) occurred in the 'first wave' (February–May 2020 vs. 2019) followed by a decrease

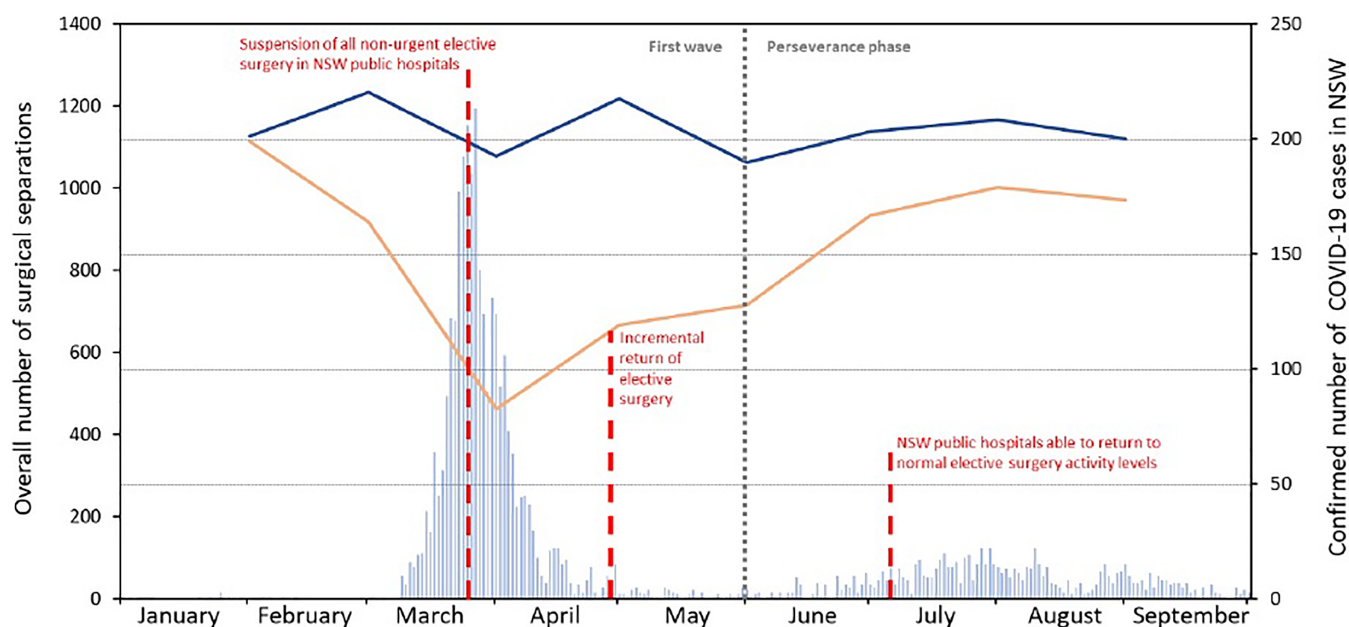


Fig 1. Impact of COVID-19 on the overall number of surgical separations. (■) COVID-19 cases, (—) number of surgeries, 2019, (—) number of surgeries, 2020

of 19% (868 cases) during the ‘perseverance phase’ (June–September 2020 vs. 2019).

Elective cases were most affected, decreasing by 37% (1212 cases) in the ‘first wave’ and 27% (864 cases) during the ‘perseverance phase’. Emergency cases decreased 20% (286 cases) in the ‘first wave’, returning to comparable activity during the ‘perseverance phase’ (Table 1).

Overall surgical outcomes

The overall mean length of hospital stay increased 0.8 days during the ‘first wave’ period. For elective procedures during this ‘first wave’, mean length of hospital stay significantly increased by half a day and by 1.1 days for overnight elective cases specifically. The rate of ICU admissions also increased by 4% during this period. The rate of postoperative complications increased by 4% and 2% within the ‘first wave’ and ‘perseverance phase’, respectively, which was driven by an increase in complications relating to a procedure (T81 code). The overall in-hospital cost, measured by NWAUs, increased on average by 0.6 during the ‘first wave’ and 0.4 during the ‘perseverance phase’. None of the other surgical outcomes changed significantly between the periods investigated including in-hospital mortality, readmissions within 28 days or discharges at the patient’s own risk (Table 1).

Overall patient demographics

There was a significant 3% increase in the proportion of public patients treated during the ‘first wave’ with a corresponding reduction in private patients. There was no significant change in the proportion of patients by their place of residence (Table 1).

Specialty specific surgical activities

Across the surgical specialties, ENT, gynaecology, liver transplant, melanoma, orthopaedics and upper gastrointestinal were the most impacted overall, with the reduction of separations ranging from –57% (ENT) to –18% (Orthopaedics) during the ‘first wave’ and reductions of 74% (melanoma) and an increase in 9% (orthopaedics) within the ‘perseverance phase’ (Table 2).

Discussion

There has been a considerable and sustained indirect impact of COVID-19 on the overall delivery of surgical services during the 8-month period of February to September 2020 compared to the same time period in 2019. This was mostly severely observed within the ‘first wave’ period from February to May 2020 when surgical activity was reduced by a third, representing a reduction of approximately 1500 patients receiving surgical treatment. Surgical outcomes including length of stay, ICU admissions, postoperative complications and average in-hospital costs per patient also significantly increased during this time. The delivery of services partially stabilised during the ‘perseverance phase’, largely driven by the return of normal emergency activity, with elective surgery remaining at significantly reduced levels (–27%). Surgical outcomes also returned to comparable levels except an ongoing increase in average in-hospital costs. The individual experience within each surgical specialty was nuanced and varied, however, all experienced greater reductions in activity within the ‘first wave’ with the exception of melanoma.

In terms of surgical activity, there are important system and individual behavioural level factors that need to be considered as possible drivers behind the variations observed.¹ In regard to emergency

Table 1 Impact of COVID-19 on overall surgical separations, outcomes and patient demographics^a

Variables	February–May		Variation (% or MD)	June–September		Variation (% or MD)
	2019	2020		2019	2020	
Surgical activity						
Overall number of separations	4660	3162	−32%**	4490	3622	−19%**
Emergency	1407	1121	−20%**	1252	1248	0%**
Overnight stay	1327	1062	−20%**	1173	1200	2%**
Same day stay	80	59	−26%	79	48	−39%
Elective	3253	2041	−37%**	3238	2374	−27%**
Overnight stay	1750	1102	−37%*	1780	1251	−30%**
Same day stay	1503	939	−38%**	1458	1123	−23%**
Surgical outcomes						
In-hospital death	38 (1%)	22 (1%)	0%	28 (1%)	23 (1%)	0%
Overall length of stay (mean days)	5.0 ± 10.2	5.8 ± 10.7	0.8*	5.1 ± 9.6	5.4 ± 10.5	0.3
Emergency cases (including same day)	8.9 ± 14.1	8.7 ± 12.4	−0.2	8.6 ± 11.2	8.2 ± 13.3	−0.4
Overnight stay	9.3 ± 14.4	9.1 ± 12.6	−0.2	9.1 ± 11.3	8.4 ± 13.5	−0.7
Elective cases (including same day)	3.3 ± 7.3	3.8 ± 7.8	0.5*	3.6 ± 8.0	3.7 ± 8.0	−0.1
Overnight stay	5.2 ± 9.5	6.3 ± 10.1	1.1*	5.7 ± 10.3	6.2 ± 10.5	0.5
Intensive care unit admissions	626 (13%)	561 (18%)	4%**	639 (14%)	597 (16%)	2%
Postoperative in-hospital complications	417 (9%)	419 (13%)	4%**	461 (10%)	458 (13%)	2%**
Readmission within 28 days	545 (12%)	338 (11%)	−1%	487 (11%)	437 (12%)	1%
Discharge at own risk	26 (1%)	24 (1%)	0%	32 (1%)	24 (1%)	0%
Overall NWAU	3.1 ± 5.6	3.7 ± 6.4	0.6**	3.3 ± 6.4	3.7 ± 6.6	0.4**
NWAU (excluding same day)	4.4 ± 6.5	5.1 ± 7.4	0.7	4.7 ± 7.5	5.1 ± 7.6	0.4
Patient demographics						
Insurance status						
Public	3378 (72%)	2384 (75%)	3%**	3290 (73%)	2677 (74%)	1%
Private	1044 (22%)	583 (19%)	−4%**	990 (22%)	779 (21%)	−1%
Other (ineligible/compensation/DVA)	238 (5%)	194 (6%)	1%**	209 (5%)	165 (5%)	0%
Place of residence^b						
New South Wales	4414 (95%)	3006 (95%)	0%	4286 (96%)	3463 (96%)	0%
Interstate	71 (1%)	28 (1%)	0%	57 (1%)	40 (1%)	0%
Overseas	172 (4%)	128 (4%)	0%	143 (3%)	119 (3%)	0%

Note: Data presented as frequency (%) or mean ± SD; NWAU = National Weighted Activity Unit.

^aMaternity and newborn ($N = 6$) and urgency of admission unknown ($N = 97$) were excluded.

^bPlace of residence unknown ($N = 7$).

* $p < 0.05$; ** $p < 0.001$.

surgery, changes in both patient lifestyle choices brought about by government-enforced lock-down, along with widespread fear of the pandemic and avoidance of hospitals, were likely to be the primary reasons for the significant reductions (−20%) observed within the ‘first wave’ period. This was evident within surgical specialties that see accident and trauma related injuries, such as within plastics and reconstructive surgery, orthopaedics and ophthalmology. This also indirectly impacted on specialties such as liver transplant, where less trauma-related deaths resulted in less donor organs being available for transplantation.¹⁷ Furthermore, the reluctance of patients to undergo medical check-ups and regular screening during this time, such as skin checks, for example, may have contributed to the reductions in activity within a number of specialties such as melanoma, which has been observed elsewhere.¹⁸ There was also notable reductions in emergent gynaecological issues with a reduction in dilation and curettage (D&C) procedures as well as the treatment of abscesses and cysts, which may have been related to patient factors. Certainly, these patient behavioural changes were outside the control of the hospital system. The return to comparable levels in the ‘perseverance phase’ perhaps reflects the release of some lock-down measures as well as the adjustment of the community to living with the pandemic and the confidence in the health system. It is worth noting that during the pandemic, no surgical patient diagnosed as COVID-19 positive was operated on at RPAH.

Conversely, the impact on elective surgical activity was largely driven by system level changes. Surgical resources were either diverted to treat COVID-19 patients, such as with the surgical inpatient beds or staff to assist with the Special Health Hotels, or reserved for severely ill COVID-19 patients, such as with the intensive care beds, resulting in a requirement for elective surgery to continue at reduced levels. Even despite the low levels of community transmission, the ever-present possibility of the pandemic escalating kept elective surgery lists remaining at 75% of full activity given the status of the hospital as a designated COVID-19 centre. Strategies such as partnering with private hospitals to provide surgical treatment to public patients were successfully implemented within the ‘perseverance phase’ and assisted many specialties including colorectal, upper GI, vascular, melanoma and orthopaedics to provide time-critical care to patients and partially accounts for the ongoing reductions in activity at RPAH. It is apparent many of the non-cancer specialties such as ENT, ophthalmology and gynaecology had the biggest impacts on their elective cases, which is in line with the restrictions only allowing Category 1 cases to proceed in the ‘first wave’. Despite this, specialties such as liver transplant experienced sizable reductions in their activity, which was related to the uncertainty surrounding the effect COVID-19 would have on the immunosuppression of their patients.¹⁹ Measuring the long-term

Table 2 Impact of COVID-19 on surgical specialty separations

Variables	February–May		Variation (%)	June–September		Variation (%)
	2019	2020		2019	2020	
Cardiothoracic surgery						
Total separations	281	219	–22	291	267	–8
Emergency	104	72	–31	88	73	–17
Elective	177	147	–17	203	194	–4
Colorectal surgery						
Total separations	395	287	–27	415	312	–25
Emergency	149	138	–7	160	171	7
Elective	246	149	–39	255	141	–45
Ear, nose and throat						
Total separations	205	89	–57**	188	121	–36**
Emergency	27	19	–30	19	27	42
Elective	178	70	–61	169	94	–44
Gynaecology						
Total separations	998	577	–42**	957	793	–17**
Emergency	144	90	–38**	116	108	–7**
Elective	854	487	–43**	841	685	–19**
Liver transplant						
Total separations	85	43	–49**	59	61	3**
Emergency	43	28	–35	29	32	10
Elective	42	15	–64**	30	29	–3**
Melanoma						
Total separations	146	76	–48**	138	36	–74**
Emergency	14	10	–29	9	5	–44
Elective	132	66	–50**	129	31	–76**
Neurosurgery						
Total separations	279	212	–24	247	234	–5
Emergency	95	81	–15	61	69	13
Elective	184	131	–29	186	165	–11
Ophthalmology						
Total separations	208	107	–49	230	133	–42
Emergency	5	3	–40	7	5	–29
Elective	203	104	–49	223	128	–43
Orthopaedic						
Total separations	552	452	–18**	483	528	9**
Emergency	301	240	–20*	296	301	2*
Elective	251	212	–16**	187	227	21**
Plastic and reconstructive surgery						
Total Separations	458	349	–24	468	393	–16
Emergency	194	114	–41	186	128	–31
Elective	264	235	–10	282	265	–6
Renal transplant						
Total separations	45	37	–18	49	43	–12
Emergency	31	24	–23	30	20	–33
Elective	14	13	–7	19	23	21
Upper gastrointestinal						
Total separations	512	326	–36*	428	342	–20*
Emergency	186	205	10	146	209	43
Elective	326	121	–63	282	133	–53
Urology						
Total separations	287	226	–21	301	204	–32
Emergency	56	45	–20	48	41	–15
Elective	231	181	–22	253	163	–36
Vascular						
Total separations	174	141	–19	203	137	–33
Emergency	45	44	–2	46	50	9
Elective	129	97	–25	157	87	–45

Note: Breast surgery ($N = 28$) and head and neck surgery ($N = 79$) were removed due to small case numbers with the activity predominantly being undertaken in a nearby public-private facility; Maternity and newborn ($N = 6$) and urgency of admission unknown ($N = 97$) were excluded; * $p < 0.05$; ** $p < 0.001$.

impact of the delay to treatment will be critical. Most specialties, with the exception of orthopaedics, continued to experience reductions in elective activity in the ‘perseverance phase’.

Given the substantial disruptions to the hospital and community overall, the impact on surgical outcomes was arguably quite moderate given the circumstances. Most critically in terms of safety, there

were no changes to the in-hospital mortality rate during the time. This was similarly reflected in the stable measures of readmissions to the hospital within 28 days and the number of patients who discharged themselves at their own risk. While there were increases in the mean length of stay, ICU admissions, postoperative complications specially related to procedures, and average in-hospital costs

per patient during the 'first wave', in particular, it is difficult to determine the exact reasons for this. It may reflect the disruption to the system, and a level of inefficiency that was created by the uncertainty and change to business as usual processes. It may also reflect a higher proportion of complex patients being treated in the hospital at that time as a result of patients presenting with more advanced pathology due to delayed presentation or the restriction to Category 1 patients and the focus on only treating those patients who were time critical. This is supported by the increase in NWAU observed.

Although this study provides an important high-level overview of the indirect impacts of COVID-19 on the delivery of surgical services at a busy teaching hospital, it does have limitations. First, it is based on the short-term inpatient experience of a single centre during a set period of time within a situation that continues to change and evolve, and as such the findings need to be considered in that context. There is an opportunity for subsequent studies to continue tracking the impacts of the pandemic including exploring other aspects of surgical services including non-operative management of patients, referral patterns, and screening, as well as to undertake specialty specific studies that focus on greater levels of detail regarding specific pathologies or procedure level implications. Due to limited data availability, this study did not examine the impact on the cancer patients treated surgically within breast, gynae-oncology and head and neck within the co-located cancer hospital, or the public patients treated offsite in private hospitals during the pandemic, which constrains the applicability and generalizability of these findings. There are also known constraints to use administrative datasets including its focus on short-term, largely in-hospital surgical outcomes as well as a potential under-reporting of patient complexity.²⁰ Future studies will be critical for examining the longer term impact of COVID-19 on surgical patient outcomes.

In conclusion, COVID-19 has had a considerable impact on the overall delivery of surgical services, which was most severely experienced in the initial months of the pandemic and observed in the reduced number of patients treated. Although there was an initial effect on some surgical outcomes, overall, the delivery of surgical treatment was safe. The delivery of elective surgery remains a challenge and reflects the ongoing system-wide changes that are required to manage the COVID-19 pandemic.

Acknowledgements

Ms. Elaine Pan and Sydney Local Health District Performance Unit for their support provided towards this manuscript.

Conflict of interest

None declared.

Author contributions

Kate E. McBride: Conceptualization; methodology; data analysis; writing original draft; review and editing. **Daniel Steffens:** Conceptualization; methodology; data analysis; table development; review and editing; visualization. **Michael J. Solomon:** Conceptualization; writing review and editing; supervision.

Data availability statement

The original contributions presented in the study are included in the article, further enquiries can be directed to the corresponding author.

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