

RESEARCH ARTICLE

The Effect of the COVID-19 Pandemic on Theatre Efficiency, Lessons to be Learned for Subsequent Waves

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Abstract

Background: This study aims to demonstrate the impact of the COVID-19 pandemic on providing trauma services at our district general hospital. We aim to identify the impact on specific areas of theatre delay to help optimize theatre efficiency and generate better protocols and improve patient flow for future pandemic waves.

Methods: Patients who underwent orthopaedic trauma surgery at our hospital between July-August 2019 (pre-COVID-19) and 2020 (first UK wave of COVID-19) were identified retrospectively and grouped by year of operation. Type of operation was recorded, including time for sending, anaesthetic induction, surgical preparation, operating time, and time for transfer to recovery. The two groups were compared for analysis.

Results: Case numbers were similar in both 2019 and 2020 (215vs.213 operations), with a similar proportion being hip fractures (39.1% and 36.6%), respectively. Median sending time (40vs.23 minutes, $P < 0.00001$) and induction time (13vs.8 minutes, $P < 0.00001$) were increased in 2020, a 74% and 63% increase compared to 2019, respectively. Median surgical preparation time (35vs.37 minutes, $P=0.06$) and operating time (56vs.50 minutes, $P=0.16$) were not statistically significant. Transfer time in 2020 (16vs.13 minutes, $P < 0.00001$) was significantly increased. Overall case time increased in 2020 (2:40vs.2:11, $P < 0.00001$) by 29 minutes.

Conclusion: COVID-19 had a significant impact on theatre efficiency in our hospital, causing multiple points of delay. As hospitals across the UK restart crucial elective services, focus should be given to maximizing theatre efficiency by providing rapid access COVID-19 testing for patients undergoing emergency surgery. We have proposed and implemented several steps for better theatre utilization.

Level of evidence: III

Keywords: COVID-19, Orthopaedics, Theatre efficiency, Theatre utilization, Trauma

Introduction

The COVID-19 pandemic has generated the single greatest public healthcare crisis in the last one hundred years. Facing an unmanageable number of COVID-19 hospital admissions, the UK Government introduced stringent national measures, including an unprecedented public lockdown in March 2020, intending to reduce infection rates and prevent hospitals from becoming overwhelmed. All elective orthopaedic

operations, including arthroplasty, were cancelled to free beds and theatre resources, although trauma and emergency lists continued throughout(1).

Evidence emerged during the first pandemic peak, showing increased morbidity and mortality associated with perioperative COVID-19 infection for patients undergoing emergency surgery (2). Surgical theatres are high-risk environments for

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nosocomial transmission of COVID-19 due to the large numbers of regularly occurring aerosol-generating procedures. The Royal College of Surgeons released intercollegiate guidance in March 2020, based on Public Health England (PHE) advice that all staff were to wear full personal protective equipment (PPE) for each operative procedure. This was regardless of patient COVID-19 status and included a deep clean occurring after each operation and delayed entering and leaving theatre spaces after an aerosol-generating procedure(3,4).

Our hospital is a busy district general hospital, with nineteen Orthopaedic consultants and daily trauma lists running seven days per week and out of hours whenever needed. The unit also acts as a tertiary referral centre for complex comminuted fractures requiring Ilizarov frames. A dedicated laminar flow trauma theatre runs morning and afternoon Monday through Friday, with a second theatre running in the afternoon to help perform additional cases. On weekends, a regular trauma list is performed both days.

This study aims to describe the impact COVID-19 has had on the trauma service provided at our hospital. We aim to identify the impact on specific areas of theatre efficiency during the COVID-19 pandemic compared to the previous year. This will improve understanding as to where delays lie, help generate better protocols and optimize theatre efficiency during other future pandemic waves. Our results could apply to all theatre services in the UK, particularly during the reintroduction of elective surgery lists.

Materials and Methods

All patients who had an orthopaedic trauma operation at [PLACE OF RESEARCH REDACTED] between 1 July – 31 August

2019, and 2020 respectively were identified from Bluespier Patient Manager Operating System. We obtained institutional approval from the research and audit department prior to the collection of data. Data from these patients were collected retrospectively and cohorted by year of operation into two discrete groups. Patients who had data missing for any of the timing fields were excluded from time comparisons. All patients in 2020 were operated on with theatre staff in full PPE per original RCS guidance (3)(3). The number of patients and type of operation were recorded alongside the time taken from:

- Sending for the patient until arrival in the anaesthetic bay (Sending time)
- Arrival to anaesthetic induction (Induction time)
- Anaesthetic induction until knife to skin or start of Surgery (Surgical prep time)
- Knife to skin or Start of Surgery until Sutures completed or End of Surgery (Operating time)
- Sutures completed or end of Surgery until arrival in recovery (Patient transfer time)

Median times were calculated for both groups at each stage of their journey through theatre, and overall times were also calculated. Mann-Whitney U testing with a two-tailed hypothesis was used to compare this non-normally distributed data using median average times with interquartile ranges (IQR) presented. Results were considered significant if $P < 0.05$.

Results

215 orthopaedic trauma operations were undertaken in July – August 2019 compared to 213 in July – August 2020. Of these, 84/215 (39.1%) and 78/213 (36.6%) were hip fracture patients. The full analysis of types of operation is summarized in [Table 1].

Table 1. Trauma orthopaedic operations performed in July - August 2019 and 2020 for comparison

Operation type	2019 (n=215)	2020 (n=213)	Number change	Percentage change
Hip Hemiarthroplasty	27	32	+5	+18.5%
PFNA	21	26	+5	+23.8%
Intramedullary Femoral Nail	10	3	-7	-70%
Periprosthetic fracture repair	8	2	-6	-75%
THR for neck of femur fracture	10	9	-1	-10%
DHS	4	6	+2	+50%
Revision THR	5	5	0	0.0%
Hip cannulation screws for neck of femur fracture	4	0	-4	-100%
ORIF	35	50	+15	+42.9%
Application of frame	11	10	-1	-9.1%
Removal of metalwork / frame	17	8	-9	-52.9%
Lumbar decompression	1	5	+4	+400%
Joint aspiration +/- washout	10	15	+5	+50%
MUA +/- percutaneous fixation	17	23	+6	+35.3%
Tendon repair	11	3	-8	-72.7%
Soft tissue injuries & abscess drainage	19	11	-8	-42.1%
Other	5	5	0	0%

PFNA ; proximal femoral nail antirotation, THR ; total hip replacement, DHS ; dynamic hip screw, ORIF ; open reduction internal fixation, MUA ; manipulation under anaesthetic

Table 2. Median time taken for each operative case at different stages through theatre in both 2019 and 2020 for comparison

Stages in theatre	July – August 2019 (n=196)	July – August 2020 (n=195)	Total time change	Percentage change	P value
Time 1 st Case sent for	08:12 (08:00-08:27)	08:04 (07:45 - 08:19)	-0:08	-	0.01*
Sending time	0:23 (0:16 - 0:32)	0:40 (00:28 - 00:55)	+ 0:17	+74%	<0.00001*
Induction time	0:08 (0:05 - 0:14)	0:13 (0:08 - 0:20)	+0:05	+63%	<0.00001*
Surgical prep time	0:37 (0:26 - 0:50)	0:35 (0:24 - 0:44)	-0:02	-5%	0.073
Operating time	0:50 (0:24 - 1:11)	0:56 (0:32 - 1:19)	+0:06	+12%	0.160
Transfer time	0:13 (0:09 - 0:17)	0:16 (0:12 - 0:21)	+0:03	+23%	<0.00001*
Overall time per case	2:11 (1:46 - 2:54)	2:40 (2:06 - 3:25)	+0:29	+22%	<0.00001*

* = statistically significant ($P < 0.05$)

196/215 (91%) and 195/213 (92%) operations in 2019 and 2020 were available for time analyses. A summary of the results is included in [Table 2]. The first case each morning was earlier in 2020 than 2019 (08:04 vs. 08:12, respectively, $P=0.01$). Median sending time in 2020 (40 vs 23 minutes, $P<0.00001$) and induction time (13 vs 8 minutes, $P<0.00001$) were significantly increased, representing a 74% and 63% increase in time taken compared to 2019, respectively. Median surgical preparation time (37 vs 35 minutes, $P=0.06$) and operating time (50 vs 56 minutes, $P=0.16$) showed no significant difference between groups. Finally, transfer time in 2020 (16 vs 13 minutes, $P<0.00001$) was significantly increased, although this only represented a 3 minute increase (23%). Overall time per case increased significantly in 2020 (2:40 vs 2:11, $P<0.00001$), increasing 29 minutes (22%) overall. Averaging 4 cases per day, lost time calculated at 1 hour and 56 minutes.

Discussion

This study demonstrates the profound impact the COVID-19 pandemic has had on theatre efficiency at our district general hospital. Interestingly, the number of cases performed in both 2019 and 2020 were similar (215 vs 213 operations respectively), despite significant theatre delays. Several similar studies reported an initial decrease in trauma burden during the months of national lockdown when people were staying at home (5,6). This study was performed at a slightly later date in 2020, suggesting that trauma burden has returned to pre-pandemic levels since operation numbers were very similar. The proportion of hip fracture patients remained almost identical (39.1% and 36.6%, respectively). However, it is likely

the number of trauma cases able to be performed stayed similar due to the cessation of elective theatre lists, allowing for more emergency work. A return to pre-pandemic numbers of trauma surgery, alongside a drive to restart elective Surgery, further highlights the importance of optimizing theatre efficiency. PPE advice has since changed for Orthopaedic Surgery based on British Orthopaedic Association (BOA) and PHE updated guidance. Both state that if patients were swab proven COVID-19 negative, then staff need not take full PPE precautions or deep theatre cleaning due to the low risk of transmission during Surgery (7,8). It should be noted that whilst this guidance was released in July 2020, this had not yet been adopted at [PLACE OF RESEARCH REDACTED] Hospital at the time of this study. However, like most UK hospitals, [PLACE OF RESEARCH REDACTED] Hospital has subsequently adopted a swab proven COVID-19 negative environment for patients in theatre unless life or limb saving emergency surgery is required.

Improving theatre efficiency remains challenging even before pandemic times. Several pre-pandemic studies have cited prolonged changeover times and late starts as areas of inefficiency in orthopaedic theatres (9). One study at a major trauma centre in Bristol demonstrated a 45% reduction in theatre turnaround time by implementing several simple interventions. These included a 15-minute warning to the preoperative rooms, patients being checked-in to the preoperative rooms rather than theatre, the patient is sent for before completion of theatre cleaning and a 5-minute warning given to theatre cleaning staff (10).

In our study, the most significant delays were from

time sending for patients to arrival (23 vs 40 minutes, $P<0.00001$), representing an increase of 17 minutes (74%). This is despite an earlier sending time for the first case in 2020 (08:12 vs 08:04, $P=0.01$). Interestingly, surgical preparation (37 vs 35 minutes in 2019 and 2020, respectively, $P=0.06$) and operating times (50 vs 56 minutes, $P=0.16$) were similar and not significant. The delay in anaesthetic induction (8 vs 13 minutes, $P<0.00001$) and transfer to recovery (13 vs 16 minutes, $P<0.0001$) may well be explained by RCS guidance at the time for isolated intubation and extubation to reduce the risk of nosocomial COVID-19 transmission. Other similar studies during the COVID-19 pandemic have noted similar delays in theatre turnaround times (5,11).

One potential limitation of our data is the accuracy of timing recordings by theatre staff. Often only times for “Knife to skin” or “start of surgery” were used rather than both as well as “suturing complete” and “end of surgery” although these cases were not excluded. Where timings were not recorded, we decided to exclude all timings to maintain the validity of data for any single point of the patient’s theatre journey. The number of timings excluded was similar between each group (91% vs 92% in 2019 and 2020, respectively), suggesting this was not affected by COVID-19 and that the data sets are comparable. The study dates are adjacent to staff changeover date at the start of August, which may explain some of these inaccuracies, possibly due to being a hectic time of year. This study’s strength is its applicability to other hospitals and other specialties – most trauma cases included in our study would be those familiar at most district general hospitals. While theatre processes vary between Trusts, most follow similar protocols. These are likely to have become more similar following RCS intercollegiate guidance for all UK theatres during the COVID-19 pandemic.

From our results, the most significant single delay is from sending to arrival. This is likely multifactorial: consent for operations takes longer to include the risk of COVID-19, particularly if telephone discussions must be had with families of patients who lack capacity and cannot visit the hospital due to COVID-19 restrictions. However, we hypothesize the most significant cause for sending delay is likely due to emergency patients, admitted from A&E, not having COVID negative status due to swab processing delays. This confuses theatre staff and surgeons deciding the operating list order and anaesthetists who review patients first on the list the night before.

Whilst UK testing availability has increased since the pandemic began, rapid testing remains expensive and limited. Our Trust recently purchased a SAMBA II@ machine at great expense, capable of highly accurate COVID-19 swab results within 90 minutes, to facilitate

rapid diagnosis of high-risk patients. Due to their limited availability, these have previously been reserved for suspected COVID-19 patients rather than patients admitted for emergency surgery. Plans to roll out this rapid testing to all patients admitted into hospital are currently underway.

With no end in sight yet to the COVID-19 pandemic, our study demonstrates the significant theatre delays secondary to COVID-19. Following advice change on PPE for COVID-19 negative patients, there is a clear need for readily available and rapid results COVID-19 testing from the point of admission for all emergency surgical patients. Therefore, we recommend rapid COVID-19 testing for all UK hospital theatres to maintain COVID-19 negative environments, which will improve efficiency and save money, time, resources, and allow for greater caseload. The implementation of proven theatre efficiency protocols, including early warnings to preoperative rooms and five minute warnings for theatre cleaning staff, are now more critical than ever. Combining these will facilitate a smoother reintroduction of elective lists, which are sorely needed to work through the backlog of life-changing operations.

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