

The impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital

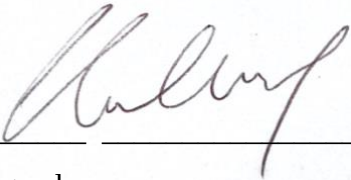
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A research report submitted to the Faculty of Health Sciences,
University of the Witwatersrand, Johannesburg,
in the partial fulfilment of the requirements for the degree of
Master of Medicine in the branch of Anaesthesiology

Johannesburg, 2023

Declaration

I, Dr Kirsten Morley-Jepson, herewith declare that this research report is my own, unaided work. It is being submitted for the degree of Master of Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



Signed

On this the 21th day of April 2023

Dedication

This project is dedicated to my husband Andrew who has supported me throughout the MMED process.

Abstract

Background

SARS-COV-2, the pathogen responsible for COVID-19, was initially identified by the World Health Organisation (WHO) on the 31st of December 2019 following the presentation of 27 patients, with an acute respiratory syndrome of unknown aetiology, in Wuhan City in China [1]. Since its discovery in late 2019, COVID-19 has altered life as we know it for a large percentage of the world's population. As of November 2022, COVID-19 has been diagnosed in 228 countries and territories and resulted in more than six million deaths [2]. COVID-19 has put immense strain on healthcare systems throughout the world. Rahima Moosa Mother and Child Hospital (RMMCH) in Coronationville, Johannesburg is no exception. From the announcement of a national state of disaster on the 18th of March 2020 and subsequent implementation of 'Lockdown' on the 27th of March 2020, hospital services have been severely altered and disrupted. The ramifications of this disruption are yet to be formally investigated. This study aims to identify the effect of the above directive on theatre utilization and compare it to theatre usage pre-pandemic at RMMCH.

Methods

A retrospective descriptive study surveying theatre utilisation for 12 months prior to, and 12 months after the onset of the COVID-19 pandemic, was conducted at RMMCH. Anaesthetic charts, theatre statistics, and theatre logs were accessed and analyzed to obtain data relating to number of theatre cases and theatre hours completed as well as data pertaining to blood product utilisation during the specified time periods. In addition, intensive care unit, high care unit and ward admission records were retrospectively analyzed for data pertaining to morbidity and mortality data for the same specified time periods. Data recording theatre case cancellations and postponements was also analyzed. All data was input into a Microsoft Excel® spreadsheet.

Results

There was a statistically significant reduction in theatre utilisation both in terms of cases done and theatre hours used when comparing data from the year preceding the onset and the first year after the onset of the COVID-19 pandemic.

There was a statistically significant increase in case postponement and cancellation after the onset of the pandemic. Recorded numbers of morbidity and mortality were low across both time periods. There were no statistically significant increases in ICU and HC admissions, blood transfusion, or mortalities for the period studied.

Conclusion

Although the study showed no statistically significant change in morbidity or mortality between the two time periods, theatre utilisation was negatively affected in the first year of the COVID-19 pandemic. This may have ramifications with respect to patient satisfaction and disease progression, as well as for the training of healthcare professionals and requires further investigation.

(Word count: 416)

Acknowledgements

To my supervisors, Dr Janine Wagner, and Dr Thomas Kleyenstuber, thank you for your constant insight, guidance, patience, and support.

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LIST OF ABBREVIATIONS

HCU	High care unit
ICU	Intensive care unit
RMMCH	Rahima Moosa Mother and Child Hospital
PUI	Patient under investigation
COVID-19	Coronavirus disease of 2019
PPE	Personal protective equipment
ENT	Ear, nose and throat
GIT	Gastrointestinal
C/S	Caesarean section delivery
Caesar/ caesarean	Caesarean section delivery

Statement

The Research Report consists of a literature review, draft article, study proposal, and appendices. The literature review and study proposal are included for background reference and are not for examination.

The formatting of this Research Report, but not the draft article, complies with the University of the Witwatersrand's Style Guide for Theses, Dissertations and Research Reports.

The formatting of the draft article is in keeping with the author guidelines (Section 2) stipulated by the South African Journal of Anaesthesia and Analgesia, the journal to which it will be submitted for publication.

Section 1. Review of the literature

Introduction:

SARS-COV-2, the pathogen responsible for COVID-19, was initially identified by the World Health Organisation (WHO) on the 31st of December 2019 following the presentation of 27 patients, with an acute respiratory syndrome of unknown aetiology, in Wuhan City in China [1]. Since its discovery in late 2019, COVID-19 has altered life as we know it for the majority of the world's population. As of November 2022, COVID-19 has been diagnosed in 228 countries and territories and resulted in more than six million deaths [2]. COVID-19 has put immense strain on healthcare systems throughout the world.

The WHO defines a pandemic as an “*epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people*” [3]. In keeping with definition, COVID-19 is considered to be the 17th major pandemic in the history of civilisation [4].

The first case of coronavirus in South Africa was declared on the 5th of March 2020 and a global pandemic was declared on the 11th of March 2020. What followed was a massive global effort to curb the spread of COVID-19. Countries worldwide began to implement strategies to limit cross contamination and to make space in their hospitals for the expected massive influx of COVID-19 patients. In South Africa the strategies were no different, however, the decisions made, and the effects of these decisions may differ significantly due to the limited resources and pre-existing massive patient and disease load characteristic of the South African public healthcare system [5].

Elective surgeries were cancelled, non-essential clinics were closed, and COVID-19 specific wards and intensive care units were opened. Strict protocols regarding the use of personal protective equipment (PPE) were put in place, and training on ‘doffing’ and ‘donning’ was instituted for all involved hospital staff. PPE was procured in large amounts, and in some provinces plans for the construction of ‘field hospitals’ were instituted [6].

Another strategy employed in South Africa, in an effort to reduce transmission and free up hospital space, was the banning of alcohol which occurred initially from the 27th of March

2020 until the 1st of June 2020, and then again from the 12th of July until the 17th of August. A third alcohol ban occurred from the 28th of December 2020 until the 1st of February 2021, and a fourth ban on the sales of alcohol for offsite consumption was declared over the 2021 Easter period of 2-5 April 2021 [7].

As the number of cases increased significantly in South Africa, a national state of disaster was announced on the 18th of March 2020. 'Lockdown' was subsequently implemented on the 27th of March 2020. This comprised many regulations being put into place to 'flatten the curve' and to slow the spread of the novel coronavirus. Strict protocols were implemented in all South African hospitals to free up ward space to treat the expected influx of COVID-19 patients, and to decrease spread occurring to non-infected in-hospital patients admitted for reasons other than COVID-19 [6].

It was observed that there was a significant decline in the number of surgical procedures being performed. Both elective and emergency cases were affected. It has been postulated that a massive surgical backlog has occurred, and that there has been an increase in morbidity related to postponed surgeries. Patient mortality may also have increased. [1]

The provision of a surgical service is a vital component of any healthcare system. Surgical procedures may be classified as either emergency or elective. According to the WHO, emergency surgery comprises interventions that are considered critical for specific conditions to prevent premature death and disability [8]. Elective surgery implies that the surgery may be scheduled in advance [9]. It is, however, a misconception that elective surgery is always optional. Elective surgery may include surgery for malignant conditions, and conditions that can significantly affect a patient's quality of life. Thus, although not emergent, the urgency at which these elective cases need to be done can vary considerably.

Rahima Moosa Mother and Child Hospital (RMMCH) is a regional public hospital, although it provides many tertiary services, located in Coronationville in Johannesburg, Gauteng. It is a 345-bed hospital offering a multitude of surgical services. The surgical services offered at RMMCH include elective and emergency obstetrics, gynaecology, and paediatric surgery. Paediatric surgery includes ear, nose, and throat (ENT), plastic surgery, dental surgery, orthopaedic surgery (elective and emergency), gastrointestinal (GIT) endoscopic procedures, and urological surgery.

There are five theatres at RMMCH. These include:

- Theatre A – Obstetric and gynaecological emergencies.
- Theatre B – Elective obstetric theatre.
- Theatre C – Elective gynaecology theatre.
- Theatre D – Used to perform septic/ grossly contaminated cases prior to COVID-19 pandemic. This theatre was converted to paediatric theatre following the onset of the pandemic.
- Theatre E – Paediatric theatre (prior to COVID-19 pandemic), converted to a dedicated theatre for confirmed or suspected cases of COVID-19 following onset of the pandemic.

Following the implementation of the nationwide lockdown and in accordance with national guidelines, on the 19th of March 2020, a directive was received to suspend all elective surgery at RMMCH [12]. The ramifications of this directive are yet to be formally investigated. This study aims to identify the effect of the above directive on theatre utilization and compare it to theatre usage pre-pandemic at RMMCH.

Similar studies have been performed in other South African hospitals [1, 9, 10] and internationally [13,14, 16, 17, 18, 19] as similar policies on the suspension of elective surgery have been implemented globally. These studies have shown a significant reduction in surgical cases done.

A study conducted in Kwa-Zulu Natal by Laäs et al. [11], examined the effect of COVID-19 pandemic decisions on tertiary-level surgical services in Pietermaritzburg. This study found that the implementation of restrictive measures on theatre procedures had significantly impacted theatre productivity and service delivery. The theatre caseload was found to have decreased by 30% from January to April 2020.

In this study the researchers predicted a ‘theatre case deficit’ by applying this percentage reduction to the number of cases normally done in the ‘pre-lock down’ phase per month and estimated that the theatre case deficit (over the four months analysed) was 1 260 cases and they would require 315 ‘theatre days’ to make up the deficit [11].

Chu et al. [1] conducted a study, including both the private and public sector, to assess the changes in surgical practice in 85 South African hospitals during the COVID-19 hard lockdown. They concluded that the change in surgical practice during the COVID-19 lockdown resulted in significantly reduced access to surgical care in South Africa, and that this could potentially result in a surgical backlog as well as an excess in morbidity and mortality [1].

In a study by Moustakis et al. [12], in the North West province in South Africa, showed that there were significant reductions in surgical admissions, both for trauma and non-trauma related pathologies. Specifically there was a 44% reduction in the incidence of non-trauma related admissions, and a 53% reduction in the incidence of trauma-related admissions during lockdown [12].

Studies conducted internationally have produced similar findings [13,14, 16, 17, 18, 19]. In the United Kingdom a directive was issued on the 17th of March 2020 instructing the postponement of all non-urgent elective surgery for at least three months [13]. MacDonald et al. [13] found that a backlog of approximately 1 200 000 cases occurred over the 3-month period. The study also described a progressive increase in waiting list times. The authors also postulated an increase in morbidity resulting from this backlog and concluded that this would place a significant burden on healthcare services in the future. Fu et al. [16] in the United States of America have emphasized that “progression is a key feature of many surgical diseases, and delays in treatment result in worse outcomes and higher mortality for patients across a broad spectrum of diseases”. As such, delays in cancer surgeries will have severe ramifications and delays in non-cancer surgeries may be costly as a result of additional emergency admissions, blood transfusions, and other additional therapeutic interventions. Additionally, significant morbidity and even mortality may occur in some cases [16, 17, 18].

Khadabadi et al. [17] in the United Kingdom reported findings of profoundly reduced theatre productivity owing mostly to increased safety protocols for theatre staff allowing far fewer cases to be done per day [17].

Ogundele et al. [18] in Nigeria, have described that the COVID-19 pandemic resulted in a cessation of elective surgeries, as well as a marked reduction in the amount of emergency surgeries performed on children. The study emphasized that the effect of a reduction in theatre utilization may be more damaging in low- and middle-income countries where resources are already limited, and healthcare systems are suboptimal such as that in South Africa.

Wang et al. [19] in Canada published a study in which the authors made an estimation on the size of the non-emergent surgical backlog during the pandemic. They determined that there was a backlog/ case deficit, between the 15th of March 2020 and the 13th of June 2020, of 148 364 surgeries, and estimated that this had resulted in a backlog time of 84 weeks.

RMMCH offers maternal and paediatric health services although obstetrics services form the major component of the surgical services rendered. Caesareans are the most commonly performed surgical procedure in obstetrics, and may either be elective or emergency. Elective caesareans, however, are not truly ‘elective surgeries’, as a great many of them, if not done timeously, will progress to being emergencies. This creates an interesting situation as although it was instructed by government to halt all elective surgery, caesareans cannot fall into this category.

Summary and recommendations for research:

The effect of the COVID-19 pandemic at RMMCH is unknown and may be significant. The aim of this research is to determine the effect of COVID-19 pandemic restrictions on theatre utilization at RMMCH.

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Section 3: Draft Article

The impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital

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Abstract:

Background:

SARS-COV-2, the viral pathogen that resulted in the COVID-19 pandemic, was identified by the World Health Organisation (WHO) on the 31st of December 2019. Efforts to curb the spread of the virus, the effects of viral infections, and resulting complications thereof, have placed immense strain on healthcare systems throughout the world. In South Africa, a nation-wide lockdown instituted on 27 March 2020 resulted in the suspension of all elective surgical services. The effect of the suspension of services has not been fully elucidated, but it has been postulated that a massive surgical backlog may have occurred due to limited resources and massive pre-existing patient loads.

Methods:

A retrospective descriptive review of theatre records was conducted at Rahima Moosa Mother and Child hospital (RMMCH) for the time period 1 March 2019 to 28 February 2021.

Results:

A total of 8 176 cases amounting to 9 656 hours and 20 minutes of theatre time occurred from 1 March 2019 to 29 February 2020 (pre COVID-19). From 1 March 2020 to 28 February 2021 (post COVID-19) a total of 7 717 cases amounting to 9 148 hours and 2 minutes were conducted. There was a statistically significant reduction in theatre utilization both in terms of cases done and in hours of theatre time after the onset of the COVID-19 pandemic. This amounted to a 5.61% reduction in cases, and a 5.26% reduction in theatre hours.

Conclusion:

The onset of the COVID-19 pandemic significantly reduced the number of cases completed at RMMCH. It also led to a reduction in total theatre utilisation. Both of these findings were most pronounced in elective gynaecology, and paediatric surgery services. There was also a statistically significant increase in intensive care unit (ICU) and high care (HC) admissions as well as mortalities for the period studied.

(287 words)

Introduction

SARS-COV-2, the viral pathogen responsible for the COVID-19 pandemic, was initially identified by the World Health Organisation (WHO) on the 31st of December 2019. This followed the presentation of 27 patients in Wuhan City in China, with an acute respiratory syndrome of unknown aetiology.¹ Since its discovery in late 2019, COVID-19 has altered life as we know it for most of the world's population. As of October 2022, COVID-19 has been diagnosed in 228 countries and territories, and has resulted in more than six million deaths.² COVID-19 has put immense strain on healthcare systems throughout the world. In April 2021 the WHO reported that 90% of countries experienced significant disruptions to essential healthcare services.³

The WHO defines a pandemic as an “*epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people*”.⁴ In keeping with definition, COVID-19 is considered to be the 17th major pandemic in the history of civilisation.⁵ The first case of COVID-19 in South Africa was identified on the 5th of March 2020, and a global pandemic was declared on the 11th of March 2020. What followed was an extensive global effort to curb the spread of COVID-19. Countries began to implement strategies to limit cross contamination and to make space in their hospitals for the expected massive influx of COVID-19 patients. In South Africa the strategies were no different, however, the decisions made and the effects of these decisions may be found to differ significantly due to the limited resources and pre-existing enormous patient load characteristic of the South African public healthcare system.⁶

As the number of cases increased rapidly in South Africa, a national state of disaster was announced on the 18th of March 2020. ‘Lockdown’ was subsequently implemented on the 27th of March 2020. This comprised many regulations being put into place to slow the spread of the novel coronavirus. Strict protocols were implemented in all South African hospitals in an attempt to free up ward space to treat the expected surge of COVID-19 patients, and to decrease the spread occurring to non-infected in-hospital patients admitted for reasons other than COVID-19, as well as to essential hospital staff.⁷

Elective surgeries were cancelled, non-essential clinics were closed, and COVID-19 specific wards and intensive care units were opened. Strict protocols regarding the use of personal protective equipment (PPE) were put in place, and training on ‘doffing’ and ‘donning’ was instituted for all involved hospital staff.⁸

The provision of a surgical service is a vital component of any healthcare system. Surgical procedures may be classified as either emergent or elective. According to the WHO, emergency surgery comprises interventions that are considered critical for specific conditions to prevent premature death and disability.⁹ Elective surgery implies that the surgery may be scheduled in advance.¹⁰ It is, however, a misconception that elective surgery is always optional. Elective surgery may include surgery for malignant conditions and conditions that can significantly affect a patient’s quality of life. Thus, although not emergent, the urgency at which these elective cases need to be done can vary considerably depending on their indication.

RMMCH is a regional public hospital, although it provides many tertiary services, located in Coronationville in Johannesburg, Gauteng. It is a 345-bed hospital offering a multitude of surgical services, both elective and emergency. The surgical services offered at RMMCH include obstetrics, gynaecology, and paediatric surgery cases. Paediatric surgery includes ear, nose and throat (ENT), plastic surgery, dental surgery, orthopaedic surgery, gastrointestinal (GIT) endoscopic procedures, and urological surgery.

Following the implementation of the nationwide lockdown and in accordance with national guidelines, on the 19th of March 2020, a directive was received to suspend all elective surgery at RMMCH.¹¹ The ramifications of this directive are yet to be formally investigated.

Locally and internationally, studies have shown a significant decline in the number of surgical procedures being performed. Furthermore, an increase in morbidity related to postponed surgeries has been observed.¹² The effect of the suspension of services in South African hospitals has not been fully elucidated, and no studies have examined services in the Gauteng Province.

It has been postulated that a massive surgical backlog (of both elective and emergency cases) may have occurred, and that patient mortality may have increased. As Gauteng is considered to be the most populous province in South Africa,¹³ these effects may be significant as a result of the large patient load and limited resources in the province. The aim of this study was to assess the extent to which the onset of the COVID-19 pandemic affected the provision of a surgical service at RMMCH.

Methods:

A retrospective descriptive review of theatre records was conducted at RMMCH for the time period 1 March 2019 to 28 February 2021. Records included all theatre registers, anaesthetic charts, HC and ICU records, as well as mortality records for the specified time period.

Morbidities were defined as any temporary or permanent non-planned adverse event or disability that may occur during the surgical or immediate post-surgical period. Thus, data pertaining to haemorrhage requiring transfusion, unplanned ICU or HC admissions, and any documented cardiac event was included. This information was obtained directly from anaesthesia charts and from the HC and ICU admission books.

Mortality data was collected from the relevant ward record books, HC, and ICU record books, as well as from anaesthesia charts in the case of a death on table. Names were cross referenced to eliminate duplications and then data was anonymised for confidentiality. Theatre cancellations were obtained from theatre reception records recorded for the specified periods at RMMCH.

Statistical analysis:

All analyses were performed using R statistical software v4.2.1. The effect on the number of cases was modelled using multi-variable Poisson regression with period 1 (one year before the onset of the COVID-19 pandemic) and period 2 (one year after the onset of the covid-19 pandemic) as main effects. Interactions were not assessed. Data were checked for over- and under-dispersion, and where detected, the modelling was conducted using a generalized Poisson distribution. The effect on the number of hours that theatre was used was modelled using multi-variable linear regression with period as the main effect. No interactions were assessed. Each model generated was checked for outliers and heteroskedastic residuals.

No outliers were detected in any models, but where heteroskedasticity was detected, robust standard errors were calculated. The number of surgical cancellations/postponements was analysed using multiple logistic regression (cases cancelled/postponed vs not cancelled/postponed) with period as the main effect. No interactions were assessed. Morbidities and mortalities were analysed using chi squared analysis of total morbidities and mortalities noted for the two periods studied. Data is presented as medians with inter-quartile ranges (IQR). $P < 0.05$ is considered significant.

Results:

A total of 8 176 and 7 717 cases were performed prior to and after the onset of the pandemic. There was a statistically significant decrease in the median number of cases performed per month after the onset of COVID-19 ($p < 0.05$), with a median of 684 (IQR 659-713), and 628 (IQR 611-672) being performed in each period. Figure 1 shows the total number cases per month prior to and after the onset of the pandemic.

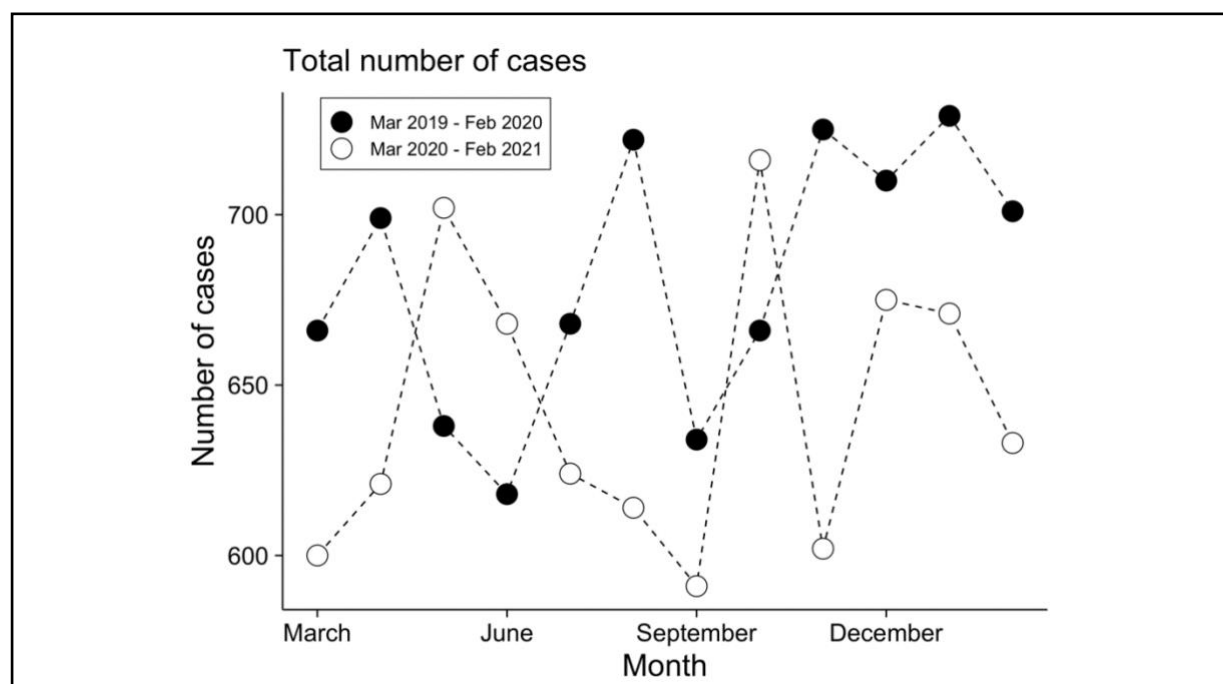


Figure 1. Total number of cases per month prior to and after the onset of the pandemic

In terms of gynaecological cases; There were 1 117 (median 96 cases per month; IQR 87-102), and 1 110 (median 91 cases per month; IQR 90-104) emergency gynaecological cases performed prior to and after the onset on the pandemic respectively.

Although there was no statistical difference in emergency gynaecological cases performed ($p=0.882$), there was a statistically significant difference in the elective gynaecological cases performed ($p<0.05$), with 592 cases being performed in period 1 (median 50 cases per month; IQR 42-58) compared to 389 cases in period 2 (median 34 cases per month; IQR 24-42).

In period 1, 985 elective caesareans were done. The median number of elective caesareans performed per month for period 1 and 2 were 86 (IQR 74-89) and 82 (IQR 72-92) respectively. Regarding emergency caesareans, the total and median number performed in period 1 and 2 were 4 344 (median 361, IQR 354-372) and 4 515 emergency caesareans (median 376, IQR 362-383) respectively. There was no statistically significant difference in the number of elective and emergency caesareans performed prior to or after the pandemic onset ($p=0.352$; $p=0.975$). The number of caesareans performed monthly is shown in Figure 2.

Other obstetric cases performed in period 1 and 2 were 102 (median of 8, IQR 8-10) and 103 (median of 8, IQR 7-10) respectively. Because of the very low numbers for non-caesarean procedures, these data were not analysed further.

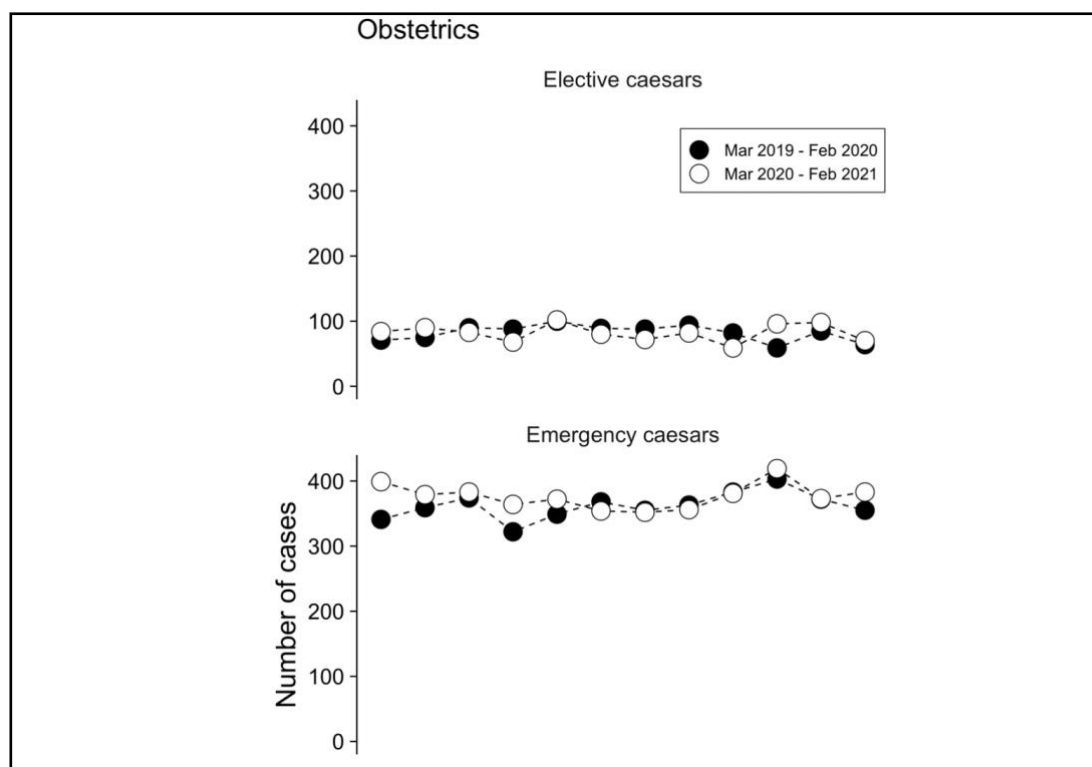


Figure 2. Number of elective and emergency caesareans performed per month prior to and after the onset of the pandemic

In paediatric dental surgery, period 1 and 2 saw a total of 238 cases (median 21, IQR 16-22) and 61 cases (median 1, IQR 0-12) respectively. This is shown in Figure 3. The data were over-dispersed, and so a generalised Poisson distribution was used. There was a strong, statistically significant effect such that period 2 was associated with a lower case rate than period 1 ($p < 0.05$) and with a 95% CI for the incidence rate ratio: 0.06-0.25.

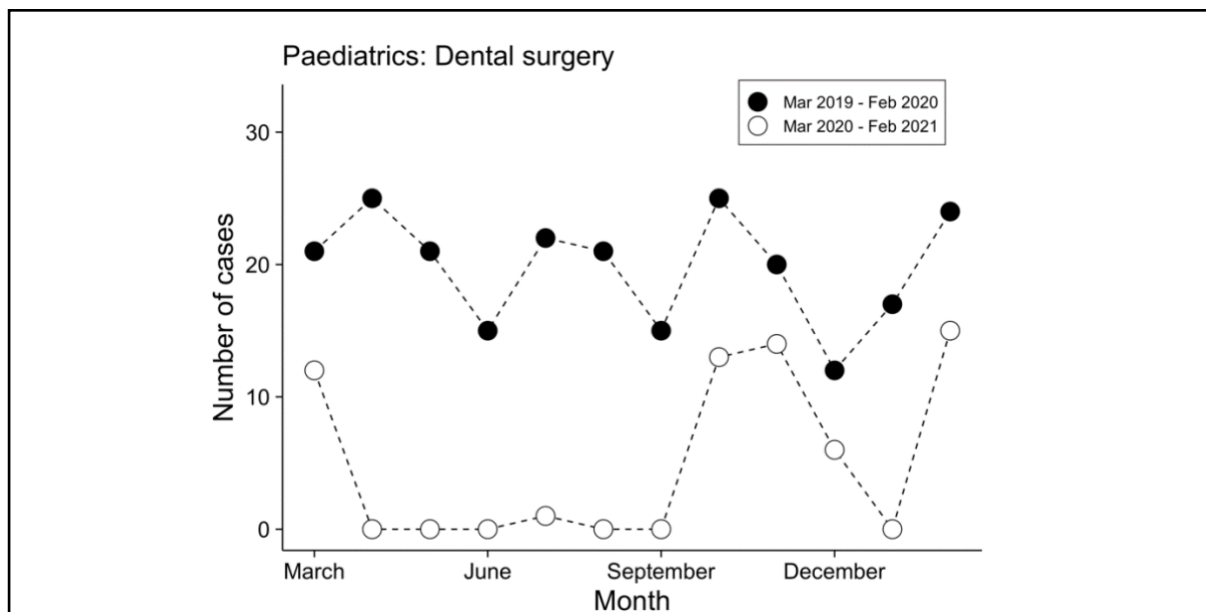


Figure 3. Number of paediatric dental surgeries per month pre-COVID-19 (March 2019 to February 2020) and during the pandemic (March 2020 to February 2021)

For paediatric ENT surgeries, period 1 and 2 saw a total of 304 cases (median 26, IQR 18-33) and 142 cases (median 5, IQR 1-14) respectively. The data were over-dispersed, and so a generalised Poisson distribution was used. There was a statistically significant effect ($p < 0.05$), such that period 2 was associated with a lower case rate than period 1 (95% CI for the incidence rate ratio: 0.06-0.25). However, while the point estimate indicated a strong effect, the estimate lacked precision (95% CI for the incidence rate ratio: 0.16-0.50). Moreover, in both periods, the number of cases was erratic, and subject to several large month-on-month changes.

In paediatric orthopaedics, period 1 and 2 saw a total number of 44 (median 4.5, IQR 2-5) and 57 (median 4, IQR 3-6) elective cases respectively. In terms of trauma/emergencies, period 1 and 2 saw a total number of 231 (median 18, IQR 17-22) and 243 (median 18, IQR 16-27) trauma/emergency cases respectively.

Analysis of elective cases showed no statistically significant effect ($p=0.197$). Due to the low case count in general, care should be taken when interpreting the results. Similar findings emerged from analysis of paediatric orthopaedic trauma. There was no statistically significant effect for period ($p=0.582$).

For paediatric gastrointestinal surgery, period 1 and 2 saw a total number of 71 (median of 6, IQR 5-6) and 72 cases (median 6, IQR 4-8) respectively. There were no statistically significant effects for period ($p=0.933$), and because of the low case count in general, care should be taken when interpreting the results.

In paediatric plastic surgery, period 1 and 2 saw a total number of 117 (median 10, IQR 6-12) and 27 (median 2, IQR 0-3) cases respectively. The number of cases in period 2 was statistically significantly lower than the number of cases in period 1 ($p<0.05$). This effect was strong (incidence rate ratio point estimate: 0.19), but the precision of the estimate was low (95% CI for the incidence rate ratio: 0.10-0.37). Due to the low case count in general, care should be taken when interpreting the results.

For paediatric urological surgery, period 1 and 2 saw a total number of 31 (median 2.5, IQR 1.75-4) and 14 (median 0.5, IQR 0-3) cases respectively. The number of cases in period 2 was statistically significantly lower than the number of cases in period 1 ($p=0.014$). This effect was strong (incidence rate ratio point estimate: 0.45), but the precision of the estimate was very low (95% CI for the incidence rate ratio: 0.23-0.82). Again, because of the low case count in general, care should be taken when interpreting the results.

After case number analysis, total theatre hours were examined. In total, 9 656 (median of 781, IQR 746- 813) and 9148 (median 729, IQR 689-769) hours of surgery were conducted at RMMCH in period 1 and 2 respectively. The number of theatre hours in period 2 was statistically significantly lower than the number of theatre hours in period 1 ($p=0.012$). Figure 4 illustrates the total number of hours theatre was utilised in period 1 and period 2.

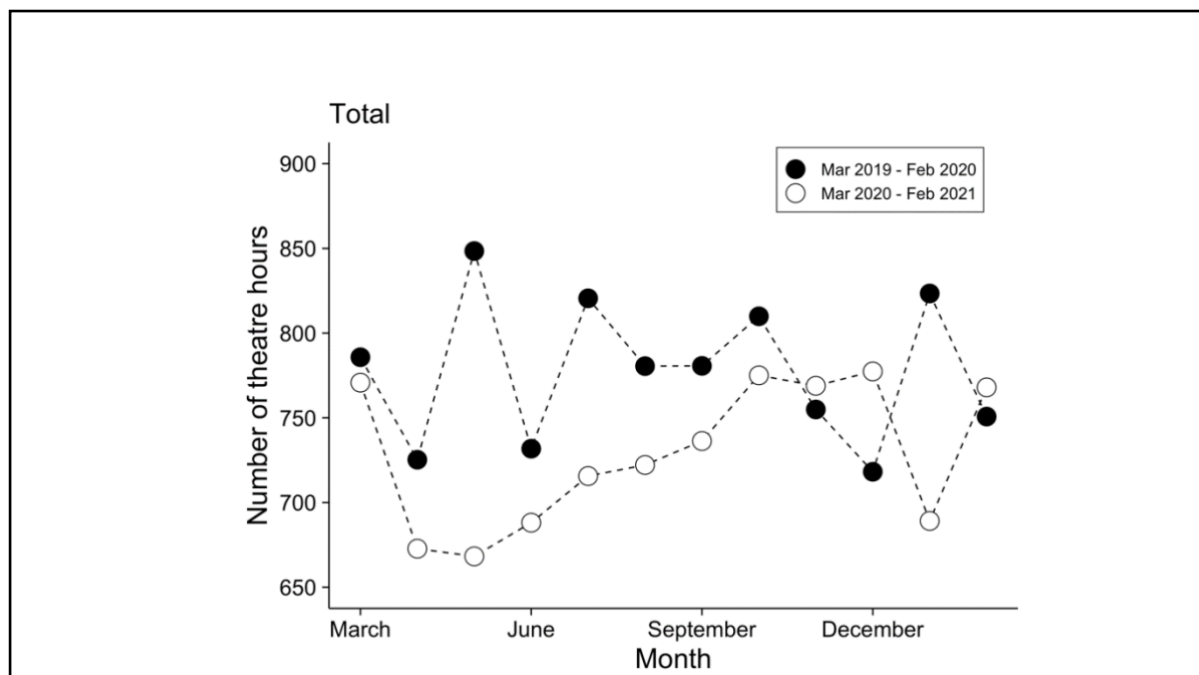


Figure 4: Total number of hours theatre was utilised in period 1 and period 2.

Each discipline was analysed individually and results displayed in Table 1. There were no significant differences in gynaecological emergency surgery ($p=0.30$), obstetric elective ($p=0.70$) or emergency ($p=0.90$) surgery, Paediatric orthopaedic elective surgery ($p=0.758$), paediatric orthopaedic emergencies ($p=0.20$) or paediatric gastrointestinal procedures ($p=0.30$). There was significantly poorer theatre utilisation in gynaecological elective surgery ($p<0.05$), paediatric dental surgery ($p<0.001$), paediatric ENT ($p<0.01$), paediatric plastic surgery ($p<0.05$) and paediatric urology ($p<0.05$).

Cancellations/ postponements

The number of cancellations or postponements pre- and post-COVID are shown in Table 2. The majority of cancellations/ postponements were the result of overbooked lists or no time for elective cases, with other reasons making a very small fraction of total cancellations/ postponements. For this reason, only the total number of cancellations/ postponements, and not each cause of the cancellation / postponement, was analysed. Overall, there was a statistically significant effect between period 1 and 2 ($p<0.001$). There was a moderately strong (95% confidence interval for the odds ratio: 1.36 to 1.79) association between the period and cancellations/ postponements, with post-COVID onset being associated with greater odds of cancellation/ postponement compared to pre-COVID onset.

Table 1. Theatre utilisation hours by surgical discipline

	Total number of hours n (median per month; IQR)		
Discipline	Period 1 (pre-COVID)	Period 2 (post-COVID)	p-value
Gynaecology emergency	1236 (111; 93-115)	1330 (108; 101-129)	0.30
Gynaecology elective	1114 (86; 78-113)	844 (74; 52-94)	<0.05
Obstetric caesarean emergency	4915 (401; (389-419)	4940 (416; 394-428)	0.90
Obstetric caesarean elective	1214 (105; 90-113)	1184 (95; 89-109)	0.70
Other obstetric cases	131(11; 7.0-13.8)	139 (11; 8.8-14.2)	0.80
Paediatric orthopaedic. elective	48 (4; 1.71-5.22)	53 (4; 2.68-4.76)	0.758
Paediatric orthopaedic. trauma	278 (23; 21-26)	343 (26; 22-36)	0.20
Paediatric ENT	357 (29; 24-36)	142 (7; 1-15)	<0.01
Paediatric plastic surgery	80 (8; 4.08-8.25)	44 (2; 0.00-5.92)	<0.05
Paediatric gastroenterology	53 (4; 3.50-5.40)	68 (6; 3.23-7.85)	0.30
Paediatric urology	59 (4; 1.81-6.73)	19 (0.58; 0.00-3.50)	0.03
Paediatric dental	172 (13; 12.1-15.5)	41 (0.3; 0.0-7.4)	<0.001

Table 2. Cancellations or postponements pre- and post-COVID

Total number of cancellations / postponements n (median per month; IQR)			
Reason for cancellation	Period 1 (pre-COVID)	Period 2 (post-COVID)	p-value Uncorrected p-value (Holm corrected p-value)
Overbooked list / no time for elective cases	1643 (130; 86-164)	3110 (234; 218-284)	0.005 (0.05)
Patient inadequately prepared or unfit	37 (2; 1-6)	36 (2; 1-4)	0.8 (> 0.9)
Infrastructure equipment related	32 (0; 0-4)	5 (0; 0-1)	0.6 (> 0.9)
List replaced by emergency cases	59 (1; 0-7)	12 (0; 0-1)	0.12 (0.84)
Surgeon not available	2 (0; 0-0)	2 (0; 0-0)	0.7 (> 0.9)
HCU or ICU beds not available	19 (1; 1-2)	7 (0; 0-1)	0.07 (> 0.9)
Re-evaluated and management changed	108 (9; 7-12)	106 (8; 6-9)	0.5 (> 0.9)
Staff shortage	1 (0; 0-0)	19 0; 0-0)	> 0.9 (> 0.9)
Total postponements	1901 (151; 106-186)	3297 (248; 235-288)	0.006 (0.054)
Total cases	8176 (684; 659-713)	7717 (628; 611-672)	0.05 (0.4)
Proportion of cases postponed (median(IQR))	0.22 (0.15-0.26)	0.39 (0.35-0.48)	0.004 (0.044)

Surgical morbidity/ mortality

While mortality was absent or negligible in most settings, there were 77 and 51 ICU admissions, 255 and 190 HCU admissions, 436 and 482 transfusions, and 2 and 3 cardiac events pre- and post-COVID respectively. In terms of mortalities, there were 6 mortalities pre-covid onset and 13 mortalities post onset. The values were used in a chi-squared test to produce the following findings:

There was no statistically significant change in ICU or HC admissions ($p=0.100$) and ($p=0.056$) respectively. There were also no statistically significant change in transfusions ($p=0.056$), cardiac events ($p=0.66$), or mortality rate ($p=0.133$).

Discussion

At RMMCH fewer cases were performed, and theatre was utilised for fewer hours in the 12 months following the onset of the COVID-19 pandemic. This finding is the same as that seen in other South African settings in studies by Chu et al.¹ in a nationwide survey conducted in July 2020, and Laäs et al.¹⁴ in Pietermaritzburg.

The number of cases performed and theatre hours utilised varied significantly by discipline and whether cases were classified as elective or emergency surgery. The statistically significant reduction in the number of elective gynaecological cases performed during the first year of the COVID-19 pandemic is in keeping with the directive issued on 19 March 2020 which stated that all non-emergency theatre cases be suspended.⁷

At RMMCH cases considered to be elective gynaecology cases included total abdominal hysterectomies for benign causes (such as painful or bleeding uterine fibroids) or for malignant causes (such as uterine carcinomas and sarcomas). Various other surgeries for malignancies are included such as vulvectomies for vulval carcinoma, hysterectomies for cervical carcinoma, and laparotomies for ovarian carcinomas. The significant reduction in the number of elective gynaecological cases done may have significant ramifications for patients suffering from these malignancies as a delay in surgery may equate to advancement of disease. In a study conducted by Stöss et al.¹⁵ across multiple European surgical centres documenting the impact of the COVID-19 pandemic on surgical oncology in Europe, there was an average reduction of 29.3% for all types of oncological resections surveyed in their questionnaire. They postulated that this would lead to an increased incidence of unresectable cancers as well as decreased survival due to follow-up cancellations and surgical postponements. In this study at RMMCH, there was a 34,3% reduction in gynaecological elective cases many of which constitute oncological surgeries which could also lead to poorer long term oncological outcomes. However, further study is recommended to confirm the long-term effects of delays / cancellations.

Increased waiting times for benign surgeries is not without consequence. Delayed myomectomies can result in increased pain and bleeding which may require more blood transfusions. It can also prolong fertility problems in women whose fibroids are affecting their ability to conceive or carry a pregnancy to a viable age.¹⁶

These delays may therefore have both financial, and ethical implications as a result of resource limitations, as well as implications with respect to patient satisfaction.

The significance of the reduction in total cases was greater than that of the reduction in theatre hours. These results indicate that fewer cases were being done, but that more time was being used per case. This may reflect the additional time required by healthcare workers to “Donn and Doff”, may be as a result of difficulties experienced with vision and ergonomics as a result of PPE, healthcare worker fatigue or burnout, or may suggest that theatre time was used less efficiently after the onset of the pandemic. A study conducted by Jeyaseelan et al.¹⁷ in London, United Kingdom, found that changes in working practices necessitated by COVID-19 led to modest delays to all aspects of theatre use, and consequently theatre efficiency. This study was, however, not designed to evaluate factors affecting theatre utilisation and efficiency. Further study is therefore recommended

Throughout the subsets of surgical disciplines there was a notable reduction in the number of elective cases done. This, however, was not the case in obstetrics. There was no statistically significant reduction both in terms of cases done and completed theatre hours. This may be explained by the fact that although termed ‘elective’ these caesareans are still procedures that need to be done timeously to avoid the risks associated with these patients transitioning into labour. For example, in our setting, ‘elective’ caesareans also include those done for mothers who have had two or more previous caesareans, twin pregnancies, have an obstructed birth canal, breech presentation as well as for anticipated large baby. These indications are in keeping with international guidelines on absolute and relative indications for caesarean delivery, and as such are not truly elective procedures.¹⁸

Paediatric surgery subspecialties were most affected by the pandemic with the exception of orthopaedic surgery. This may be attributed to the fact that the large majority of paediatric orthopaedic surgeries done at RMMCH are trauma related, and therefore not considered to be elective surgery and as such would have continued to be conducted throughout the entire lockdown period.

The results of this study may differ from these other studies as they were conducted over shorter periods of time and did not evaluate time periods over which lockdown restrictions were eased.

In paediatric urology, dental, ENT and plastic surgery there were statistically significant reductions in cases in period 2 compared to period 1. Park et al.¹⁹ conducted an interrupted time series analysis on low and middle income countries and found a similar steep decline in total paediatric surgical cases by a third in the first month following March 2020, followed by slow recovery thereafter.

A cross-sectional study by Gunadi et al.²⁰ also showed a significant reduction in the number of elective paediatric surgical cases completed and emphasised the importance of a strategy to avoid morbidity from the neglected elective surgeries during the pandemic, including the proper comparison between the real risk of COVID-19 cross-infection and the benefits of elective procedures.

The reduction in theatre utilisation could have consequences for patients, healthcare workers, and medical students. RMMCH is an academic hospital affiliated to the University of the Witwatersrand and plays an important role in education and training of specialising doctors and students. The reduction in case load may limit junior doctors' opportunities for learning as a result of a decrease in their exposure to many types of elective procedures. The findings of this study are similar to Banerjee et al.²¹ who showed that lockdown negatively impacted Nepalese students' learning opportunities, and limited their ability to study as they had done previously.

This study showed that the odds of cancellation / postponement was greater after the pandemic onset. The reason for cancellation or postponement in the majority of cases was "overbooked lists" or "no time for elective procedures".

A possible reason for this may be various delays which were experienced throughout the pandemic, for example late results of covid testing or increased anaesthetic and surgical time due to new COVID-19 protocols. However, this is anecdotal and further research to delineate reasons for cancellation or postponement is required.

Sims et al.²² have found that aside from the expected repercussions already mentioned such as progression of disease and decreased survival, cancellations / postponements also lead to increased anxiety and decreased functional activity in certain patient groups.²³

Analysis of rates of surgical morbidity and mortality produced extremely sparse data and thus we then analysed total morbidity and mortality between the two periods, rather than that for each subspeciality. Surgical mortality is defined as any death, regardless of cause, occurring within 30 days after surgery in or out of the hospital.^{24, 25} In our study only data pertaining to deaths occurring in hospital were accessible.

Changes in ICU and HC admissions, as well as in theatre related mortalities can be attributed both directly and indirectly to the COVID-19 pandemic.

Indirectly, issues such as delayed time to surgery due to waiting for COVID-19 test results and prolonged surgical time due to difficulty operating whilst in PPE may be potential contributing factors. In a meta-analysis by Farsi Y, et al.²⁶ mortality rate was found to be higher after the onset of the pandemic. They stipulated stricter patient selection criteria for surgery leading to longer waiting times as well as progression of disease as possible reasons for increased peri-operative mortality after the onset of the pandemic. These findings were not noted in our study as there were no significant changes in morbidity or mortality. This may be due to the low numbers noted in our study and research over a longer period may be warranted.

Directly, concomitant COVID-19 infection may increase the risk of HC and ICU admissions and in some cases with progression to mortality.²⁷ However, in this study, specific causes of morbidity and mortality were not investigated beyond being theatre or surgery associated. Knisely A, et al.²⁷ found that surgical patients with concomitant COVID-19 had both an increased rate of ICU admission, and peri-operative mortality. Frequently, in our setting, diagnosis of COVID-19 was unknown at the time of surgery, ICU or HC admission or at time of death. The COVID-19 status of ICU, HC admissions and mortalities were not recorded in this study. Thus, it is also a potential area of further research. Furthermore, once again, there was no statistically significant change in morbidity or mortality noted in this study which may be attributable to low numbers noted in these groups.

In this study it was found that approximately 20% of gynaecological emergency cases required blood product transfusion. This is significant as RMMCH currently does not have access to an onsite blood bank afterhours. This data may be useful in the assessment of, and motivation for, the establishment of a 24 hour blood bank service.

Due to the nature of this research, the study was limited by the accuracy at which records were recorded and stored. Illegible, incomplete, and damaged records were excluded. The possibility of incorrect filing, mislabeling, or missing records is a further limitation and cannot be exactly quantified.

This study comprised of convenience sampling which may result in some degree of sampling bias. This study is a contextual study undertaken at RMMCH. The results may not be generalizable to other institutions. The study was undertaken for a two-year period. Extension of this time period could yield increased statistical significance and less sparseness of the data in some cases.

Conclusion

Theatre utilisation hours, as well as the number of cases performed, were significantly reduced after the onset of the COVID-19 pandemic. At RMMCH, these findings were most pronounced for elective gynaecology, and the paediatric surgical disciplines other than paediatric orthopaedic surgery. The onset of the COVID-19 pandemic also coincided with an increased rate of cancellation and postponement of surgeries. This study showed no statistically significant increase in surgical morbidity or mortality associated with the onset of the COVID-19 pandemic. However, further research is required to determine the effect on patient satisfaction and implications for patients' health as a result of the reduction in theatre utilisation at Rahima Moosa Mother and Child Hospital.

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Appendix 1: Proposal

The impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital

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1. Introduction

SARS-COV-2, the viral pathogen responsible for Coronavirus of 2019 or COVID-19, was initially identified by the World Health Organisation (WHO) on the 31st of December 2019. This followed the presentation of 27 patients in Wuhan City in China [1], with an acute respiratory syndrome of unknown aetiology. Since its discovery in late 2019, COVID-19 has altered life as we know it for the large majority of the world's population. As of July 2022, COVID-19 has been diagnosed in 228 countries and territories and resulted in more than six million deaths [2]. COVID-19 has put immense strain on health care systems throughout the world.

The WHO defines a pandemic as an “*epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people*”[3]. In keeping with definition, COVID-19 is considered to be the 17th major pandemic in the history of civilisation [4].

The first case of coronavirus in South Africa was declared on the 5th of March 2020, and a global pandemic was declared on the 11th of March 2020. What followed was a massive global effort in order to curb the spread of COVID-19. Countries worldwide began to implement strategies to limit cross contamination and to make space in their hospitals for the expected massive influx of COVID-19 patients. In South Africa the strategies were no different, however, the decisions made, and the effects of these decisions may differ significantly due to the limited resources and pre-existing massive patient load characteristic of the South African public healthcare system [5].

As the number of cases increased significantly in South Africa, a national state of disaster was announced on the 18th of March 2020. ‘Lockdown’ was subsequently implemented on the 27th of March 2020. This comprised many regulations being put into place to ‘flatten the curve’ and to slow the spread of the novel coronavirus. Strict protocols were implemented in all South African hospitals in an attempt to free up ward space to treat the expected influx of COVID-19 patients and to decrease spread occurring to non-infected in-hospital patients admitted for reasons other than COVID-19.

Elective surgeries were cancelled, non-essential clinics were closed, and COVID-19 specific wards and intensive care units were opened. Strict protocols regarding the use of personal protective equipment (PPE) were put in place, and training on ‘doffing’ and ‘donning’ was instituted for all involved hospital staff. PPE was procured in large amounts, and in some provinces plans for the construction of ‘field hospitals’ were instituted [6].

Another strategy employed in South Africa in an effort to reduce transmission and free up hospital space was the banning of alcohol, which occurred initially from the 27th of March 2020 until the 1st of June 2020, and then again from the 12th of July until the 17th of August. A third alcohol ban occurred from the 28th of December 2020 until the 1st of February 2021, and a fourth ban on the sales of alcohol for off-site consumption was declared over the 2021 Easter period of 2-5 April 2021 [7].

It was observed that there was a significant decline in the number of surgical procedures being performed. Both elective and emergency cases were affected. It has been postulated that a massive surgical backlog has occurred, and there has been an increase in morbidity related to postponed surgeries. Patient mortality may also have increased.

The provision of a surgical service is a vital component of any healthcare system. Surgical procedures may be classified as either emergency or elective. According to the WHO, emergency surgery comprises interventions that are considered critical for specific conditions to prevent premature death and disability [8]. Elective surgery implies that the surgery may be scheduled in advance [9]. It is, however, a misconception that elective surgery is always optional. Elective surgery may include surgery for malignant conditions and conditions that can significantly affect a patient’s quality of life. Thus, although not emergent, the urgency at which these elective cases need to be done can vary considerably.

Rahima Moosa Mother and Child Hospital (RMMCH) is a regional public hospital, although it provides many tertiary services, located in Coronationville in Johannesburg, Gauteng. It is a 345-bed hospital offering a multitude of surgical services.

The surgical services offered at RMMCH include obstetrics, both emergency and elective cases, gynaecology, elective and emergency, and paediatric surgery. Paediatric surgery includes ear, nose & throat (ENT), plastic surgery, dental surgery, orthopaedic surgery (elective and emergency), gastrointestinal (GIT) endoscopic procedures, and urological surgery.

There are five theatres at RMMCH. These include:

- Theatre A – Obstetric and gynaecological emergencies.
- Theatre B – Elective obstetric theatre.
- Theatre C – Elective gynaecology theatre.
- Theatre D – used to perform septic/ grossly contaminated cases prior to COVID-19 pandemic. This theatre was converted to paediatric theatre following the onset of the pandemic.
- Theatre E – Paediatric theatre (prior to COVID-19 pandemic), converted to a dedicated theatre for confirmed or suspected cases of COVID-19 following onset of pandemic.

Following the implementation of the nationwide lockdown and in accordance with national guidelines, on the 19th of March 2020, a directive was received to suspend all elective surgery at RMMCH [10]. The ramifications of this directive are yet to be formally investigated. This study aims to identify the effect of the above directive on theatre utilization before and after the onset of the COVID-19 pandemic at RMMCH.

Similar studies have been performed in other South African hospitals and internationally as similar policies on the suspension of elective surgery have been implemented globally [1, 11, 12, 13, 14, 16, 17, 18, 19]. These studies have shown a significant reduction in surgical cases done.

A study conducted in Kwa-Zulu Natal by Laäs et al. [11], examined the effect of COVID-19 pandemic decisions on tertiary-level surgical services in Pietermaritzburg. This study found that the implementation of restrictive measures on theatre procedures had significantly impacted theatre productivity and service delivery. The theatre caseload was found to have decreased by 30% from January to April 2020. In this study the researchers predicted a ‘theatre case deficit’ by applying this percentage reduction to the number of cases normally done in the ‘pre-lock down’ phase per month and estimated that the theatre case deficit (over the four months analysed) was 1 260 cases and they would require 315 ‘theatre days’ to make up the deficit [11].

Chu et al. [1] conducted a study, including both the private and public sector, to assess the changes in surgical practice in 85 South African hospitals during the COVID-19 hard lockdown. They concluded that the change in surgical practice during the COVID-19 lockdown resulted in significantly reduced access to surgical care in South Africa and that this could potentially result in a surgical backlog as well as an excess in morbidity and mortality [1].

A study by Moustakis et al. [12], in the North West province in South Africa, showed that there were significant reductions in surgical admissions, both for trauma and non-trauma related pathologies. Specifically, there was a 44% reduction in the incidence of non-trauma related admissions, and a 53% reduction in the incidence of trauma related admissions during lockdown [12].

Studies conducted internationally have produced similar findings [13, 14, 16, 17, 18,19]. In the United Kingdom a directive was issued on the 17th of March 2020 instructing the postponement of all non-urgent elective surgery for at least three months [13]. MacDonald et al. [13] found that a backlog of approximately 1 200 000 cases occurred over the 3-month period. The study also described a progressive increase waiting list times. The authors also postulated an increase in morbidity resulting from this backlog and concluded that this would place a significant burden on healthcare services in the future.

Fu et al. [16] in the United States of America have emphasized that “progression is a key feature of many surgical diseases, and delays in treatment result in worse outcomes and higher mortality for patients across a broad spectrum of diseases”. As such, delays in cancer surgeries will have severe ramifications [14, 16]. Delays in non-cancer surgeries may also be costly as a result of additional emergency admissions, the possible increased requirement of blood transfusions, and increased need for additional therapeutic interventions. Significant morbidity and even mortality may occur in some cases [15, 16].

Khadabadi et al. [17] in the United Kingdom reported findings of profoundly reduced theatre productivity owing mostly to increased safety protocols for theatre staff allowing far fewer cases to be done per day [17].

Ogundele et al. [18] in Nigeria, have described that the pandemic resulted in a halting of elective surgeries, as well as a marked reduction in emergency surgeries performed on children [18]. The study emphasized that the effect of a reduction in theatre utilization may be more damaging in low- and middle-income countries where resources are already limited, and healthcare systems are suboptimal.

Wang et al. [19] in Canada published a study in which the authors made an estimation on the size of the non-emergent surgical backlog during the pandemic. They determined that there was a backlog/ case deficit, between the 15th of March 2020 and the 13th of June 2020, of 148 364 surgeries, and estimated that this had resulted in a backlog time of 84 weeks [19].

Together these studies show that surgical practice has been globally affected by the COVID-19 pandemic. There has been a widespread reduction in theatre utilization predominantly for elective surgical procedures, but in some cases emergency surgery theatre utilization has also been affected.

The effects of reduced theatre utilization or the significant increase in delay/cancellation of surgical procedures may have effects that are far reaching. These effects include possible disease progression, psychological, social, and financial implications for patients, and also a significant loss of training opportunities for training doctors. It may also result in a significant waste of resources, especially when cases are cancelled on short notice [20].

RMMCH is considered to be a mother and child hospital. Obstetrics forms a major component of the surgical services rendered. Caesarean sections are the most commonly performed surgical procedures in obstetrics [21]. Caesareans may either be elective or emergent. Elective caesareans, however, are not truly 'elective surgeries', as a great many of them, if not done timeously, will progress to being emergencies. This creates an interesting situation as although it was instructed by government to halt all elective surgery, caesareans cannot fall into this category.

The effect that the COVID-19 pandemic had at RMMCH is unknown and may be significant. The aim of this research is to determine the effect of COVID-19 on theatre utilization at RMMCH

2. Problem statement

The COVID-19 pandemic has resulted in a significant reduction in the utilisation of surgical/ theatre services in hospitals worldwide. The extent of this reduction at RMMCH is unknown.

3. Aim

To compare theatre utilisation 12 months prior to, and 12 months after, the onset of the COVID-19 pandemic at RMMCH.

4. Objectives

Primary objectives:

- To determine and compare the number of cases performed per theatre and in total for 12 months prior to, and after the onset of the COVID-19 pandemic.
- To determine and compare the number of hours that theatres were used by theatre and in total for 12 months prior to, and after the onset of the COVID-19 pandemic.
- To determine and compare the number of surgical cancellations/ postponements for 12 months prior to, and after the onset of the COVID-19 pandemic.

Secondary objectives:

- To describe the surgical morbidity/ mortality that occurred for 12 months prior to, and after the onset of the COVID-19 pandemic (1st March 2019-29 February 2020 compared with 1st March 2020 to 29 February 2021).

Specific data that will be captured will include:

- Number of pediatric surgical cases performed by each discipline [Ear nose and throat (ENT), plastic surgery, orthopaedics, dental surgery, urology, and gastrointestinal (GIT) endoscopy].
- Number of gynaecological surgical cases performed (emergency, oncology, and elective non-oncology).
- Number of obstetric cases performed (emergency and elective caesareans, as well as other obstetric surgery).
- Number of theatre hours utilized between the 1st of March 2019 and the 28th of February 2021.

- Number of cases cancelled between the 1st of March 2019 and the 28th of February 2021).
- Number of deaths, unplanned ICU admissions, unplanned HCU admissions, blood transfusions and recorded in theatre cardiac events.

5. Research assumptions

The following definitions will be used in the study:

- Pandemic – an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people [3].
- Epidemic - a widespread occurrence of an infectious disease in a community at a particular time [22].
- Elective surgery – surgery that can be scheduled in advance [23].
- Emergency surgery – Surgery done due to an urgent medical condition, that may or may not be life threatening [23].
- PUI – Patient under investigation (a patient who is awaiting results of a COVID-19 test).
- Theatre register/ record – record of all theatre throughput – i.e., details of all theatre cases performed at RMMCH.
- Theatre statistics – statistics compiled by the anaesthetic department detailing the number of cases performed and cancelled daily at RMMCH.
- Surgical morbidity- any temporary or permanent non-planned adverse event or disability that may occur during the surgical or immediate post-surgical period e.g., haemorrhage requiring transfusion, unplanned ICU admission, cardiac event etc. [24].
- Surgical mortality - any death, regardless of cause, occurring within 30 days after surgery in or out of the hospital [25].

6. Demarcation of study field

A retrospective survey of theatre cases performed from the 1st of March 2019 until the 28th of February 2021) will be conducted at RMMCH. This 24-month period will be divided in pre and post pandemic periods in order to conduct a comparison.

RMMCH is a 345-bed regional hospital with five operating theatres. RMMCH is affiliated with the Faculty of Health Sciences at the University of the Witwatersrand.

During normal circumstances RMMCH theatre conducts approximately 440 obstetric cases, 150 gynaecology cases, and 85 paediatric surgical cases per month [26].

Morbidity and mortality information will be obtained from analysis of departmental morbidity and mortality statistics from the paediatric as well as the obstetrics and gynaecology departments for the same 24-month period.

7. Ethical considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (Medical) and the Postgraduate Studies Committee of the University of the Witwatersrand. Approval to conduct this study will be requested from the RMMCH Medical Advisory Committee (Appendix B).

Approval to conduct this study will also be obtained from the Head of Department of Anaesthesiology, Head of Department of Obstetrics and Gynaecology, and the Heads of Departments of the Paediatric Surgical Disciplines (ENT, orthopaedics, and GIT) at RMMCH (Appendix C).

Data will be retrospectively collected from 1 March 2019 to 28 February 2021. Theatre register data will not include patient details and will remain anonymous and therefore no patient consent is required. Morbidity and mortality statistics will be obtained from the obstetrics and gynaecology and paediatric departments. Patient details will not be captured (Appendix D).

Confidentiality will be maintained as only the researcher and supervisors will have access to the captured data. The data collected will be stored securely on a password protected database for six years after the study's completion. The study will be conducted according to the principles of the Declaration of Helsinki [27] and the South African Guidelines for Good Clinical Practice [28].

8. Research Methodology

8.1 Research design

A retrospective descriptive study surveying theatre utilisation on a monthly basis for 12 months prior to, and after the onset of the COVID-19 pandemic will be conducted at RMMCH.

8.2 Study population

The monthly department statistics and theatre registers at RMMCH from 1 March 2019 to 28 February 2021 will be reviewed.

8.3 Study sample

Sample size

Data pertaining to cases performed in all five theatres at RMMCH from 1 March 2019 to 28 February 2021 will be examined and recorded per month. Data will be obtained from the theatre record documenting number of cases done per surgical department as well as by surgical hours used.

All morbidity and mortality data obtained from morbidity and mortality departmental records from 1 March 2019 to 28 February 2021. These records will be obtained from the obstetric and paediatric departments.

Sampling method

A consecutive convenience sampling method will be utilized in this study. Consecutive convenience sampling will attempt to include all data from the time period stipulated as in available in the theatre records. Convenience sampling, a subtype of non-probability sampling, relies on the collection of data conveniently available for study participation [29].

Inclusion criteria

All theatre registers, records, and statistics from March 2019 to February 2021 will be included.

Exclusion criteria

Illegible, incomplete, or missing records will be excluded from the study.

8.4 Data collection

Data will be collected from RMMCH once the necessary approvals have been granted by the relevant authorities. Data capturing will be done in the department of anaesthesia, obstetrics and gynaecology, and paediatrics at RMMCH by the researcher. No theatre registers or records will be removed from the hospital premises. Data will be entered onto a data collection sheet (Appendix D).

8.5 Data analysis

A Microsoft Excel® spreadsheet will be used to capture data. Data will be analysed in consultation with a biostatistician using the statistical program STATA version 15 (StataCorp®, USA). Continuous (number of theatre hours) and count data (remaining variables) will be summarised using medians and interquartile ranges. Poisson regression will be used for count data within each level of analysis (e.g., number of cases for elective surgery in obstetrics per period), while a Wilcoxon rank-sum test will be used within each level of analysis for the number of hours in theatre. A p-value of ≤ 0.05 will be considered statistically significant, with the family-wise error rate controlled for within each discipline (obstetrics, gynaecology, and paediatrics) using the Holm method. For variables aggregated across analysis levels, a meta-analysis using difference in medians will be completed. In this analysis, a pooled difference in median count/hours will be calculated over the levels using sample size to weight the levels. A 95% confidence interval for the pooled difference in medians that exclude 0 will be considered statistically significant.

8.6 Significance of the study

This study is significant as it will allow quantification of the effect of the COVID-19 pandemic on theatre utilisation at a regional Gauteng hospital. It will help us to understand the extent of the backlog created as well as assist in planning in order to ‘catch up’ on cases not done due to the nationwide lockdown.

As the situation with the COVID-19 pandemic is still ongoing and this is predicted to be the case for some time, plans need to be made to improve theatre utilisation in order to prevent further increments in the surgical backlog. This study may assist with this planning.

9. Validity and reliability of the study

Study validity refers to how well the results of the study represent true findings among similar settings outside the study. It can be separated into two subsections:

- Internal validity: the extent to which the observed results represent the truth in the population we are studying and, thus, are not due to methodological error
- External validity: the study results apply to similar scenarios in a different setting [30].

Study Bias refers to any trend or deviation from the truth in data collection, dataanalysis, interpretation, and publication which can cause false conclusions [31]. To ensure study validity and limit bias the following measures will be taken:

- Employing a retrospective design to prevent alteration in management.
- Data will be collected by a single researcher.
- Data will be reviewed by the supervisors and researcher for accuracy.
- Analysis of data will be done in consultation with a biostatistician.

10.Potential limitations of the study

This study is a contextual study undertaken at RMMCH. The results may not be generalizable to other institutions. This is a retrospective study and may be affected by the quality of the departmental statistics and theatre records. These records and statistics may be incomplete, incorrect, or illegible. The use of convenience sampling is also considered a limitation as this may result inthe sampling bias.

11.Project outline

11.1 Time frame

Year	2021	2021	2021	2021	2021	2021	2021	2022	2022
Month	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Proposal	X								
Ethics approval			X						
Postgraduate approval			X						
Data collection				X	X				
Data analysis						X	X		
Submission								X	

11.2 Financial plan

Description	Price per item	Number of items	Total
Printing proposal	R 150	1	150
Printing research report	R 350	2	350
Binding final research report	R 200	1	200
Printing of data collection sheets	R 200	1	10
Total			710

The department of anaesthesiology will incur the costs of paper and printing for the post graduate application. The researcher will incur the remaining costs.

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Appendix 2: Request to CEO of Rahima Moosa mother and child hospital:

Dear Dr Mkabayi

My name is Dr Kirsten Morley-Jepson. I am a registrar in the Wits Department of Anaesthesia. I am planning to conduct research in the pursuit of my MMed at Rahima Moosa Mother and Child Hospital (RMMCH). The basis of my research is to investigate the impact of the COVID-19 pandemic on theatre utilization at RMMCH.

I will require access to theatre registers, statistics, and records from the time period 1 March 2019 to 28 February 2020. I will not be removing any records from the premises and I will not be including and patient details.

My research is being supervised by Dr Janine Wagner and Dr Thomas Kleyenstuber.

The aim of my research is to determine the effect that the COVID-19 pandemic had on theatre utilization.

Thank you very much for your consideration.

Yours faithfully

Dr Kirsten Morley-Jepson

MBBCh, DA, Dip Pec SA

Staff: A0037086

W-39-01-83

Student: 359422

Tel: 0834768033

Email: kmorleyj23@gmail.com

Appendix 3: Request to the Medical Advisory Committee

To Whom It May Concern

Re: MMED: The impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital

My name is Dr Kirsten Morley-Jepson and I am a registrar in the Department of Anaesthesiology. In the pursuit of my specialization in anaesthesia I am required to conduct research in the form of an MMed. My topic of research is to investigate the impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital.

I would like to request permission to access theatre registers, statistics, and records as well as the morbidity and mortality records from the Department of Anaesthesiology for the years 2019 and 2020 in order to conduct my study.

I will also require access to the records of cancellations, and information regarding morbidity and mortality from the paediatric and obstetric departments. Data collection will take place in the anaesthetic, obstetrics and gynaecology, and paediatrics departments at RMMCH, and no records will be removed from the hospital premises.

My research is being supervised by Dr Janine Wagner (a consultant anaesthetist at RMMCH) and Dr Thomas Kleyenstuber (the HOD Anaesthesia at RMMCH)

Yours faithfully

Dr Kirsten Morley-Jepson

MBBCh, DA, Dip Pec SA

Staff: A0037086

W-39-01-83

Student: 359422

Tel: 0834768033

Email: kmorleyj23@gmail.com

Appendix 4: Permission request to Heads of Department anaesthesia, obstetrics and gynaecology, and paediatrics

Dear Dr Kleyenstuber, Dr Wise, and Prof Coovadia.

In the pursuit of my MMED I would like to conduct research on the impact of the COVID-19 pandemic on theatre utilization at the Rahima Moosa Mother and Child Hospital.

In order to do this, I would like to request access to theatre registers, records, and statistics from the period 1 March 2019 to 28 February 2021.

I aim to establish whether or not there was a major change in theatre utilization comparing the year prior to the pandemic with the 1st year following the onset of the COVID-19 pandemic.

I will also require access to the theatre records regarding cancellations. Data collection will take place in theatre and in the departments of anaesthesia, obstetrics and gynaecology, and paediatrics at RMMCH, and no records will be removed from the hospital premises.

I would like to request access to morbidity and mortality data from the above period. I will not be removing any records from the premises and I will be anonymizing the data and not be including any patient details.

Yours faithfully

Dr Kirsten Morley-Jepson

MBBCh, DA, Dip Pec SA

Staff: A0037086

W-39-01-83

Student: 359422

Tel: 0834768033

Email: kmorleyj23@gmail.com

Appendix 5: Data Collection Sheet

The Impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital

Appendix D: Data Collection Sheet

[illegible][illegible]

Total Cases during		Feb 2019 - March 2020	March 2020 - Feb 2021
Obstetrics:	Elective caesarean		
	Emergency Caesarean		
	Other obstetric cases		
Gynaecology:	Elective Cases		
	Elective oncology		
	Emergency cases		
Paediatrics:	Hearse and throat (HNT),		
	plastic surgery		
	orthopedics - elective		
	orthopedics - emergency		
	dental surgery		
	urology		
	Gastroenterology (GI/GH) endoscopy		

Total Cases postponed:		Feb 2019 - March 2020	March 2020- Feb 2021
Obstetrics :			
Gynaecology:			
Pediatrics:			
	(Total)		

Total morbidities	ICU admission	Non-ICU admission	Admission to day surgical	Feb 2019 - March 2020	March 2020 - Feb 2021
Obstetrics:					
	Elective caesarean				
	Emergency Caesarean				
	Other obstetric cases				
Gynaecology:					
	Elective Cases				
	Elective oncology				
	Emergency cases				
Paediatrics:					
	Ear nose and throat (ENT), plastic surgery				
	orthopaedics - elective				
	orthopaedics - emergency				
	dental surgery				
	urology,				
	Cardiovascular (CVD) endoscopy				
	Other				

Total specialties		Feb 2019 - March 2020	March 2020 - Feb 2021
Obstetrics:	Elective caesarean		
	Emergency Caesarean		
	Other obstetric cases		
Gynaecology:	Elective Cases		
	Elective oncology		
	Emergency cases		
Paediatrics:	Ear nose and throat (ENT), plastic surgery		
	orthopedics - elective		
	orthopedics - emergency		
	dental surgery		
	urology,		
	Gastroenterology (GDM, endoscopy, etc)		

Number of theatre hours utilized		Feb 2019 - March 2020	March 2020 - Feb 2021
Obstetrics:	Elective caesarean Emergency Caesarean Other obstetric cases		
Gynaecology:	Elective Cases Elective oncology Emergency cases		
Paediatrics:	Ear nose and throat (ENT), plastic surgery orthopedics - elective orthopedics - emergency dental surgery urology, oncology, ENT, paediatric dental (GUM) endoscopy		

Appendix 6: Ethics approval for protocol amendments



HUMAN RESEARCH ETHICS COMMITTEE
(MEDICAL)

01 September 2021

To Whom It May Concern

SUBJECT: CONFIRMATION OF PROVISIONAL STUDY APPROVAL

(This letter is not a clearance certificate - not yet cleared)

Protocol Ref No: M210845

Protocol Title: The impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital

Principal Investigator: Dr Kirsten Morley-Jepson

Department: Clinical Medicine

This letter serves to confirm that the Human Research Ethics Committee (Medical) has granted provisional approval for the above mentioned study. The researcher is required to submit written approval to conduct the study in your district/institution in order for a clearance certificate to be issued.

Please note that this provisional approval letter does not permit data collection/secondary data analysis or any other form of research. Research may only be started when an applicant has received the final clearance certificate from the HREC (Medical) Secretariat.

Should you have any queries, you may contact me at tel: 011 717 2656/2700/1234 or by email Mapula.Ramaila@wits.ac.za or HREC-Medical.ResearchOffice@wits.ac.za

Yours Faithfully,

Miss Mapula Ramaila
Administrative Officer
Human Research Ethics Committee (Medical)



Appendix 7: Human research ethics committee clearance certificate

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG



R14/49 Dr Kirsten Morley-Jepson

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M210845

NAME: Dr Kirsten Morley-Jepson
(Principal Investigator)
DEPARTMENT: Health Sciences - Clinical Medicine
Rahima Moosa Mother and Child Hospital

PROJECT TITLE: The impact of the COVID-19 pandemic on theatre utilization
at Rahima Moosa Mother and Child Hospital

DATE CONSIDERED: 27/08/2021

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Dr J. Wagner and Dr T. Kleyenstuber

APPROVED BY: 
Dr CB Penny, Chairperson, HREC (Medical)

DATE OF APPROVAL: 02/11/2021

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **August** and will therefore be due in the month of **August** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 8: Rahima Moosa Mother and Child Hospital CEO Approval



GAUTENG PROVINCE

HEALTH
REPUBLIC OF SOUTH AFRICA

Rahima Moosa Mother and Child Hospital

Enquiries: Adjunct Professor Ashraf Coovadia

Tel: 011 470 9284/9100

Email: Karen.Marshall@wits.ac.za

TITLE OF RESEARCH PROJECT:

"THE IMPACT OF THE COVID-19 PANDEMIC ON THEATRE UTILIZATION AT RAHIMA MOOSA MOTHER AND CHILD HOSPITAL"

NAME OF SUPERVISORS:

Dr's Janine Wagner and Thomas Kleyenstuber

NAME OF RESEARCHER:

Dr Kirsten Morley-Jepson
Department of Anaesthesiology
University of the Witwatersrand

NHRD REF NO: GP_202108_013

Dear Dr Morley-Jepson,

Permission is granted for you to conduct the research as indicated in the title above.

The terms under which this permission is granted is contained in the Researcher Declaration form that you have signed. Failure to comply with these conditions will result in the withdrawal of such permission.

It is crucial for you to inform the Research Coordinator, Karen Marshall of the actual start and end dates of your study. This could be done by e-mail.

Should the study commence more than 12 months after receipt of this approval letter you will have to go through the process of applying again.

You are strongly advised to keep a signed copy of the declaration form to ensure that the terms of this agreement are always complied with.

Yours sincerely,

DR NP MKABAYI

Chief Executive Officer

Rahima Moosa Mother and Child Hospital

2021:10:05

Appendix 9: Approval letters from HOD's: Obstetrics and Gynaecology, Paediatrics and Anaesthesia



7 September 2021

Dear Dr Morley-Jepson

The impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital

Regarding your study, I think it will be of value and support it going forward.

Kind regards

Dr Amy Wise

Acting HoD Obstetrics and Gynaecology

Rahima Moosa Mother and Child Hospital

Faculty of Health Sciences

Johannesburg Hospital | Private Bag X39, Johannesburg, South Africa | T +27 11 488 3179 | F +27 11 643 2522 | www.wits.ac.za

Department of Paediatrics & Child Health
School of Clinical Medicine, Faculty of Health Sciences
University of the Witwatersrand

Private Bag X20, Newclare, South Africa, 2112· Telephone: +27 11 470 9100/9284· E-mail: Ashraf.Coovadia@wits.ac.za

13 October 2021

To whom it may concern,

Permission to conduct- a retrospective descriptive study entitled: The impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital

As Head of the Department of Paediatrics at Rahima Moosa Mother and Child hospital (RMMCH) I support the research conducted by Dr Kirsten Morley-Jepson, a registrar in the department of anaesthesia. This study will be supervised by Dr J Wagner and Dr T Kleyenstuber. We support the use of clinical records provided they are anonymized and not removed from the premises and pending final ethics approval for the research.

No costs will be borne by the paediatric department, the anaesthetic department, ICU or RMMCH.

The paediatric department accepts that ethical clearance will be mandatory prior to commencement of the study.

The paediatric department expects all results and outcomes gathered during this study to be presented to the CEO of Rahima Moosa and Helen Joseph hospitals, the paediatric department, the anaesthetic department, and the intensive care unit prior to publication in any national or international journals.



ADJUNCT PROFESSOR ASHRAF HASSEN COOVDIA
Academic Head of Paediatrics and Child Health
Rahima Moosa Mother and Child Hospital



Department of Anaesthesiology
Rahima Moosa Mother and Child Hospital
Tel: (011) 470-9106
E-mail: kleyenstuber@hotmail.com
Thomas.Kleyenstuber@wits.ac.za

6 September 2021

Attention: The Chair of the Human Research Ethics Committee

Permission to collect data in the Department of Anaesthesia at Rahima Moosa Mother & Child Hospital

I hereby grant permission for data to be collected in the Department of Anaesthesia at Rahima Moosa Mother & Child Hospital for the following MMED research project: **The impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital.**

Kind Regards

Dr T Kleyenstuber

Head: Clinical Unit – Anaesthesiology

Rahima Moosa Mother & Child Hospital

Appendix 10: National Health Research Database (NHRD) number:

GP_202108_013

Appendix 11: Postgraduate Committee Approval



CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
DIRECTORATE - ANAESTHESIA
Tel. number: (011) 933-9334/5
Fax number: 086 553 2529
Email: Palesa.Mogane@wits.ac.za



6th September 2021

To whom it may concern

RE: APPROVAL OF MMED CORRECTIONS

I would like to confirm that I have read and approved the corrections made by Dr. Kirsten Morley-Jepson (student number 359 422) on her MMED project with the following title:

The impact of the COVID-19 pandemic on theatre utilization at Rahima Moosa Mother and Child Hospital

Subsequently she has submitted these corrections to the postgraduate department. As chairperson for the panel that reviewed her MMed I am happy that the process took place appropriately and that her protocol is of a standard adequate for her to continue with her study provided she has Human Research Ethics Committee.

Kind regards.

DR PALESA MOGANE
CHIEF SPECIALIST AND HEAD OF DEPARTMENT
DEPARTMENT OF ANAESTHESIOLOGY
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
UNIVERSITY OF WITWATERSRAND
EMAIL: PALESA.MOGANE@WITS.AC.ZA
EMAIL: MOGANEP@GMAIL.COM

Appendix 12: Turnitin report

Turnitin Originality Report

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- Submitted: 1

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