Operating theatre efficiency at a Tertiary Eye Hospital in South Africa

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ABSTRACT

BACKGROUND: South African is a resource limited country that needs efficient operating theatres to operate cost-effectively. There is therefore a need to regularly assess theatre efficiency.

AIM: To describe theatre efficiency in ophthalmology theatres at a tertiary hospital in South Africa.

SETTING: St John Eye Hospital is a tertiary academic hospital located in Diepkloof, a township in Soweto, South Africa. It has 3 operating theatres and does not have a dedicated emergency theatre. Emergency surgical cases are added onto one of these three elective lists, as and when they arise.

METHODS: A cross-sectional study of the three operating theatres registry, of surgeries performed over a 6-month period. Data which were analysed included the starting and finishing times of theatre lists, surgical cases which were cancelled on the day of surgery and operating theatre utilization rates.

RESULTS: A total of 1482 surgeries from 229 theatre lists were included in the study. Sixty-five percent of these theatre lists started late, accounting for 4236 minutes of lost theatre time. Lists finishing after 16:15 (theatre overrun) and before 16:00 (theatre underrun) were in 23% and 30% respectively. The difference between starting and finishing times was not statistically significant between general and local anaesthesia lists'. Theatre utilization rate was 62.39%. The cancellation rate was 16.26%, and the most common reasons for cancellations were being medically unfit and no operating theatre time available.

CONCLUSION: All theatre efficiency parameters at St John Eye hospital were below international benchmarks.

INTRODUCTION

The South African public health system has limited resources and long surgical waiting lists. Therefore, efficient running of the theatre is particularly crucial given the limited budget. Operating theatre inefficiency is a significant cause of wasted resources.[1] In the United States, operating time cost is estimated at 22- 80 US Dollars per minute.[1] In South Africa, Samuel et al found that theatre time costs ZAR (South African Rands) 32/minutes, and as its utilisation decreases this cost amount increases.[2] Operating theatres are specialised facilities requiring highly specialised equipment as well as high staff to patient ratio[2]; accounting for a large proportion of a hospital's budget. Theatre inefficiency will resultantly increase the operating costs of the hospital.

There is no clear definition of theatre efficiency as it is measured by a variety of parameters. In public operating theatres, theatre efficiency depends on the appropriate use of the limited resources and time to complete as many cases as possible, reducing the long waiting lists. In the private sector, theatre efficiency can be defined as the use of theatre to generate earnings, since money is earned only if the theatre is in use.[3]

Theatre efficiency can be measured by a variety of parameters. These include theatre utilisation rate, change-over time, cancellation rates, as well as the procedure start-times and overrun times.[3, 4] Theatre utilisation measures whether there is optimal use of the available operating theatre capacity. Short cases have a high turnover time and thus tend to have low utilisation rates compared to long cases.[4] Ophthalmology theatres usually have short cases compared to other specialties; therefore, they might have a lower utilisation rate when compared to other specialties.

Late-starts result in wasting of time available for surgery at the beginning of the lists, it risks late-finishes with the associated unbudgeted overtime costs and unplanned case cancellations.[5] The Royal College of ophthalmologists has suggested that fewer than 10% of the theatre lists should start more than 10 minutes later.[5] Estimation of start time and case duration before surgery is important to avoid underrunning and overrunning of theatre.[6]

Cancellation rate is the proportion of cases cancelled to those booked on the list. Case cancellations lead to delays and can also contribute to low theatre utilisation. It's estimated that

60% of daily theatre cancellations are avoidable.[4, 6] Cancellation of cases not only disrupts operating theatre lists, but also causes emotional stress and anxiety to patients and their families; disrupts their work, wastes their money and affects the patients trust in the health system.[1, 4]

Theatre efficiency is particularly important in South Africa where there are limited resources available in the public health sector. The aim of this study was to describe theatre efficiency at a tertiary eye hospital in South Africa over a period of 6 months.

METHODOLOGY

This was a cross-sectional study of surgical operations performed over a 6 month period at St John Eye Hospital. St John Eye Hospital is a tertiary academic eye hospital located in a township called Diepkloof in Soweto. It serves a large population of Soweto and surrounding areas, and receives referrals from 6 secondary hospitals, two of which are the main referral hospitals in the North-West Province. It has 3 operating theatres, and elective lists run from Monday to Friday from 08:00 until 16:00 (8 hours/480 minutes). It has no dedicated emergency theatre and therefore emergencies are added onto the elective theatre list as they arise. This has the potential of resulting in cancellation of elective cases or an overrun of the list beyond the allocated 8 hours. The information recorded in this theatre register routinely includes the time the patient is put on the operating table, anaesthesia time, surgery starting and ending times and the time the patient leaves the operating theatre.

Data for this study were collected from the theatre register, for surgeries performed from December 2018 to May 2019. Data for the month of January 2019 were missing and could not be found at the time of collecting data. The inclusion criteria were elective lists, emergencies that were added to the elective list and cases that were cancelled on the day of elective surgery. Elective lists run during the month of December run from the 1st of December until the 14th of December, when the elective lists for the hospital stop for the national festive holidays and resume on the 15th of January. All records with incomplete data for the study were excluded.

. The study data was de-identified and entered on Redcap (Research Electronic Data Capture) program, which is hosted by the University of the Witwatersrand, and exported into Excel Microsoft.

Variables used to describe theatre efficiency in this study are:

- Theatre utilisation - The proportion of theatre time used to perform surgical operations as a percentage to the theatre time available.

  Utilization = $\frac{Time\ used}{Time\ available}$

  The time used is the time patients spend inside the operating theatre: the recorded time indicating the period from the time when they enter the operating theatre to the time when they leave. The time available refers to the normal hospital working hours, from 08:00 until 16:00 (480 minutes).

- **Starting time:** The time the first patient on the list is put on the theatre table.
- **Finishing time:** The time the last patient on the list leaves the operating theatre.
- **Cancellation rate:** The proportion of patients cancelled on the day of surgery to those booked on the list.
- **A theatre list late-start:** When the first surgery case of the day is put on the theatre table after 08:15.
- **A theatre list "overrun":** When the last surgery case of the day leaves the operating theatre after 16:15.
- **A theatre list "underrun":** When the last surgery case of the day leaves the operating theatre before 16:00.

Reasons for the cancellation of cases are categorised as either patient-related or hospital-related. Patient related cancellations include being medically unfit, not arriving for surgery, refusing surgery, incomplete surgical workup, change in treatment plan and others. Hospital related cancellations are no theatre time, surgeon or nursing staff not available, equipment not available, no electricity, schedule error, no beds or others.

Statistical analysis

Statistical analysis was performed using Stata. (StataCorp.2019 Stata Statistical Software: Release 17. College Station, TX: StataCorp LLC). The Shapiro-Wilk test showed that the data was not normally distributed. Medians with interquartile ranges (IQR) were used to describe starting and finishing times and analyzed using the Mann-Whitney Wilcoxon test. Categorical data were analyzed using the chi-squared test.

Ethical clearance was obtained from the Human Research Ethics Committee, University of the Witwatersrand (Reference number M1911133)

RESULTS

A total of 1527 patient theatre records were collected. Twenty-nine of these records had incomplete data and 16 were operated on public holidays and were therefore excluded (an attrition rate of 2.95%). A total of 1482 patients, in 229 surgery lists, were included in the study. One hundred thirty-five lists were under local anaesthesia and 94 lists were under general anaesthesia. There were 796 (53.71%) females and 686 (46.29%) males. The average age of patients was 52 years (interquartile range 26 – 67 years). The cases performed under general anaesthetic were 550 (37.11%) and 932 (62.89%) were done under local anaesthesia as demonstrated in Table 1.

Table 1: Frequency table describing age, gender and surgical procedures performed

	GA	LA	Total
Age, years (IQR)	13 (5 – 38)	63 (48 – 71)	52 (26 – 67)
Gender n (%) Female Male	259 (47%) 291 (53%)	537(58%) 395(42%)	796 (57%) 686 (46%)
Surgical procedure performed n (%)			
Cataract	27 (5%)	532 (57%)	559 (38%)
Cornea	12 (2%)	53 (6%)	56 (4%)
Corneoscleral	63 (11%)	8 (1%)	71 (5%)
Evisceration	20 (4%)	0%	20 (1%)
Extraocular	7 (1%)	84 (9%)	91 (6%)

Glaucoma	7 (1%)	71 (8%)	78 (5%)
Oculoplastics	130 (24%)	19 (2%)	149 (10%)
Paediatric	188 (34%)	4 (0.4%)	192 (13%)
Retina	70 (13%)	60 (6%)	130 (9%)
Other	26 (5%)	101 (11%)	127 (9%)
Total	550	932	1482

Age is reported as medians with interquartile range (IQR). Gender and surgical procedures are reported as number of cases (n) and percentages (%).

Starting time

There were 224 cases done as "first case" on the list. The overall median starting time was 15 minutes (interquartile range (IQR) 5 – 30 minutes)) later than the scheduled start time (08:00). The median starting time for lists under local anaesthesia was 12.5 minutes (IQR: 0 – 30 minutes) and for general anaesthesia 20 minutes (IQR: 10- 30 minutes) later than scheduled start time. One hundred twenty-four lists (55%) started on time (started by 08:15), eighty-one (65%) of these lists were under local anesthesia and 43 (35%) were under general anaesthesia. The list starting time was not statistically different between general anaesthesia and local anaesthesia (p value – 0.061). There were 4236 minutes of total theatre time lost due to starting late. *Fig 1* shows the proportions of theatre lists' starting times.

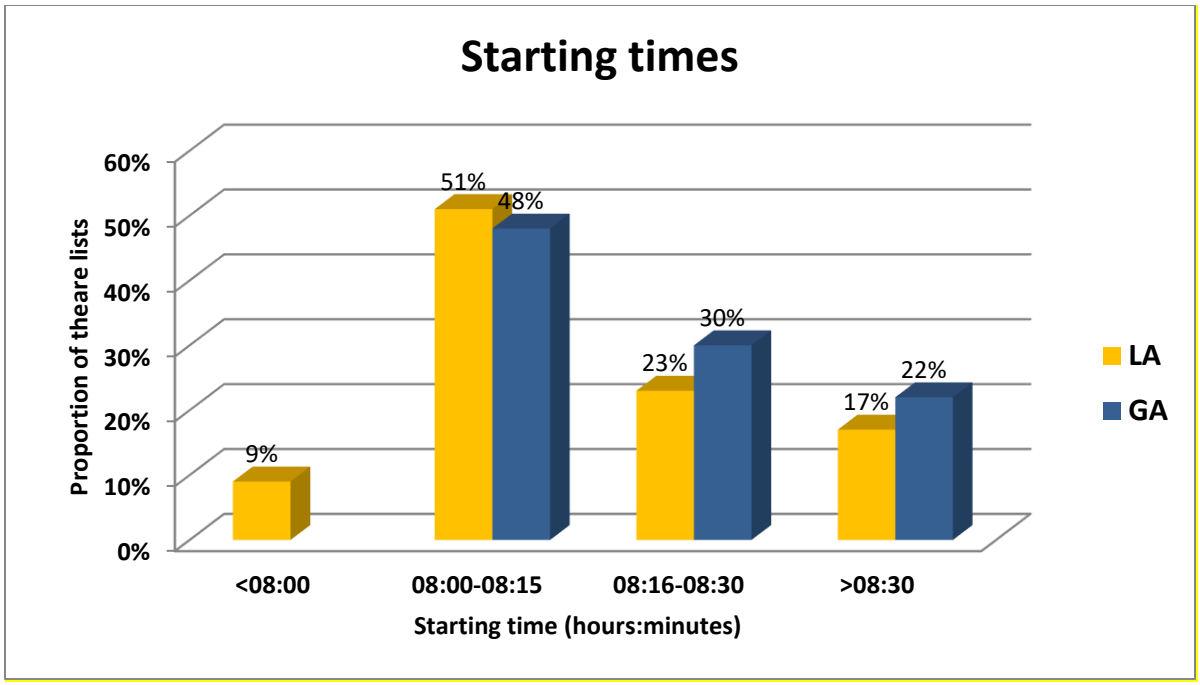

Figure 1: A bar chart showing proportion of theatre lists and their starting times. LA (local anaesthesia) is compared to GA (general anaesthesia). There were no GA cases starting before 08:00.

Finishing time

There were 221 cases done last on the list. Overall the median finishing time was 30 minutes (IQR: 15-50 minutes) later than the scheduled finishing time (16:00). Local anaesthesia cases finished 30 minutes (IQR: 15 – 30 minutes) and general anaesthesia cases finished 23 minutes (IQR: 10 – 40) minutes later than the scheduled finishing time.

Fifty (23%) lists overran (finished after 16:15). Nine (18%) lists that overran did so by more than 60 minutes (finished after 17:00). Forty (80%) of the lists that overran were under local anaesthesia. The difference in finishing times between general and local anaesthesia was not statistically significant p=0.324. Figure 2 shows finishing times of theatre lists.

One hundred thirty-six (61%) lists underran (finished before 16:00). Sixty-six (49%) lists underran by more than 60 minutes accounting for a total of 8275 minutes of lost theatre time.

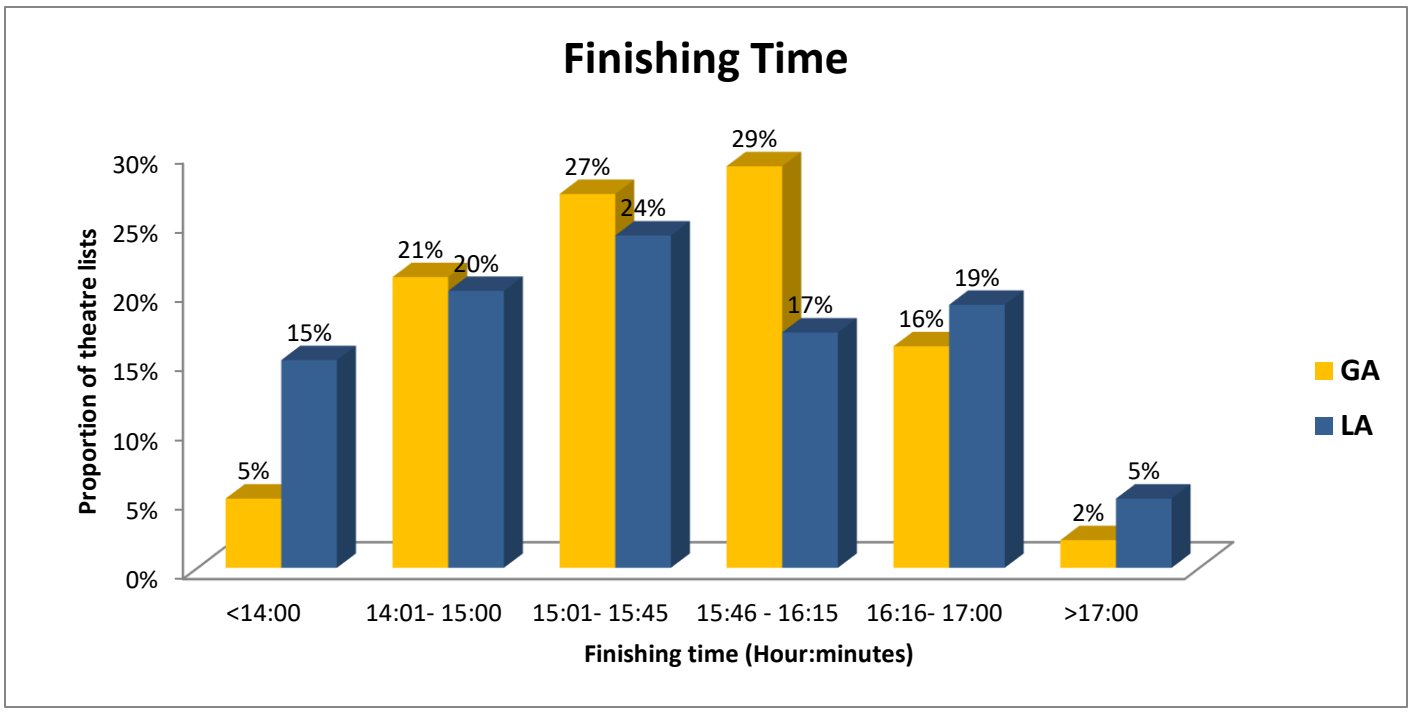

Figure 2: A bar chart showing the proportion of theatre lists and their finishing times. LA (local anaesthesia) is compared to GA (general anaesthesia).

Theatre utilization

There were 128 640 minutes of theatre time available. Overall theatre utilization was 64%. "Overrun" theatre time can overestimate theatre utilization, because it includes time outside of the available theatre time. To adjust for this potential overestimation of theatre utilization rate, we removed the "overrun" time from our calculation, giving an overall theatre utilization rate of 62.39%.

Cancellations

There were 241 total theatre cases cancelled, a cancellation rate of 16.26%. Reasons for cancellations are depicted in tables 2 and 3. One hundred and twenty-eight (53%) of these cancellation were patient-initiated and 113 (47%) were hospital-initiated cancellations. The most common reasons for patient-initiated cancellations were patients' medical unfitness (n=60, 47%) and patients not arriving for surgery (n=43, 34%). The most common reasons for hospital-initiated cancellations were unavailability of theatre time (n=63, 56%) and theatre equipment (n= 30, 27%).

Medical unfitness was the most common reason for patient initiated cancellations in patients under both local (n=43, 52%) and general anaesthesia (n=19, 38%) lists. The most common reasons for hospital-initiated cancellations in general anaesthesia and local anaesthesia lists were unavailability of theatre time (n=27, 79%) and unavailability of theatre equipment (n=30, 54%) respectively.

Table 2: Hospital initiated and patient initiated cancellations

PATIENT INITIATED CANCELLATIONS % (n)		HOSPITAL INITIATED CANCELLATIONS %(n)	
Medically unfit	60 (46.88%)	Equipment not available	30 (26.55%)
Did not arrive for surgery	43 (33.59%)	No theatre time	63 (55.75%)
Incomplete surgical work-up	5 (3.91%)	Schedule error	2 (1.77%)
Change in treatment plan	5 (3.91%)	No electricity	5 (4.42%)
Refused surgery	6 (4.69%)	No beds	1 (0.88%)
Others	9 (7.03%)	others	12 (10.62%)

Cancellations as a percentage %. (n): total number

DISCUSSION

Access to ophthalmology health services in South Africa is still challenging, with long waiting lists and limited resources. In 2015, most patients on elective surgery waiting lists at a tertiary hospital in South Africa were waiting for an ophthalmic procedure.[7] The surgical waiting lists continue to grow, it is therefore important to use available theatre time efficiently.

There is still no consensus on national targets for theatre utilisation, starting times and cancellation rates in South Africa. Most studies use targets set elsewhere around the world, which are quite variable. Hartmann et al found a 48% utilisation rate at a South African private hospital while Asmal et al found a 55% utilisation rate at a public South African Hospital. [3, 8] In their study, Asmal et al excluded overrun time in the calculation of utilisation rate as it has been found to overestimate theatre utilisation. Ford et al found a 59.8% utilisation rate at a paediatric theatre complex, overrun time was also excluded in the calculation of theatre utilisation.[9] A

theatre utilisation rate of 80% is considered ideal.[10] Our study reports an overall utilisation rate of 62.39% in this public facility and this is similar to results of Asmal et al.

The definition of starting time is different between different institutions. In an audit of ophthalmic theatre time at a Nigerian, staff members belonging to the same operating theatre gave 3 different definitions of the time that theatre should start.[11] These 3 definitions were: the time the first patient on the list enters the operating theatre, the time that the first patient on the list has anaesthesia and the time that the first patient on the list started their operation. Similarly in an audit at a Queensland public hospital, staff members gave different definitions of what they thought was starting times.[12] Different theatre start time definitions contribute to theatre lists starting late. The definition of theatre start time should be uniform, since theatre start time is an important theatre efficiency variable.

Lewis LA found 91.3% of lists started late at a UK hospital while locally in South Africa Asmal et al found 74% of lists started late.[8,13] They also defined theatre late starts as lists starting after 08:15. In our study 44.2% started late, which compares favourably with these other studies. Despite this, there were 4236 minutes of theatre time lost due to starting late. Our study did not report on the reasons for starting late. In their study, Asmal et al found that 46% of late starts were avoidable.[8]

Older age and higher American Society of Anaesthesiologists status IV (ASA) has been associated with delayed starting times in general anaesthesia lists. A possible strategy to reduce the number of late-starts is to start the list with the "golden patient".[14] A golden patient is a young, usually medically well and appropriately investigated patient who is designated to be first on the list to minimise interruptions.

Theatre lists finishing before their scheduled "finish-time", underrunning, reduces theatre utilisation. In our study, underrunning by 60 minutes resulted in a loss of 8275 minutes, which is a 6.4% reduction in theatre utilisation. Ophthalmic procedures are generally short theatre cases, particularly if they are done under local anaesthesia. Theatre time equivalent to this "lost time" could accommodate a lot of procedures such as cataract surgery and have a large impact on reducing the ophthalmic waiting list.

Overrunning lists incurs additional costs for work that is done overtime. Overrunning can also overestimate theatre efficiency.[8] The Royal College of Anaesthetists recommends that less than 10% of lists should end over 15 minutes later than scheduled finishing time.[15]

Case cancellations on the day of surgery may lead to underrunning of theatres, resulting in wasted time. This adds to the long waiting lists as these cancelled patients are now added to the waiting list. An international benchmark for cancellations is 2%, according to New South Wales guidelines.[10] In our study the cancellation rate was 16.26%, which is significantly more than this recommended rate.

The commonest reason for patient-initiated cancellations was medical unfitness of patients. Some of the causes of patients' medical unfitness were: high blood pressure, high blood glucose and coughing. Pre-operative assessments are usually done the day before surgery and patients that are not medically fit for surgery should ideally be identified and cancelled the day before. Some of these cancellations could have been avoided by optimising patients before surgery.

As found in this study, the most common hospital-initiated cancellation was lack of theatre time (56%). South Africa has resource restraints; it is therefore not surprising that inaccessibility to equipment was the second most common reason for hospital-initiated cancellations.

There are several limitations to the study. The retrospective nature of the study means one cannot confirm the accuracy of the data. There were no reasons recorded for the delayed starting time, which would have given more information about where the inefficiencies are.

CONCLUSIONS

This study provides a better understanding of factors affecting theatre efficiency. Although the theatre efficiency parameters are suboptimal, with a large room to improve, theatre utilization of 62% and only 45% late starts are better than those found in other local studies. Scheduling of lists is very important and will improve most of the parameters governing an efficient theatre. The overall cancellation rate of 16% is also suboptimal. To reduce cancellations and improve overall theatre efficiency, more attention should be paid to pre-operative assessments of not only the patients, but also the equipment required on the day of surgery.

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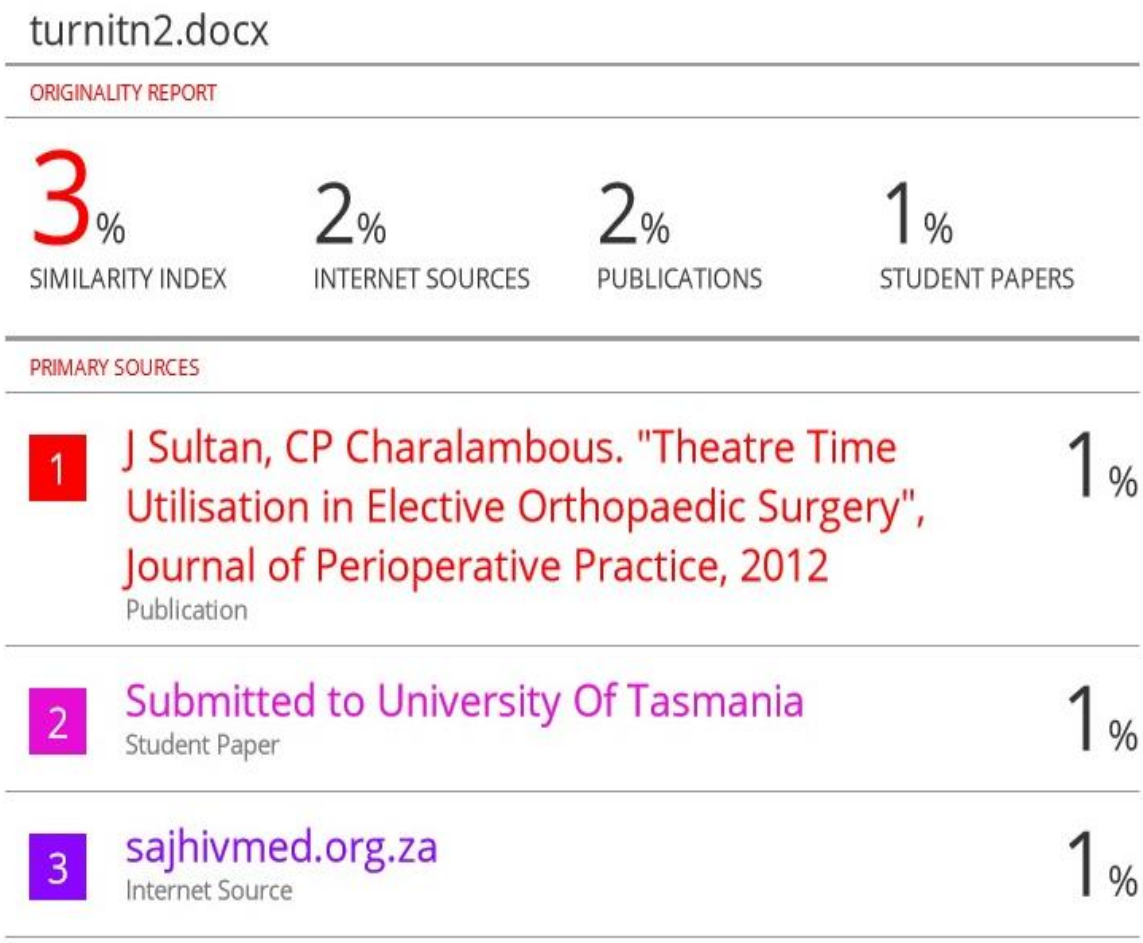
APPENDIX A



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ORIGINALITY REPORT

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SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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1	J Sultan, CP Charalambous. "Theatre Time Utilisation in Elective Orthopaedic Surgery", Journal of Perioperative Practice, 2012 Publication	1%
2	Submitted to University Of Tasmania Student Paper	1%
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APPENDIX B

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr M Tsimanyane

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M1911133

NAME: (Principal Investigator)	Dr M Tsimanyane
DEPARTMENT:	School of Clinical Medicine Department of Neurosciences Division of Opthalmology St John's Eye Hospital Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Operating theatre efficiency at a tertiary hospital in South Africa
DATE CONSIDERED:	2019/11/29
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr K Koetsie
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2020/03/11

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 3rd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

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 submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **November** and will therefore reports and re-certification will be due early in the month of **November** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Tsimanyane

Principal Investigator Signature

2020/03/11

Date

PLEASE QUOTE THE CLEARANCE CERTIFICATE NUMBER IN ALL ENQUIRIES