ADDIS ABABA UNIVERSITY COLLEGE OF HEALTH SCIENCE AND SCHOOL OF MEDICINE, TIKUR ANBESSA SPECIALIZED HOSPITAL

THE IMPACT OF STANDARDIZED ANESTHESIA READY TIME ON OPERATING ROOM EFFICIENCY AT TIKUR ANBESSA SPECIALIZED HOSPITAL, ADDIS ABABA, ETHIOPIA

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Statement of declaration

By my signature below, I declare and affirm that this thesis is my own work. I have followed all ethical principles of scholarship in the preparation, data collection, data analysis and completion of this thesis. All scholarly matter that is included in the thesis has been given recognition through citation. I affirm that I have cited and referenced all sources used in this document. Every serious effort has been made to avoid any plagiarism in the preparation of this thesis. This thesis is submitted in partial fulfillment of the requirement for specialty of anesthesiology degree to AAU. I would like to declare that this thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

Resident

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ABBREVATIONS AND ACRONYMS

ACT	Anesthesia Controlled Time
ACCPM	Anesthesiology, Critical Care and Pain Medicine
ART	Anesthesia Ready Time
ASA	American Society of Anesthesiology
AAU	Addis Ababa University
CSE	Combined Spinal Epidural
FCOTS	First Case On Time start
OR	Operating Room
SCT	Surgeon Controlled Time
TASH	Tikur Anbessa Specialized Hospital
TOES	Time Out Engagement and Standardization
TPT	Total Procedure Time

ABSTRACT

Background: Operating rooms (ORs) are critical healthcare resources that face efficiency challenges globally. An efficient OR should start early, finish on time , allocate minimal time for preparation between procedures and have a low rate of cancellation. Poor utilization of the OR leads to wastage and drains resources in an already underserved population in low income countries with a highly unmet need for surgery. The study is important in addressing OR efficiency and delays, enhanced patient care and improving OR staff satisfaction.

Objectives: The study primarily assessed the effect of implementing a standardized anesthesia ready time on improving operating room efficiency at Tikur Anbessa Specialized Hospital, Dec-Mar 2024/5

Methods: A single-centered Quasi-experimental study was conducted at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, Dec-Mar 2024/5. The sample size was 211 and Google form was used for data collection. The study used before-and-after design, with before group n =105 and after group n =106, evaluating impact of standardized ART on overall operating room efficiency. Statistical analysis, including descriptive analysis, comparative analysis and regression modeling, was conducted to assess the impact of the ART protocol on the study outcomes.

Results: Two hundred eleven cases were included in the study, with 105 cases (before) and 106 cases (after) application of standardized ART protocol. The average ART decreased from 17 to 15 minutes, the mean OR start time improved from 8:34 to 8:25, case cancellation declined from 27.6% to 19.8%, greater proportion of cases achieved turnover time of less than 15 minutes (85.8%) which was 65% before and over all OR finish time shifts to 16:01(10:01 day local time) from 14:17 (8:17 day local time) indicating optimal utilization.
A t-test was run for mean ART, OR start time and OR finish time and the mean difference between the groups were significant with a p-value of 0.035, 0.001, and 0.001 respectively.
Conclusion: Standardizing ART has a positive impact on OR efficiency, teamwork, and patient safety. Its success depends on team engagement, protocol customization and sustained quality monitoring.

Key words:- Anesthesia Ready Time , Surgeon controlled time, Anesthesia controlled time, Operating Room Efficiency, Total procedure time

1. INTRODUCTION

1.1 Background

Operating rooms (ORs) are critical healthcare environments where surgical procedures are performed. It is one of the most expensive areas of a hospital, requiring significant capital and recurring investments. OR efficiency is a critical factor in healthcare delivery, as it directly impacts patient outcomes, resource utilization, and healthcare costs. Efficient OR processes result in reduced surgical complications, shorter hospital stays, and improved patient satisfaction. Conversely, inefficient practices lead to increased healthcare costs, wasted resources, and decreased revenue generation for the hospital [3, 4]. This problem is particularly pronounced in developing countries like Ethiopia, where there is highly unmet surgical need [20-25]. Therefore, optimizing OR efficiency is essential for enhancing patient care and ensuring the sustainability of healthcare systems.

Operating room efficiency is paramount for enhancing patient care and resource utilization in healthcare settings. Inadequate efficiency leads to prolonged waiting lists, high cancellation rates, and decreased patient satisfaction [7]. Utilizing predictive models and machine learning can improve scheduling, optimize clinical outcomes, and maximize operating room utilization [13]. Implementing effective algorithms like Genetic Algorithm and Particle Swarm Optimization can address the complexity of operating room scheduling problems [14]. Enhancing operating room performance through integrated time management can reduce costs, increase revenues, and improve patient satisfaction [15-17]. Identifying and mitigating these factors are crucial for achieving optimal operating room efficiency and delivering high-quality care while minimizing financial losses.

An efficient OR should start early, finish on time, allocate minimal time for preparation between procedures and have a low rate of cancellation. An essential determinant of OR efficiency is the standardized Anaesthesia-Ready Time (ART), which refers to the time taken by the anesthesia provider to adequately prepare the patient for surgery, including anesthesia administration, patient monitoring, and pre-operative assessments. Standardized ART plays a vital role in balancing waiting times for surgeons and anesthesiologist, optimizing workflow, and improving overall operating room efficiency [1, 2].

ART is a component of Anesthesia Controlled Time(ACT) which altogether with Surgeon Controlled Time(SCT) determines Total Procedure Time(TPT). Anesthesia Controlled Time (ACT) is defined by the sum of Anesthesia Ready Time (ART) and Anesthesia Recovery Time (ART) during surgical procedure [14,15]

TPT plays a big role in OR efficiency which in turn significantly impacted by ACT and ART. Efficient OR management demands accurate prediction of the times needed for all components of care including SCT and ACT for each surgical procedure.[14,15]. Predicting TPT is challenging because it entails several elements subject to variability, such as room setup and take down, patient positioning, prepping and draping as well as the two principal components: SCT and ACT. If TPT could be better predicted, this could lead to a reduction in over utilized OR time and fewer case cancellation.

Anaesthesia-Ready Time (ART) plays a crucial role in the success of surgical procedures. The anesthesiologist's responsibilities during ART include administering appropriate anesthesia, ensuring patient safety through monitoring, and conducting pre-operative assessments to determine the patient's readiness for surgery [5]. By effectively managing ART, the anesthesiologist contributes to reducing the risk of complications, adverse events, and anesthesia-related morbidity and mortality [6]. Standardized ART protocols ensure consistency and efficiency in patient preparation, leading to improved surgical outcomes.

Standardized ART has several key benefits that contribute to improved operating room efficiency. First, it enhances time management by reducing variability in preparation times and ensuring consistent patient readiness . Second, standardized ART protocol improves patient safety and quality of care by enabling thorough pre-operative assessments, optimizing anesthesia administration, and ensuring proper patient monitoring throughout the surgical process. Lastly, standardized ART facilitates better resource allocation, including efficient scheduling, appropriate equipment and supplies availability, and coordinated teamwork among the surgical team.[26]

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1.2 Statement of the Problem

Inefficient utilization of operating rooms significantly impacts quality of care, leading to prolonged waiting lists, high rates of cancellations, frustration among operating room personnel, and increased patient anxiety, ultimately affecting patient health negatively [7-9]. Studies highlight the critical need for strategic, tactical, and operational decisions to optimize operating room efficiency, focusing on reducing surgical case variability, overutilized time, and improving operational metrics that matter while minimizing less factors like first-case start delays and turnover times [10].

Supporting evidence suggests that delays in anesthesia-ready time can significantly impact operating room efficiency. A study found that delays in preoperative processes, including anesthesia preparation, were associated with increased surgical case cancellation rates and prolonged waiting times for surgeries. Similarly, another study demonstrated that improving anesthesia preparation time resulted in reduced surgeon waiting times and increased operating room utilization. These findings highlight the importance of addressing the problem of standardized anesthesia ready time to enhance operating room efficiency.

Tikur Anbessa Specialized Hospital, located in Addis Ababa, Ethiopia, is a major referral center for specialized medical care in the region. However, the hospital faces significant challenges in operating room efficiency. High surgical case cancellation rates and prolonged turnover times have been documented, hindering the timely delivery of surgical care[7]. There is a recognized problem regarding standardized anesthesia ready time, which affects operating room efficiency [26]. Delays or inefficiencies in this process can lead to suboptimal operating room utilization, prolonged waiting times for surgeons and anesthetists, and compromised patient care. The specific challenges contributing to this problem may include inconsistent preoperative assessment practices, inadequate communication among surgical team members, and variations in anesthesia protocols. In the context of Tikur Anbessa Specialized Hospital, a prospective study conducted over two months in 2019 revealed a high cancellation rate of 35.8%, with the most common reasons being patient preparation, shortage of time and lack of facilities. The study also found that start times were delayed in 93.4% of cases, and turnover times were prolonged in 34.5% of cases, indicating significant inefficiencies in the operating room [7].

The problem of suboptimal standardized anesthesia ready time and operating room efficiency has several consequences for various stakeholders involved in surgical care at Tikur Anbessa Specialized Hospital. First, patients experience extended waiting times, which can lead to increased anxiety, dissatisfaction, and compromised patient safety due to prolonged fasting periods. Second, surgeons and anesthetists face reduced productivity, increased stress, and potential burnout due to prolonged waiting times and inefficient scheduling. Thirda, the hospital as a whole experiences financial losses resulting from surgical case cancellations, decreased resource utilization, and increased healthcare costs.

1.3 Significance of the Study

Despite the growing recognition of the importance of operating room efficiency, there is a lack of comprehensive studies specifically addressing the problem of standardized anesthesia ready time at Tikur Anbessa Specialized Hospital in Addis Ababa, Ethiopia. Existing literature primarily focuses on broader aspects of operating room efficiency, such as workflow optimization or surgical scheduling practices, without specifically addressing the challenges related to anesthesia preparation in this low resource setting.

While some studies have explored the impact of delays in preoperative processes on operating room efficiency, they lack context-specific insights and fail to provide actionable recommendations for improvement in the unique context of Tikur Anbessa Specialized Hospital. Therefore, there is a need for a dedicated study to fill this gap and provide evidence-based solutions to enhance standardized anesthesia ready time and overall operating room efficiency. This study aims to investigate the importance of standardized anaesthesia ready time on improving operating room efficiency at Tikur Anbessa Specialized Hospital.

This study holds significant importance in optimization of operating room efficiency. Standardizing anaesthesia ready time (ART) can significantly impact by improving the following:

- **Efficiency of operating rooms:** By reducing delays and optimizing the time spent on anaesthesia preparation, the overall productivity of the operating room can be improved, leading to better resource allocation and reduced waiting times for both surgeons and anesthetists.

- **Enhance patient care:** Standardized ART can ensure that patients receive timely and efficient anaesthesia care, which is critical for their safety and comfort. This study can help identify and address delays in anaesthesia preparation, ultimately improving patient outcomes and satisfaction.
- **Resource allocation and cost effectiveness:** By optimizing anaesthesia ready time, the study can help reduce unnecessary delays and improve the allocation of resources within the operating room. This can lead to cost savings and more efficient use of resources, ultimately benefiting the hospital and the healthcare system as a whole.
- **Addressing delays and inefficiencies:** The study can identify specific causes of delays in anaesthesia preparation, such as teaching activities or equipment issues, and provide recommendations to address these inefficiencies. This can lead to targeted interventions and improvements in the operating room workflow.
- **Improving surgeon and anesthetist satisfaction:** By reducing waiting times and improving operating room efficiency, the study can contribute to increased satisfaction among surgeons and anesthetists. This can lead to more collaborative environment, improve morale, and enhance overall performance in the operating room.

2. LITRATURE REVIEW

2.1 Preview

Efficient utilization of OR is crucial in modern healthcare due to their high costs and demand. One significant determinant of OR efficiency is ACT. ACT significantly impacts OR efficiency, influencing start times, turn over time, costs and patient outcomes. Optimizing ACT through standardized protocols, preoperative preparation and technological solutions has proven effective in reducing delays and improving OR throughput. Therefore, the need for a standardized approach to ART is paramount to minimizing surgical delays and enhancing both patient safety and healthcare cost effectiveness.

2.2 Impact of Anesthesia Ready Time (ART) on Operating Room Efficiency

Anaesthesia ready time is a crucial component of OR efficiency, as it directly affects the start time of surgical procedures. Studies have shown that prolonged ART can lead to delays in surgical start times, resulting in inefficient use of OR resources and increased costs. Delays in anesthesia induction for the first case of the day can cascade into subsequent cases, reducing the number of surgeries performed. A quasi-experimental study by Overdyk et al. (2016) assessed the effect of implementing a standardized anesthesia protocol across multiple hospitals. The study used pre-post intervention design comparing OR metrics six months before and after standardization. The result demonstrated a 12% improvement in FCOTS and a 9 minute average reduction in induction time. A comparative study by F J Overdyk et al. (1998), evaluated impact of multidisciplinary strategies to enhance OR efficiency over 1787 cases and after the implementation of the strategies first case of the day, patient in room, anesthesia ready, surgical preparation start, and procedure start time were significantly earlier and procedure start time for the first case of the day occurred, on average, 22 min earlier than all other procedures. For all cases combined, turnover time decreased, on average, by 16 min. unavailability of surgeons, anesthesiologists, and residents decreased significantly($p < 0.05$) as causes of OR delays[32]. A comparative study by Zafar et al.(2006), conducted over a two month period at a teaching hospital in Pakistan, evaluated the implementation of standardized ART benchmarks across 300 elective surgical cases. The benchmarks were defined based on ASA classifications, with specific time targets set for various anesthesia procedures. The study found that 78% of cases met these standards. The most common causes of delays included teaching procedures to undergraduate and postgraduate trainees and the management of pediatric patients. The authors concluded that adopting standardized ART benchmarks and conducting regular audits can help improve OR scheduling and reduce patient costs[36].

A retrospective study by Morgan L Brown et al. (2023), analyzed 44,418 congenital cardiac surgery cases from the society of thoracic surgeons congenital heart surgery database (2017-2021). It identified a median ART of 51 minutes and found that factors such as lower patient weight, prematurity, presence of chromosomal abnormalities and the involvement of anesthesia trainees were associated with prolonged ART. The study suggests that recognizing these predictors can help in allocating additional anesthesia staffing to improve efficiency [23]. A study by Christopher Ryan Hoffman et al.(2019), examined factors contributing to delays in first-case start times on 3071 surgical cases over five years. The study found that variables such as the day of the week, the attending surgeon, and the anesthesiology resident were significant predictors of delay time. The findings suggest that these metrics can be useful in assessing system-based practice competencies among residents [15]. A study by Joos et al.(2021) conducted a multicenter prospective study across 36 hospitals in Germany to assess the incidence, duration, and causes of delays in ART for first case surgeries. Over a two week period, the study collected data from 3628 first-of-day cases, comparing performance across small community hospitals, larger community hospitals and university hospitals. The results revealed delays in ART can range from 26.5% to 40.8%, with reasons including prolonged induction of anesthesia, patient logistics, and delayed patient arrivals. Additionally, the complexity of anaesthesia inductions, organizational challenges, and delayed patient transport contribute to delays in finishing anaesthesia induction, with an average delay of 19.3 minutes[39]. Furthermore, addressing delays in operating room start times through interventions like automatic pre-operative orders and improved documentation processes can lead to substantial cost savings and increased efficiency in academic medical centers. A study by Harders et al.(2006) focused on enhancing OR efficiency through a multidisciplinary process redesign. Conducted over a three month period at tertiary academic medical center, the prospective study targeted two of seventeen ORs aiming to reduce non operative time (NOT), which encompasses room turnover and anesthesia induction/emergence times. The study highlighted that standardizing emergence protocols improved turnover times by 15%, allowing for more procedures with in the same schedule [9]. A study conducted in Ethiopia found high rates of cancellation and delays in ORs, primarily due to inadequate patient preparation and delayed start times rather than a lack of resources or infrastructures. A study done at TASH the start time of the first case is delayed in 93.4% of cases, and the cancellation rate is 35.8% with the most common reason for cancellation being patient preparation and shortage of time. Studies done in other major teaching hospitals in Ethiopia also had similar findings with cancellation rate at Gondar university hospital 33.1%, Hawassa university hospital 31.6% and Jimma university hospital 23% [28]. A study by Negash et al(2022), conducted comparative assessment of the total OR utilization by using five key OR indicators over three months on 933 elective procedures and found a wide range with a majority 57.3% either underutilized or over utilized. The finish time was very early or late in 75.7%. More over the turn over time is prolonged in 34.5 % of cases, indicating inefficient use of operating theater resources. These findings underscore the critical role of standardization and process improvements in enhancing operating room efficiency, ultimately benefiting patient care and healthcare costs.[7]

2.3 Standardization of Anesthesia Ready Time

Standardization of ART is essential to improve OR efficiency. Standardized ART includes establishing fixed protocols for pre-induction assessments, staffing, room setup and medication preparation. It may also assign specific roles to anesthesia team members and use checklist to ensure consistency. Several experimental studies show that applying such standardization can immensely reduce variability and workflow coordination among perioperative staff, Stepaiak et al, 2010; sherry et al, 2012. A study by Dexter et al.(2011) demonstrated that standardized induction and emergence protocols minimize variability and improve predictability. A study in Pakistan established benchmark timings for ART, demonstrating the effectiveness of standardization in reducing delays and improving efficiency. Similarly, a study in the United States emphasized the importance of identifying predictors of prolonged ART to guide the allocation of additional anaesthesia staffing and improve efficiency.

2.4 Operating Room Efficiency and its determinants

Operating room efficiency is generally assessed in reference to indicators like first case on-time starts (FCOTS), turn over time (TOT), surgical utilization rates, case cancellation and case delay. Case delays, turnover time, cancellation, surgical usage and first case on time starts are some of the often cited causes for OR inefficiencies, Macario et al, 2010. Variability due to non-standardized practices in ART is described in several studies to hinder both scheduling and resource allocation, Dexter & Epstein, 2005.

2.5 Conceptual frame work

The conceptual frame work was developed from different literature reviews [36,37]

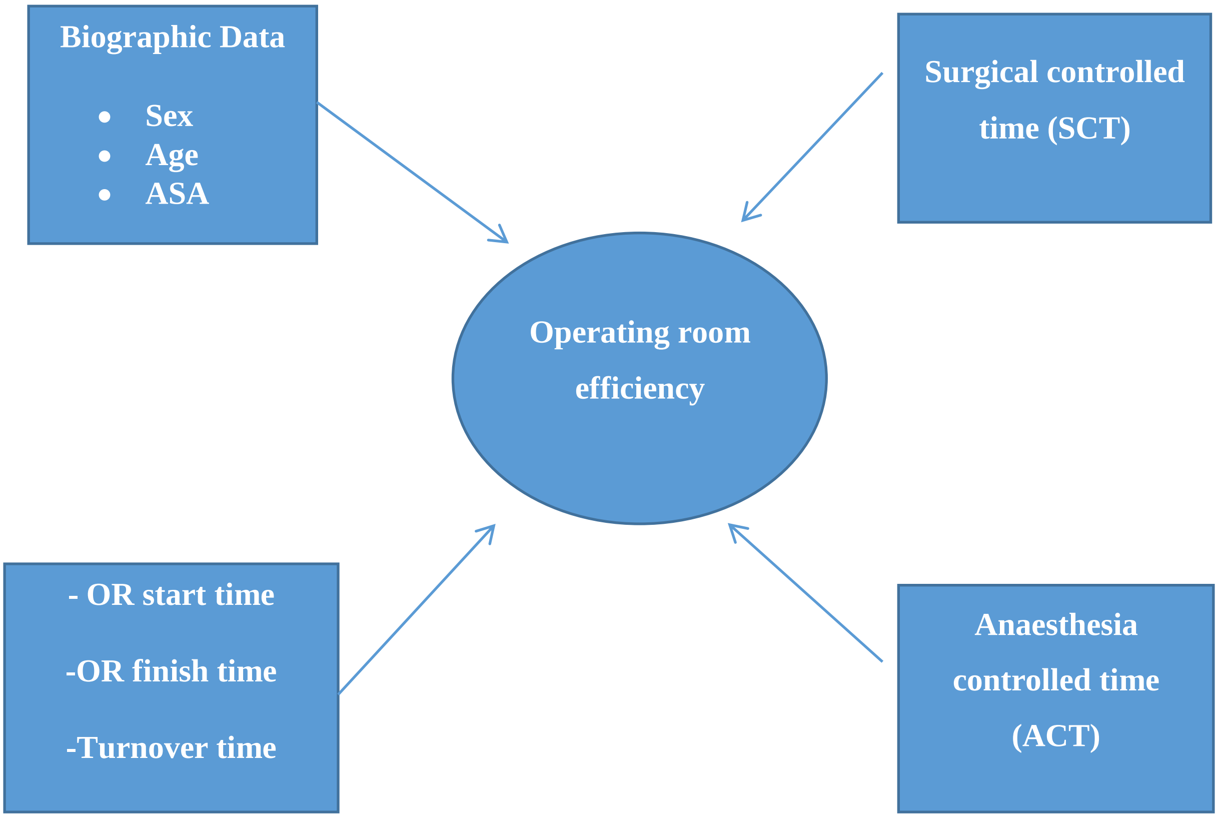

Figure 1: Conceptual frame work for the study of impact of standardized anesthesia ready time on improving OR efficiency at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, Dec 2024/5

3. OBJECTIVES

3.1 General Objective

- To evaluate the impact of standardized anesthesia ready time (ART) on improving operating room efficiency at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, Dec-Mar 2024/5

3.2 Specific Objectives

- To determine the current average anesthesia ready time (ART) at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, Dec-Mar 2024/5
- To measure the effect of standardized ART on operating room efficiency at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, Dec-Mar 2024/5

4. MATERIALS AND METHODS

4.1 Study Design

Institution based Quasi-experimental study with before and after comparison was conducted. The study used a before-and-after design, evaluating the impact of standardized ART on OR efficiency:

- **Before group:** 105 patients (pre-intervention)
- **After group:** 106 patients (post-intervention)
- ART protocol was introduced between the two groups
- Outcomes like ART, First case start time, OR finish time, OR utilization, Case cancellation and Turnover time were compared.

4.2 Study Setting

The study was conducted at Tikur Anbessa Specialized Hospital, a major tertiary care hospital in Addis Ababa, Ethiopia. The hospital has a significant volume of surgical cases, making it an ideal setting to study the impact of standardized anaesthesia ready time on operating room efficiency. It has a total of 13 elective OR's where the study was conducted. The study was conducted from December - March, 2024/5

4.3 Population

4.3.1 Source population

All patients who came for elective surgery at Tikur Anbessa Specialized Hospital

4.3.2 Study population

The study population consisted of all elective surgical cases performed at Tikur Anbessa Specialized Hospital during a study period.

4.3.3 Inclusion and Exclusion criteria

4.3.3.1 Inclusion criteria

- All surgical patients undergoing elective surgery at the time of data collection

4.3.3.2 Exclusion criteria

- All surgical patients undergoing emergency surgery
- Patients from OPD (Outpatient cases)

4.3.4 Study Variable

4.3.4.1 Dependent variable

- OR efficiency

4.3.4.2 Independent variable

- Anesthesia ready time (ART)
- Surgical controlled time (SCT)
- OR start time
- OR turnover time
- OR finish time
- Patient characteristics (Age, Sex, ASA classification,)

4.4 Operational Definition

Surgical controlled time (SCT): time taken by surgical side to complete procedure (it starts from first incision made and ends when last dressing applied)

Anesthesia controlled time (ACT): Anesthesia ready time (ART) + Anesthesia recovery time (ART)

Total procedure time (TPT): ACT + SCT + positioning + nurse preparation

Anesthesia Ready Time (ART): The time taken by the anaesthetist to provide sufficient anaesthetic depth for the start of surgery.

Anesthesia Recovery Time (ART): The time from the last surgical (wound) dressing applied till the patient leaves the OR.

Benchmark ART: 15 min was set for ASA 1 and 2 patients, 30 min for ASA 3 and 4 patients, 20 min for spinal and 30 min for epidural anesthesia. An additional 15min for each invasive procedure was used.

Staff (Team) idle time: refers to periods when members of surgical team are present in the OR but are not actively engaged in productive tasks due to delays or inefficiencies. This includes prolonged anesthesia induction, delays in patient arrival, equipment or instrument preparation, prolonged turnover time.

Operating Room Efficiency: Measured by the percentage of cases that start on time, the number of surgeries completed within the scheduled time, turnover time, OR utilization and cancellation rates.

- **Start time:** time first patient of the day entered the OR. **Late start** is when patient entered later than 15min of scheduled time
- **Turnover time:** time between one patient leaving the operating table and another patient entering(time for cleaning and preparing for next patient). **Long turnover time** is when >25min lapse between cases
- **Finish time:** time the last patient of the day left the operating room. **Early finish time** is 1hr before working hours (before 3:00 pm). **Late finish time** is 1hr after working hours (after 5:00 pm).
- **OR utilization:** proportion of time with in the working hours in which a patient is in the OR(does not include turn over time). **Low utilization: <75%** of working hour utilized(<6hr). **Over utilization:** more than allocated working hours(**>100% / >8hr**). **Optimal utilization:** between 6-8 hours.
- **Cancellation rate:** day of surgery cancellation. **High cancellation rate:** greater than 5%

4.5 Sample Size and Sampling Techniques

4.5.1 Sample Size

Patients that come for elective surgery is less than ten thousand. Since this is a before and after study the minimum number of samples required for this study is determined by using Double proportion population formula:

$$n = Z^2_{1-\alpha/2}[P_1(1-P_1) + P_2(1-P_2)]/d^2,$$ ***where,***

n = **sample size**

$Z^2_{1-\alpha/2}$ = **confidence interval**

P_1 = **estimated proportion (larger)**

P_2 = **estimated proportion (smaller)**

d = **desired precision**

n= minimum sample size required for the study

Z= standard normal distribution (Z=1.96) with confidence interval of 95% and α=0.05

P= the proportion of variability in ART

d = Absolute precision or tolerable margin of error (d) =5%=0.05

$$n = \frac{(Z\alpha/2)^2\,[p_1(1-p_1)+p_2(1-p_2)]}{d^2} = \frac{(1.96)^2\,[0.5(1-0.5)+0.24(1-0.24)]}{(0.05)^2} = 282$$ [7,26,36]

By considering 10% non-response = (282 x 0.1 =28.2 ≈ 29). The final sample size will be

$n = 282 + 29 = 311$

Since within a month around 660 elective surgeries are done in average in the 13 elective OR table, this number is less than 10000, we use correction formula,

$$n = \frac{n_1}{1 + \frac{n_1}{N}} = \frac{311 \times 660}{660 + 311} = \frac{205{,}260}{971} = \mathbf{211\ (final\ sample\ size)}$$

Hence, first group n =105 and second group n =106.

4.5.2 Sampling Techniques

To ensure that the sample is representative of the entire population across different surgical departments and procedures, a stratified sampling technique was employed. The elective surgeries at Tikur Anbessa Specialized Hospital were conducted across 11 different operating rooms, which handle a variety of surgical procedures. These surgeries can be grouped into distinct strata based on type of surgery, such as general surgery, orthopedics, neurosurgery, etc.. The steps involved in the stratified sampling approach are as follows:

1. Stratification of the Study Population:

The elective surgeries were divided into strata based on surgical departments or specialties (e.g., general surgery, orthopedics, neurosurgery, urology, etc.). This ensures that the variability in ART, which may differ across surgical specialties, is adequately captured.

2. Proportional Allocation:

The total sample size (n=211) was distributed proportionally across the strata based on the average number of elective surgeries performed by each department in the previous month. For example, if the general surgery department accounts for 25% of all elective surgeries, then 25% of the 211 sample was allocated to this stratum.

- Let Ni represent the number of elective surgeries performed in the i-th stratum, and N represent the total number of surgeries in all strata. The sample size for each stratum n_i was calculated as:

$n_i = N_i/N \times n$

Where n_i= the proportion sample size for stratum i

N_i= the number of elective surgeries performed in stratum i

N= the total number of elective surgeries in all strata

n= the total sample size

Based on this the proportional sample size will be 35(orthopedics), 14(chest), and 18 for the remaining OR tables as orthopedics has 5 surgeries on average per day, followed by the other tables around 2-3 surgeries per day on average and least being chest table with 2 surgeries per day.

3. Systematic Random Sampling within Strata:

Once the sample size for each stratum was determined, systematic random sampling was applied within each stratum. The sampling interval (K) for each stratum was calculated based on the number of surgeries in that stratum and the sample size for that stratum:

- After determining K, the first surgery in each stratum was selected randomly using a lottery method and subsequent surgeries were selected at regular intervals (every Kth case) until the desired sample size for that stratum is reached.

OR Tables	**Proportional allocation**
Orthopedics	35
Endo urology	18
Open urology	18
Gynecology	18
GI	18
Pediatrics	18
Neurosurgery	18
Vascular	18
Chest	14
ENT	18
OBS	18

Table 1: sample size and proportional allocation per table

4.6 Data Collection

4.6.1 Data collection instrument

The data was collected using a structured questionnaire which was designed by adoption from variable studies. The questionnaire has four sections: patient demographics, surgical department, anesthesia ready times and operating room efficiency indicators. The data collectors filled out the data abstraction form with answers from the patient's medical record and key performance indicator data.

4.6.2 Data collection procedure

Data was collected using Google Forms, an online electronic method by trained data collectors under the supervision of the principal investigator. The Google Form is a part of the Google web-based apps suite, which is free online software that allows the creation of survey questionnaires, and the collection and analysis of information from study participants.

The data was collected before and after application of standardized ART protocol. The benchmark ART protocol (described in the operational definition section) was applied after getting grant from the department and all anesthesia care providers were made to know about it. The benchmark ART was introduced on the department's and residents official telegram group. The collection was conducted by two trained health professionals holding diplomas, two supervisors, one from anesthesia and one from nursing; oversaw the data collection process. Training was provided to both data collectors and supervisors, covering the study objectives, questionnaire administration, data collection process, informed consent procedures and how to ensure privacy during data collection. Interviews and data abstraction took place in a private setting to protect patient confidentiality

4.6.3 Data quality control

To ensure the data quality Pre-test was done one week before the actual data collection on 10 % of the population in the St. Paul's Millennium Medical College. Feedback from the pre-test guided revisions to improve the clarity, simplicity and comprehension of the questionnaire. Additionally, a half-day training session was conducted for data collectors and supervisors to familiarize them with the data collection tools and procedures. The supervisors overseeing the data collection process ensured consistency and accuracy.

4.7 Data Analysis

The collected data was exported to Microsoft Excel; incomplete data was cleaned. The cleaned data was coded and entered to be analyzed using IBM SPSS Statistics, Version 27.0. The analysis included both descriptive and inferential statistics:

• Descriptive Analysis: Frequencies, percentages, means, and standard deviations were calculated for each variable. Tables and charts were used to present the data, ensuring that the magnitude and relationships between study variables were clearly illustrated.

. Comparison between the before and after groups were done to show the significance in mean difference by t-test for the numerical data and chi-square for the categorical data and those differences with a p-value <0.05 considered statically significant.

4.8 Ethical Considerations

Ethical clearance was obtained from the Department of ACCPM, Addis Ababa University. Informed consent was taken from each patient before observation, following the hospital's written consent procedures. The study ensured that no personal identifiers are recorded, and confidentiality and anonymity of participants were strictly maintained. Participants were informed that they have the right to withdraw from the study at any time without consequences.

4.9 Dissemination of Results:

The result of the study will be disseminated to relevant departments within AAU, including Department of Anesthesiology and Critical Care, Department of Surgery, Department of Obstetrics and Gynecology, AAU School of Medicine. Additionally, it will be submitted for presentation at professional meetings and conferences at the local, national and international levels. The study results will also be submitted for publication in peer-reviewed national and international journals.

The outline ensures clarity in the data collection, analysis and ethical sections promoting a well-structured research approach that adheres to both scientific and ethical standards.

5. Result

Two hundred eleven patients were included in this study of the impact of standardized anesthesia ready time on OR efficiency and a complete response (100%) was obtained. The descriptive analysis of patient demographics is summarized in two groups as before and after introduction of standardized anesthesia ready time. The first group includes 105 patients and the later has 106 patients making a total of 211.

5.1 Descriptive statistics of the study population before standardization

Before the introduction of standardized anesthesia ready time among 105 patients, most of them were in the age group of 21 to 40 years (44.7%) and with the majority being females (56%). Most of the patients included in the study were from Urology side (17.2%) and the majority of patients had no underlying chronic medical co-morbidity (62.9%). The most commonly used mode of anesthesia was general anesthesia which was used in 54 patients (51.4%) and most of the anesthesia care was provided by year 3 anesthesia residency trainees 41(39%). Senior anesthesiology consultants were available during the induction of anesthesia of 55.2% of the patients and all OR team were available during induction of anesthesia in 94.3% the cases.

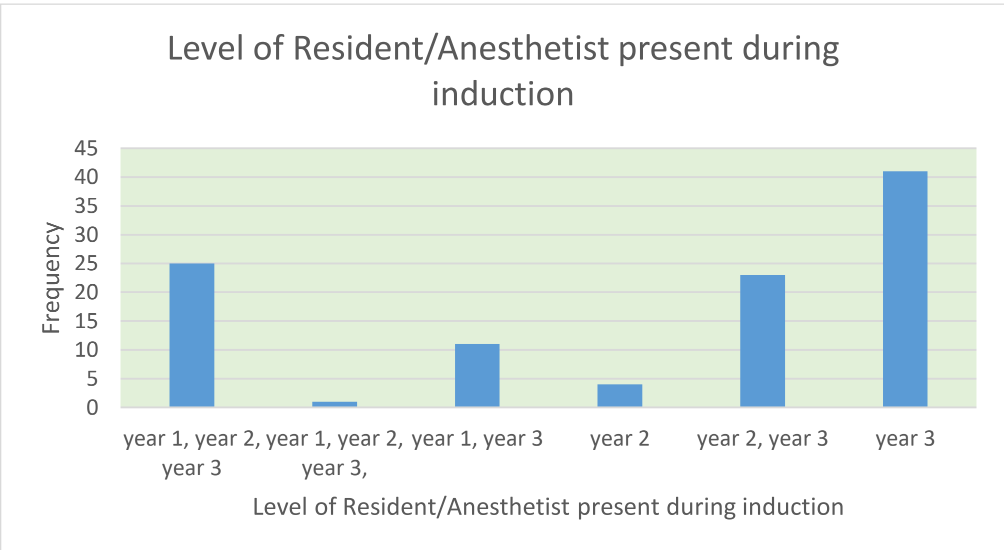

Figure 2: Level of Residents/Anesthetist present during induction

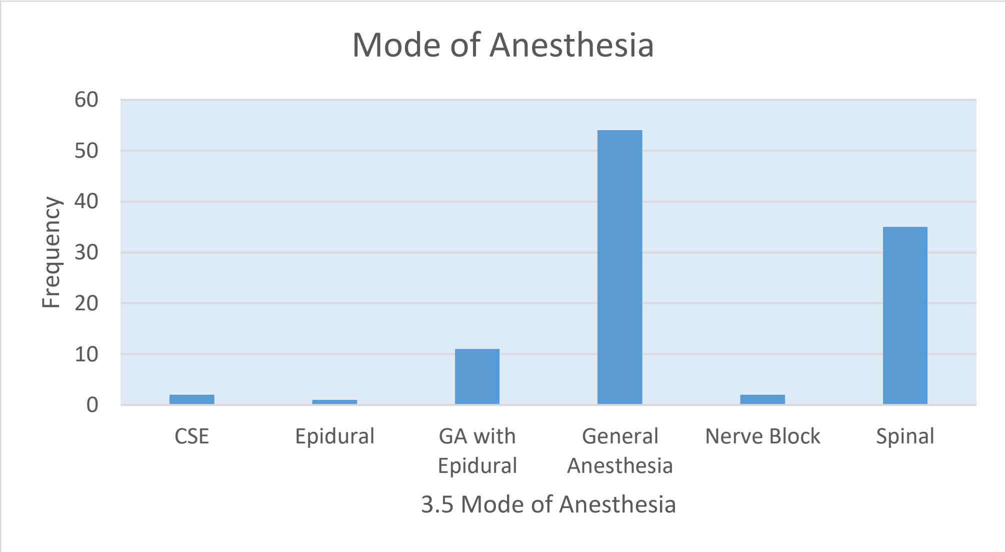

Figure3: Mode of Anesthesia

Table 2: Demographic and health characteristics of patients included in a study of the impact of standardized anesthesia ready time on OR efficiency at TASH before standardization, 2025(n=106).

Variables	Frequency	Percentage
Age		
<1 yr	6	5
>40 yrs	35	33.3
1-10 yrs	12	11
11-20 yrs	5	4
21-40 yrs	47	44.7
Sex		
Female	59	56
Male	46	44
Chronic medical illness		
No	66	62.9
Yes	39	37.1
ASA Class		

1	44	41.9
2	54	51.4
3	7	6.7
Surgical departments		
Chest	7	6.6
Endo-urology	9	8.6
ENT	9	8.6
GI	9	8.6
Gynecology	9	8.6
Neurosurgery	9	8.6
OBS	9	8.6
Orthopedics	17	16
Pedi	9	8.6
Open-urology	9	8.6
Vascular	9	8.6
Mode of Anesthesia		
CSE	2	1.9
Epidural	1	1.0
GA with Epidural	11	10.5
General Anesthesia	54	51.4
Nerve Block	2	1.9
Spinal	35	33.3
Level of Resident/Anesthetist during induction		
year 1, year 2, year 3	25	23.8
year 1, year 2, year 3,	1	1.0
year 1, year 3	11	10.5
year 2	4	3.8
year 2, year 3	23	21.9
year 3	41	39.0

All OR staff member present during induction		
No	6	5.7
Yes	99	94.3

5.2 Descriptive statistics of the study population after standardization

After introduction of standardized anesthesia ready time among 106 patients, most of them were in the age group >40years (41.5%) and majority are females (58.5%).

Most of the patients included in the study were from urology (17.2%) and majority of the patients didn't have chronic medical co-morbidity(66%). The most commonly used mode of anesthesia was general anesthesia which is used in 59(55.7%) of the patients and most of the anesthesia care 52(49.1%) was provided by year 1and 3 anesthesia residency trainees. Senior anesthesiology consultants were available during the induction of anesthesia of 59.4% of the patients and all OR team were available during induction of anesthesia in 100% of the cases

Table 3: Demographic and health characteristics of patients included in a study of the impact of standardized anesthesia ready time on OR efficiency at TASH after standardization, 2025(n=106).

Variables	Frequency	Percentage
Age		
<1 yr	3	2.8
>40 yrs	44	41.5
1-10 yrs	16	15.1
11-20 yrs	8	7.5
21-40 yrs	35	33.0
Sex		
Female	62	58.5
Male	44	41.5
Chronic medical illness		

No	70	66.0
Yes	36	34.0
ASA Class		
1	53	50.0
2	48	45.3
3	5	4.7
Surgical departments		
Chest	7	6.6
Endo-urology	9	8.6
ENT	9	8.6
GI	9	8.6
Gynecology	9	8.6
Neurosurgery	9	8.6
OBS	9	8.6
Orthopedics	18	16.9
Pedi	9	8.6
Open Urology	9	8.6
Vascular	9	8.6
Mode of Anesthesia		
CSE	2	1.9
GA with Epidural	3	2.8
General Anesthesia	59	55.7
Nerve Block	2	1.9
Sedation	4	3.7
Spinal	36	34.0
Level of Resident/Anesthetist during induction		
Non physician anesthetist	4	3.8
year 1, year 2, year 3	16	15.1
year 1, year 3	52	49.1
year 2	1	.9
year 2, year 3	32	30.2

All OR staff member present during induction		
No	0	0
Yes	106	100

5.3 Anesthesia ready time and OR efficiency before standardization

The data from the first 105 cases were collected before the introduction of standardization and the **mean** time of OR arrival was 8:06, 7:35 and 7:31 of the surgical team, nursing team and Anesthesia team respectively.

The average anesthesia ready time was 17 minutes and the mean time at which first case started (incision made) was 8:34. The Operating room was optimally utilized in 61.9% of the cases and the cancellation rate was found to be 27.6%. The OR turnover time in majority of the cases (65%) is less than 15 minutes and the mean OR finish time was 14:17 which is 8:17 day local time.

Variables	**Mean**	**St. deviation**	**Minimum**	**Maximum**
Time Surgical team arrived OR	8:06	0:25	7:30	9:40
Time Nursing team arrived OR	7:35	0:22	7:20	9:00
Incision Start Time	8:46	0:43	7:40	11:50
Time Anesthesia team arrived OR	7:31	0:07	7:00	7:55
Time patient entered OR	8:36	1:01	7:15	12:00
Induction Start Time	8:25	1:05	7:15	12:30
Anesthesia ready time	**0:17**	0:10	0:05	0:45
Induction Over Time	8:42	1:04	7:30	12:15
First case start time	8:34	0:22	8:00	9:55
OR finish time	14:17	1:24	10:00	17:55

OR utilization	**Frequency**	**Percentage**

Low utilization(<75%) or (<6 hrs))	22	20.9
Optimal utilization(80-100%) (6-8 hrs))	65	61.9
Over utilization(>100%) (>8 hrs))	18	17.2
Operating table turnover time		
<15 min	69	65
15- 30 min	29	26
31- 45 min	3	3
40-60 minn	1	1
>60 min	3	3
Number of cancelled cases(in days)		
None	76	72.3
1	27	25.7
2	2	1.9

Table 4: ART and OR efficiency before standardization

5.4 Anesthesia ready time and OR efficiency after standardization

The data from the late 106 cases were collected after the introduction of standardization and the **mean** time of OR arrival was 8:00, 7:36 and 7:33 of the surgical team, nursing team and Anesthesia team respectively.

The average anesthesia ready time was 15 minutes and the mean time at which first case started was 8:25. The Operating room was Optimally utilized in 67.9% of the cases and the cancellation rate was found to be 19.8%. The OR turnover time in majority of the cases (85.8%) is less than 15 minutes and the mean OR finish time was 16:01 which is 10:01 day local time.

Variables	**Mean**	**St. deviation**	**Minimum**	**Maximum**
Time Surgical team arrived OR	8:00	0:07	7:50	8:29
Time Nursing team arrived OR	7:36	0:05	7:19	7:50
Incision Start Time	8:25	0:16	8:00	9:20
Time Anesthesia team arrived OR	7:33	0:06	7:09	7:40
Time patient entered OR	8:02	0:54	1:50	9:20
Induction Start Time	8:03	0:54	1:50	9:20
Anesthesia ready time	**0:15**	0:35	0:02	6:10
Induction Over Time	8:20	0:41	1:59	9:30
First case start time	8:25	0:14	7:50	9:10
OR finish time	16:01	1:25	9:59	17:55

OR utilization	**Frequency**	**Percentage**
Low utilization(<75%) or (<6 hrs))	21	19.8
Optimal utilization(80-100%) (6-8 hrs))	72	67.9
Over utilization(>100%) (>8 hrs))	12	11.3
Operating table turnover time		
<15 min	91	85.8

15- 30 min	15	14.2
Number of cancelled cases(in days)		
None	85	80.2
1	20	18.8
2	1	.1

Table 5: ART and OR efficiency after standardization

5.5 comparative analysis of ART and OR efficiency results before and after standardization

A Summary of independent t-test for continuous numerical OR efficiency parameters showed that ART, First case start time and OR finish time had statistically significant difference before and after standardization.

Variables	**Mean**		**Mean difference**	**Df**	**P Value**
	Before	**After**			
Anesthesia ready time	0:17	0:15	0:02	209	**0.035**
First case start time	8:34	8:25	0:08:57.47	209	**0.001**
OR finish time	14:17	16:01	-1:43	209	**0.001**

Table 6: T-test analysis of ART, first case start time and OR finish time between before and after groups

A Summary of Chi Square test for categorical OR efficiency parameters showed that OR turn over time had statistically significant difference before and after standardization with a p value of 0.006.

Variables	**Categories**	**Time of collection**		**Df**	**P Value**
		Before	**After**		
OR Utilization	Under	22	21	3	0.462

	Optimal	65	72		
	Over	18	12		
OR turn over time	<15 min	69	91	4	**0.006**
	>60 min	3	0		
	15- 30 min	29	15		
	31- 45 min	3	0		
	45-60 minn	1	0		
Number of cancelled cases	0	76	85	2	0.392
	1	27	20		
	2	2	1		

Table 7: Chi-square analysis of OR utilization, OR turnover time and case cancellation between before and after groups

6. Discussion

An efficient OR should start early, finish on time, allocate minimal time for preparation between procedures and have a low rate of cancellation. Efficient and smooth running of the OR helps control total cost of procedure and standardization of OR booking time. Delays in start and completion of a procedure result in increased OR stay of the patient as well as prolongation of overall scheduled list duration and at times necessitates postponement of other cases to the next day. One of the factors responsible for this delay is the variation in time taken by the anesthetists for induction of patients. Poor utilization of OR leads to wastage and drains resources which is very valuable in low-income countries with high unmet need for surgery.

This study investigated the effect of standardizing ART on OR efficiency and perioperative workflow. It evaluated the impact of standardizing ART on OR efficiency using key performance parameters. The comparison of Operating Room efficiency before and after standardization of ART is described with OR efficiency parameters. Pre-intervention data revealed a lack of uniformity in anesthesia preparation practices, often resulting in inconsistent ART and frequent delays in surgical start times. These inefficiencies not only impacted case flow but also had downstream effects on resource utilization and staff coordination. Post-intervention analysis demonstrated a notable improvement in first-case on-time starts and a reduction in avoidable delays, consistent with findings from prior studies emphasizing the importance of standardizing perioperative processes.

The benchmark timing for different anesthetic procedures were taken based on the experience and observation of our hospital and as well as from previous studies that have been done but of course this benchmark timing can be variable for different hospital settings and conditions.

Two hundred eleven patients were involved in the study where we classified them into two groups, 105(before) and 106(after) groups, with the application of a standardized ART protocol to see if there were any change to the OR efficiency. Most patients involved were from urology side due to increased 2 dedicated ORs for endoscopic and open urological cases. The most used mode of anesthesia was general anesthesia which was used in 113(53%) of the patients and most of the anesthesia care, 63(29.9%) was provided by year 1 and year 3 anesthesia residency trainees. Senior anesthesiology consultants were available during the induction of anesthesia in 57.3% of the patients. Fourty six percent (97) of the patients included in the study were ASA 1, 102(48.3%) patients were ASA 2, and 12(5.7%) patients were ASA 3. This does not reflect the actual case mix based on ASA classification at our institution where the proportion of ASA 3 and 4 patients is much higher.

Following the introduction of a structured ART protocol, the average ART decreased from 17 minutes to 15 minutes, indicating a 2 minute reduction in the perioperative preparation phase. Furthermore, the mean OR start time improved from 8:34 to 8:25 which is 9 minutes earlier that helped minimize downstream delays. A notable outcome was the reduction in case cancellation rates: cancellations declined from 27.6% before standardization to 19.8% post-intervention. This finding suggests that standardized ART contributed to more effective scheduling, reduced last-minute postponements, and improved patient flow. Additionally, a greater proportion of cases (85.8%) achieved turnover times of less than 15 minutes compared to 65% before standardization. Another significant improvement was observed in the overall OR finish time. The mean OR closing time shifted from 14:17(8:17 day local time) to 16:01(10:01 day local time). This acceleration in finishing time potentially translates to enhanced resource utilization and staff satisfaction, as well as the opportunity to accommodate additional cases if needed. Operating rooms were optimally utilized in 67.9% of cases post-intervention compared to cases before introduction of the standardized protocol (61.9%). Test of significance was run for these parameters including t-test (for mean ART, OR start time and OR finish time) and chi-square (for OR utilization, case cancellation and OR turnover time). The outcome of t-test showed significant mean differences (for mean ART, OR start time and OR finish time) between the groups with p-values 0.035, 0.001and 0.001 respectively. From the chi-square outcomes only OR turnover time showed significant difference between groups with a p-value of 0.006.

A comparison of this study in the rate of cancellation with another study done at TASH which had a cancellation rate of 35.8 showed a lower cancellation rate. Comparing this with studies done in other major teaching hospitals in Ethiopia also showed lower rate. The cancellation rate at Gondar university hospital, Hawassa university hospital and Jimma university hospital was 33.1%, 31.6% and 23% respectively which is 13.3, 11.8 and 3.2 higher than our study after standardization that is 19.8%. The reasons for cancellation were also similarly related to shortage of time (over scheduling) and inadequate patient preparation. These differences suggest that systematic interventions such as protocol driven ART may play a pivotal role in reducing day of surgery cancellation. In terms of OR utilization in the previous study at TASH, it was found that in the majority of the cases(57.3%) the operating room is either underutilized or over utilized indicating inefficient use of operating theater resources compared to current result after introduction standardized anesthesia ready time in which case the operating room is optimally utilized(67.9%). [28]

Furthermore, comparing it to a study done at TASH in 2022, the mean first case start time was 8:56, which was 31 minutes higher than this study (8:25). This is the most important parameter as it decides the day's surgical activity [7]. Downstream effect of the late starts can also be the cause for frequent cancellations observed in our study due to lack of OR time. OR finish time was 2:54 which was 1 hour and 7 minutes earlier than this study(04:01am). OR utilization was better compared to the previous study where it is underutilized in 42.7% of the cases and over utilized in 14.6% of the cases. Whereas over utilization was 11.3% and underutilization was 19.8% in the current study. Early finish time can be improved by decreasing the cancellation rate, especially those related to patient preparation. Overutilization and late finish times also need to be corrected as it leads to staff burnout and overtime costs. Having a late start time can again be an important factor cascading to delay in the finish time. The mean turn over time was 25 minute in the previous study which was higher compared to this result where turn over time was less than 15 minutes in 85.8% of the cases. This is an astonishing figure considering the best performing ORs report turnover time less than 25min. These comparisons underscore improvements are mainly due to introduction and application of quality improvement project based on key performance indicators and potential of standardized anesthesia process to improve scheduling efficiency, minimize cancellations and enhance operating room productivity across diverse health care settings.

Several studies have noted that patient-related factors such as ASA classification, age, and comorbidity conditions can contribute significantly to variability in ART. The presence of comorbidity, central line cannulation and ASA class of the patient showed significance association with 95% confidence interval for the variability of ART in our study where as in a study done at Aga Khan University Hospital, Pakistan the teaching of undergraduates and postgraduates, pediatric patients, epidural insertion were factors significantly affecting anesthesia ready time.

7. Conclusion and Recommendation

This study was an attempt to focus on the standardization of time taken for anesthetic induction in different surgical procedures so that a standard anesthesia-controlled time can be taken into account for scheduling the cases. This would help with smooth running of the OR, completion of the cases with in allotted time and efficient time management of OR staff including surgeons, anesthetist and technician. The standardization of ART significantly improved OR efficiency, reduced delays, and promoted better interdepartmental coordination. The implementation of a structured ART protocol allowed for consistent readiness criteria, enhanced patient safety through timely completion of pre-induction checks and contributed to improved workflow predictability. Despite initial resistance, sustained team engagement and leadership support facilitated successful adoption. This study highlights the value of standardized perioperative processes and supports further implementation across institutions with continued quality improvement and periodic audit strategies. In addition to time efficiency, standardizing ART enhanced adherence to pre-induction safety checks, including equipment preparation, airway assessment, medication availability and documentation review. These factors contribute directly to patient safety and have been identified in existing literature as key components of safe anesthesia practice.

Compared to existing literature, our findings reaffirm that ART standardization contributes to improved efficiency and safer perioperative practices. However local adaptations are essential and flexibility must be maintained to accommodate case-specific needs.

Future research should include larger multicenter trials with long-term follow-up to assess sustainability of the results. Additionally, cost-effectiveness analysis and patient satisfaction metrics could add value to the overall evaluation.

8. Strength and Limitation of the study

Strengths:

1. The primary objectives were addressed

2. Clear before and after comparison

3. High response rate

4. Context specific benchmarking

Limitations:

1. Single-center design:

The study was conducted only at TASH, which may limit the generalizability of the findings to other settings

2. Short post-intervention observation period:

The study monitored outcomes for a limited time after implementing the ART protocol, restricting insights into long term sustainability

3. Limited scope of measured variables:

Some influential variables, such as team dynamics, real-time communication challenges, and hospital level administrative factors were not captured

4. Initial resistance to change:

Implementation faced resistance from some staff members, especially during high pressure situations, affecting early adherence to the protocol

5. Financial and logistical constraints:

Resource limitation may have affected the full scale application and evaluation of ART standardization across all OR

6. Absence of cost analysis patient satisfaction metrics:

The study did not assess the cost effectiveness of the intervention or include patient reported outcomes like satisfaction or perioperative anxiety**.**

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Annex

Annex 1: Information Sheet

Hello,

This is a research questionnaire on "Impact of Standardized Anesthesia Ready Time on improving operating room efficiency", by Dr. Ibrahim Mohammed, who has granted permission from Addis Ababa University, College of Health Science, School of Medicine, Department of Anesthesiology Critical Care Pain Medicine to conduct the study. This tool was designed to gather data on patient demographics, surgical department, anesthesia ready times and operating room efficiency indicators at TASH, Addis Ababa, Ethiopia. All the information will be taken from the individual patient, during their stay in the OR. Under the supervision of the principal investigator, a trained healthcare provider will gather the data.

For further information contact address:

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Hello, My name is………………………………I am collecting data on behalf of Dr. Ibrahim Mohammed, Final year resident at AAU School of Medicine Department of Anesthesiology.

Annex 2: Questionnaire

Section 1: patient demographics	
1.1 Age	a. <1yr b. 1-10 c. 11-20 d. 21-40 e. >40
1.2 Gender	a. Male b. Female
1.3 Comorbidity	a. Yes b. No
1.4 If yes to Q 1.3 please specify the comorbidity	
1.5 ASA classification	a. ASA 1 b. ASA 2 c. ASA 3 d. ASA 4
Section 2: surgical department information	
2.1 Surgical departments	a. Orthopedics b. Gynecology c. Neurosurgery d. Urology e. Chest f. ENT g. OBS h. Pedi i. other
2.2 Type of procedure	
2.3 Time Surgical team arrived OR	
2.4 Time Nursing team arrived OR	
2.5 Incision start time	
2.6 Duration of Surgery	
Section 3: Anesthesia ready time	
3.1 Time patient entered OR	
3.2 Induction start time	
3.3 Induction over time	
3.4 Mode of anesthesia	a. General anesthesia b. GA with epidural

	c. Spinal d. Epidural e. CSE f. Nerve block
3.5 Types of procedure under anesthesia	a. A-line b. C-line c. Caudal d. Nerve block e. other
3.6 Level of resident/anesthetist present during induction	a. year 1 b. year 2 c. year 3
3.7 Anesthesia consultant present during induction	a. Yes b. No
3.8 All OR staff member present during induction	a. Yes b. No
3.9 Reason for delay in anesthesia start	a. Patient not arrived at OR area b. Anesthesia team delay c. OR equipment issues d. Scheduling conflict e. Other
3.10 What factors contribute for variability in ART	a. Patient complexity b. Availability of equipment c. Communication issues d. Staffing levels e. Staff readiness f. other
3.11 Time Anesthesia team arrived OR	
3.12 Duration of Anesthesia	
Section 4: operating room efficiency	
4.1 First case start time	
4.2 Operating room turn over time	a. <15 min b. 15-30 min c. 31-45 min d. 40-60 min e. >60 min
4.3 OR utilization	a. Optimal utilization b. Low utilization c. Over utilization
4.4 OR finish time	
4.5 Number of cancelled case	

Thanks !

Declaration

The undersigned agrees to accept responsibility for the scientific ethical and technical conduct of the research project and for provision of required progress reports as per terms and conditions of the Department and College, in effect at the time of grant is forwarded as the result of this application.

Name of the Student: ____

Date: ____________________________ Signature: _______________________

Approval of the First Advisor

Name of the First Advisor: ____________________________________

Date: ____________________________ Signature: _______________________

Approval of the Second Advisor

Name of the Second Advisor: ____________________________________

Date: ____________________________ Signature: _______________________