



**ST PAUL'S HOSPITAL MILLENNIUM MEDICAL COLLEGE
GRADUATE STUDY PROGRAM**

**ASSESSMENT OF PRE-ANAESTHESIA MACHINE CHECK AND ASSOCIATED
FACTORS AT ST PAULS HOSPITAL MILLENNIUM MEDICAL COLLEGE**

ALUAT CHOL WILLIAM

ADDIS ABABA, ETHIOPIA

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St. Paul's Hospital Millennium Medical College

Graduate Study Program

**Assessment Of Pre-Anaesthesia Machine Check And Associated Factors At Saint Pauls
Hospital Millennium Medical College**

Dr Aluat Chol William

**Dr Mathias Negussie, MD, Assistant Professor Of Anaesthesiology, Critical Care
&Pain Medicine.**

**Dr Lemi Belay Tolu, MD, Assistant Professor Of Obstetrics & Gynaecology, Family
Planning And RH Sub-Specialist.**

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Medical College.**

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Name	Aluat Chol William	
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Adress	Tel: +251 985245553	Email: lullachol93@gmail.com
Advisors	Dr Mathias Negussie.	
	Dr Lemi Belay Tolu.	

Summary

Introduction

Pre-anesthesia machine check is an essential step in ensuring the safety and effectiveness of anesthesia administration. This assessment involves a detailed inspection of the anesthesia machine and its components to ensure that everything is functioning properly before the start of any surgical procedure.

Problem of statement:

Pre-anaesthesia checkout procedure (PAC) is a mandatory part of anaesthesia practice, failure to check the machine before use could be hazardous and may lead to patient death. Hence this study is aiming to assess the adequacy of pre-anaesthesia machine check at St Paul's Hospital Millennium Medical College.

Objectives:

To assess the adequacy of pre-anaesthesia machine check in St Paul's Hospital Millennium Medical College before elective surgery.

Methods:

Observational cross-sectional study on the assessment of adequacy of pre-anaesthesia machine check was conducted in St. Pauls hospital operation theatre from 1st July 2023 – 1st March 2024.

The Data collected was analysed by SPSS, presented in tables and graphs, and finally the results of this study will be disseminated to the department of Anesthesiology and critical care.

Estimated budget:

The total budget for this study is estimated to be **28.000 ETB**.

Results:

In this study the overall all compliance rate for preanesthesia machine check was 72.5%, out of which non of the checks observed was complete.

Conclusion:

This study concluded that the preanesthesia machine check was not adequate in reference to the standards.

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Acronyms and Abbreviations

ASA: American Society of Anaesthesiologist.

BSc: Bachelor of science.

ECG: Electrocardiogram

FMOH: Federal Ministry of Health.

MSc: Master of science.

PAC: Pre-anaesthesia checkout procedure.

Psig: Pounds per square in gauge.

SPHMMC: St Pauls Hospital Mellinium Medical College.

SPSS: Statistical Package of Social Science.

UK: United Kingdom.

USA: United States of America

Chapter one

1. Introduction

1.1 Background:

The anesthesia machine is a medical device that is used by anesthesia providers to support the delivery of anesthesia to patients and to allow for intolerably painful procedures to be carried out (1). The main functions of the anesthesia machine are to support oxygenation, deliver accurate measurements of inhalational anesthetics, provide an appropriate mode of ventilation, and prevent anesthetic gas pollution.(1)(2)

In the mid 1800s, the first anesthesia device was demonstrated by Morton at Massachusetts General Hospital, United states of America (USA), and it was all about ether-soaked towels applied directly into the patient's nose and mouth(1). Later in the late 1800s, this demonstration led to the manufacturing of anesthesia devices based on the Morton demonstration which consisted of a small glass container for ether with a sponge inside to increase evaporation and entrance and exit orifices connected to the patient's respiratory tract(3). But the amount of anesthetic agent delivered was not accurately measured, nor was it able to deliver a mixture of gases (1)(3).

Later in 1862, Joseph Thomas demonstrated a chloroform anesthesia device that was able to deliver accurate measurements and mixed chloroform with air to avoid overdoses. Also, other devices like the Junker apparatus was developed in 1867, which had a hand operated bellows to propel the mixture of gases to patients. However accidents like anesthetic agents overdose was still common, and spontaneous ventilation was the only mode of breathing made it clear that more specific anesthesia devices were needed.(1)(2)

Over time, the anesthesia delivery system has evolved to the modern day anesthesia machine, which has ever greater accurate measurements of inhalational anesthetic agents and delivery of mixed gases, allowing the use of spontaneous and additional controlled modes of breathing, and other features such as allowing rebreathing of the exhaled anesthetic gases, continuously measuring the inspired oxygen concentration, and the addition of safety features. (1)

Despite this great evolution of the anesthesia machine, it became more complicated to be understood by anesthesia providers, partly because of the complexity of the components of the modern anesthesia machine and partly because of the increased diversity in design that is being manufactured by different companies, making it important for anesthesia providers to

have a solid understanding of the anesthesia machine to carry out a proper pre-anesthesia machine check.(2)

In 1993, anesthesia apparatus checkout recommendations were designed to identify the important steps that must occur before the safe delivery of anesthesia(2)(4). The committee on equipment and facilities initiated an effort to revise those steps at the 2003 American Society of Anesthesiologists "ASA" annual meeting after recognizing that the previous recommendations did not apply to modern anesthesia delivery systems (4). The 2008 recommendation lists 15 separate items to be checked or verified at the beginning of each day, eight of which should be checked prior to each procedure (2)(4). Some of these steps are now part of an automated checkout process in the anesthesia machine, and some may be done by technicians and not the anesthesiologist. (4)

Improperly checking anesthesia equipment prior to use can lead to patient injury and has also been associated with an increased risk of severe postoperative morbidity and mortality (4). Despite the accepted importance of the Pre-anesthetic Checkout Procedure (PAC), available evidence suggests that the current version is neither well understood nor reliably utilized by anesthesia providers (1)(4).

Furthermore, anesthesia delivery systems have evolved to the point that one checkout procedure is not applicable to all anesthesia delivery systems currently on the market. For these reasons, a new approach to the PAC has been developed. The goal was to provide guidelines applicable to all anesthesia delivery systems so that individual departments could develop a PAC that could be performed normally. (2)

Despite the fact that adverse anesthetic outcomes related to anesthesia machine mishaps have decreased over the last decade to less than 1% in the 2000s, according to the ASA's closed claims database, when they do occur, they are usually fatal or result in permanent brain injury (4).

A complete pre-anesthesia checkout procedure must be performed each day before the anesthesia workstation is first used, and an abbreviated version should be performed before every subsequent case, according to ASA recommendations for the pre-anesthesia checkout procedure(2).

1.2 Statement of the problem

Pre-anesthesia checkout procedure (PAC) has been a mandatory part of anesthesia practice for over 30 years, but experience suggests that anesthesia providers do not frequently perform PAC, in part due to unawareness of the full PAC or due to time shortages (3). Previously, the anesthesia provider was solely responsible for PAC. However, the 2008 ASA guideline identifies those aspects of the PAC that could be completed by a qualified anesthesia and/or biomedical technician (4). And they realized that placing biotech to perform some aspects of the PAC might improve compliance with the PAC. Steps completed by a technician may be part of the morning pre-use check. Some important checkout steps (e.g., availability of backup ventilation equipment) will benefit from intentional redundancy; hence, having more than one individual responsible for checking the equipment would be important (2). Regardless of the level of training and support provided by technicians, the anesthesia care provider must be responsible for the proper function of all equipment to be used before delivery of anesthesia care (2)(4).

A study conducted in three hospitals in Australia in 2012 discovered that recommendations for checking the anesthesia delivery system were not followed. (5)

Another study done in Canada in 2005 on inadequate pre-anesthesia equipment checks in a simulator concluded that the overall mean score was low and that the equipment checking practices of anesthesiologists required considerable improvement when compared with national and international standards (6).

Recently, a study was done in Ethiopia, Gondar in 2022, where they found that there was poor compliance with anesthesia machine checks and equipment preparation before anesthesia induction in the operating theater, according to the standards (7).

However, no data on the quality of pre-anesthesia checkout procedures in St. Paul's Hospital Millennium Medical College is available; thus, the purpose of this study is to assess the quality of pre-anesthesia checkout procedures in relation to ASA recommendations and the associated factors affecting the adequacy of PAC.

1.3 Significance of the Study:

The study will focus on assessing the pre-anesthesia checkout procedures in the morning before the start of elective surgery. The results of the study are expected to benefit anesthesia care providers by increasing their vigilance in applying suitable and effective PAC, as well as improve patient safety.

The results of this study will guide other researchers in the field of anesthesiology.

1.4 Objectives of the study.

1.4.1 General objectives:

To determine the adequacy of the pre-anesthesia machine check and associated factors by the anesthesia providers at St. Paul's Hospital Millennium Medical College.

1.4.2 Specific objectives:

To determine the adequacy of pre-anesthesia machine check among the anesthesia providers at St. Paul's Hospital Millennium Medical College.

To determine factors associated with adequacy of pre-anesthesia machine check practice among the anesthesia providers at St. Paul's Hospital Millennium Medical College.

Chapter Two

2. Literature review

2.1 Pre-Anaesthetic Checkout Procedure:

Pre-anaesthetic checkout procedure(PAC) was developed to improve patient safety, to prevent intraoperative machine malfunction, and most importantly to reduce human error in the use of anaesthetic equipment, which was found to account for 14% of critical events during delivery of anaesthesia(5).

The anesthesia machine is able to deliver accurate and continuous supply of medical gases such as oxygen and nitrous oxide, mixed with inhalational anesthetic agents like halothane to patient's respiratory system. It consist of a vaporizer to saturate the gases with inhalational anesthetic agents, a ventilator to assist the patient on breathing, and pressure regulating valve to limit excess pressure in the breathing circuit that deliver gases to and from the patient, scavenging system to remove waste gases, and safety features to improve patient safety in cases of emergency.(2)(3)

PAC has listed 15 important items to be checked by a bio technician or an anaesthesia provider, the first item is to make sure there is an auxiliary oxygen cylinder and a manual ventilation devise in case the anaesthesia machine fails to ventilate the patient.

Second item is to verify suction machine is adequate to clear airway secretions, third item is to verify AC power is connected, fourth item is to visually verify the availability of monitors and check alarms, fifth item is to verify that pressure is adequate in the auxiliary oxygen cylinder(4).

The sixth item is to verify the minimum gas supple pressure in the central pipe system is more than 50 psig, seventh item is to confirm the vaporizers are filled, eighth item is to carry a gas supply leak test which is usually done automatically by the machine, ninth item is to check for proper connection of the scavenging system to prevent air pollution, tenth item is calibration of oxygen concentration monitor and its alarm.(4)

The eleventh item check the carbon dioxide absorbent and to change it if exhausted, the tweleveth item is to check the breathing system pressure and weather the pressure can be relieved manually by the pressure reliving valve, and to carry out leak test.

The thirteen item is asses for proper function of the inspiratory and expiratory valves within the breathing circuit, the fourteen item is to document the completion of the PAC and last the fifteenth item is to confirm ventilator settings and to evaluate readiness for delivery of anaesthesia that is anesthesia time out before delivery of anesthesia.(4)

2.2 Global context:

A survey of the literature reveals multiple studies related to inadequacy of pre-anaesthetic machine check, mishaps and human error.

In 2012, a study was done in three hospitals in South Australia, observations of anesthesia providers were made while they were checking their designated anesthetic machine, either at the beginning of a day's list or between cases. At the end they concluded poor compliance with recommendations was significant, the backup oxygen cylinders' pressure were not checked in 45% of observations, the emergency ventilation device was not checked in 67% of observations and the breathing circuit was not tested between patients in 79% of observations.(6)

A study published in 2000, done in university of Toronto, described how completely anaesthesiologists check their machine and equipment before use, and they concluded that the equipment-checking practices of anaesthesiologists require considerable improvement when compared with national and international standards.(7)

The scope of medical errors in the US is a major concern to patients and healthcare workers alike. While anaesthesiologists have done much to improve the reporting and reduction of errors, much work remains to be done(5).

A Prospective Study on Anaesthesia Machine Fault Identification, described the correlation between duration of anaesthesia practice and the ability to detect anaesthesia machine faults. concluded that anaesthesia machine check- out continues to be a problem even within experienced anaesthesia providers (5).

Studies that address the issue of anaesthetic mis- haps, human error and insufficient pre-anaesthetic checking of the anaesthesia machine are a recurring theme.

A study published in 1981, done in United Royal hospital, UK, found out that human error constituted 65% of intraoperative anaesthetic events of which failure to perform pre-anaesthetic check was the commonest associated factor.(8)

In 2002, Fasting and Gisvold noted that 31% of equipment problems involved the anaesthesia machine and breathing circuit, with the main cause of human error being insufficient checking of the anaesthesia machine before use, especially between cases. They stated, "In our study, human error was the main contributing factor in one-quarter of cases, and most of these involved the anaesthesia machine. The main cause was insufficient checking of the anaesthesia machine before use, especially between cases."(9)

Mayor and Eaton found out that up to 41 % of anaesthetists perform inadequate tests, or none at all, while of those that do, few follow the guidelines. although 90% of the anaesthetists questioned had read the guidelines and believed that safety would be improved, they did not follow the recommendations.(6)

Regarding the use of a checklist, Barthram and McClymont were concerned about the time to carry out the pre-anaesthetic checkout procedure, and found that the mean time to check one machine was 8-9 min (range 5-19 min) , and yet faults were found in 60% of machines checked and that 18% of these were serious faults. These times are very reasonable considering the possible implications of failing to carry out a proper check.(7)

In 2018, another study was done in King Fahad, Kingdom of Saudi Arabia, they concluded that there was improved compliance (98%) with pre- use anaesthesia machine check in adherence with their own developed checklist.(10)

2.3 local context:

A study was done in Ethiopia, Gondar in 2022, concluded that the overall compliance rate was 87% for pre-anesthetic machine check, which is considered as poor in adherence to the standards.(11)

Another study done in Debre Berhan Comprehensive Specialized Hospital, North Shewa, Ethiopia in 2020, showed that there was poor compliance among anesthetists in regard to pre anesthesia machine check, There was only (77.1%) fully met checking events, (17.7%) soda lime was not checked. Among 19 checklists, only three (power source plugged in, power source switched on, and functionality of monitoring) were perfectly completed; however, the rest sixteen checklists are in bad practice among them seven checklists (presence of functional self-inflating bag, automatic machine check, power source backup battery, anti-hypoxic device, ventilator, difficult airway equipment and scavenging systems) were checked below 90%. (12)

About 2% of the closed claims have resulted from gas delivery equipment, with death and permanent damage in 76% of the outcomes. A recent case–control study of anaesthesia management characteristics on severe morbidity and mortality demonstrated equipment check with protocol and checklist, and documentation of the equipment check was significantly associated with decreased risk.(10)

Chapter Three

3. Methodology

3.1 Study Area:

The study was conducted at St. Paul's Hospital Millennium Medical College is a public referral hospital in Addis Ababa under the Ethiopian Federal Ministry of Health (FMOH). It is the second-largest public hospital in the nation, built by the Emperor Haile Selassie in 1961 with the help of the German Evangelical Church. The hospital was established to serve the economically underprivileged population, providing services free of charge to about 75% of its patients. In 2007, it became a medical college, and its core services include the provision of medical care, teaching, and research. It has 800 clinical and non-clinical staff members that provide medical specialty services to an estimated 110,000 people annually who are referred from all over the country. (13)

Generally, there are 18 elective operating rooms during this study time. One general surgery room, two pediatrics, one cardiothoracic, one hepato-biliary, two urology, one gynecology surgery, four cesarean sections, and two ear, nose, and throat operation rooms, one maxillofacial and three ophthalmology operating rooms.

3.2 Study Design:

Observational cross-sectional study on the assessment of adequacy of pre-anesthesia machine check was conducted at St. Paul's hospital operation theatre from 1st July 2023 – 1st of March 2024.

3.4 Study Period:

The study period was conducted between 1st July 2023 – 1st of March 2024.

3.5 Study Population:

Anesthesia residents, MSc anesthetists, and Bsc anesthetist providing anesthesia care for elective surgery patients in the operation theater at St. Paul's Hospital.

3.6 Sample Size:

In St. Paul's Hospital Millennium Medical College, there are a total of 18 elective operation rooms, in which surgical patients are scheduled daily for five days a week for elective surgery and pre-anesthesia machine check is done daily in the morning before the start of elective surgery. Within four weeks duration, there will be a total of 360 pre-anesthesia machine checks.

Using sample size calculation formula at 95% confidence interval, Z score of 1.96, standard deviation of 0.5 and margin of error +/-5%.

$$\text{Necessary Sample Size} = \frac{(\text{Z-score})^2 \times \text{StdDev} \times (1-\text{StdDev})}{(\text{margin of error})^2}$$

The sample size was **186.16**, and we rounded the number to **187**, considering a non respondent rate of 10%, the final sample size would be **205.7**.

Therefore, we proposed a sample of **206** of pre-anesthesia machine checks would be satisfactory to assess the adequacy of pre-anesthesia machine check in St. Paul's Hospital Millennium Medical College.

3.7 Sampling Procedures:

The machines are checked regularly on the morning of each day before the start of elective surgery. Since there is no available pre-anesthesia checklist specific to St. Paul's Hospital, we used the pre-anesthesia checklist as in the ASA 2008 recommendation, converted to questions with yes or no as an answer.

Lottery method based simple random sampling was applied every morning of elective surgery to choose five tables from 18 available elective surgery tables. Then observation was carried out by data collectors on those randomly selected five tables every morning, public holidays were substituted and if one table was not functional it was immediately substituted by another table randomly, The same procedure was repeated every day until the expected sample of **206** of pre-anesthesia machine checks. The data was collected by first observation and second questioning the anesthesia provider performing PAC.

3.8 Inclusion criteria:

Pre-anesthesia machine check before the start of elective surgery in the operation theater at St Paul's Hospital Millennium Medical College.

3.9 Exclusion Criteria:

Pre-anesthesia machine check before the start of emergency surgery is excluded because of difficulty with observing and collecting data since timing of emergency surgeries is unpredictable.

3.10 Variables of The Study:

3.10.1 Dependent Variables:

Fifteen items to be fulfilled according to ASA pre-anesthesia checkout list.

3.10.2 Independent Variables:

- Number of year of practice of the anesthesia provider.
- Time shortage and availability of a checklist.
- Type of surgery (department).

3.11 Data Collection tools:

Questionnaires were designed in the form of questions with yes or no as an answer, and filled out by the data collector.

We assigned five first year anesthesiology residents for data collection after they were oriented about the questionnaires and how to observe the items required in this study.

3.12 Operational Definitions:

The pre-anesthesia checkout procedure, or pre-anesthesia machine check, is a list of 15 separate items that should be fulfilled prior to the administration of anesthetics for surgical patients.

The pre-anesthesia machine check is considered adequate when all the tests and checks are completed and the results are within normal parameters.

An anesthesia care provider is a person who is responsible for administering anesthesia to surgical patients, including anesthesiologists, anesthesia residents, and nurse anesthetists.

Non-respondents are the participants who were not willing to respond to the questions during the data collection period.

3.13 Data Analysis Procedure:

Data collected was coded, entered using Excel and was analyzed by SPSS version 26. Frequency and cross tabulation were used to summarize descriptive statistics. Means and percentages were used to present nominal statistics. Graphs and tables were used for data presentation as appropriate.

Associations between dependent and independent variables were assessed using odds ratios (OR) and 95% confidence interval (CI). ordinary logistic regressions was used to predict the association between outcome and the variables.

3.14 Ethical Consideration:

Ethical approval was obtained from St. Paul's Hospital's Millennium Medical College Research Committee, confidentiality was ensured from all data collectors and no personal identification was included in the questionnaire. As well only data relevant to the study was collected after verbal consent was obtained from the anesthesia provider.

3.15 Dissemination of Results:

The result of this study is in fulfillment of anesthesiology and critical care training at St. Paul's Hospital Millennium Medical College, it will be disseminated to the department of Anesthesiology and critical care, and it may be released publically in print or electronically in professional websites and published in journal articles.

Chapter four:

4.1 Results:

4.1.1 Pre anesthesia check list:

In this study a total of 206 pre-anesthesia checking events were observed from 1 of December 2023 to 30th of January 2024, in SPHMMC operating theatre before the start of elective surgery. Out of these, 6 questionnaires were incomplete and were dropped out, making non response rate of 2.9%.

The overall compliance rate of preanesthesia machine check in SPHMMC was 72.5%. All of the checks observed was incomplete. However, all of the pre anesthesia machine checks observed had AC power connected, suction apparatus available and there was also no leak in both the breathing system and between the flow meters and the common gas outlets. Auxiliary cylinder and AMBU bag was available in 20% and 79% of the checks respectively.

In this study, the monitors like blood pressure, pulse oximetry and ECG were available and functional in 99% of all the checks observed, but in about 49.5% of the cases, capnography was not available and in 14.5% the available ones were not functional.

Table 1: preanesthesia checklist

Is auxiliary cylinder available?		
	Frequency	Percentage
Yes	169	84.5
No	31	15.5
Is Ambo-bag (self-inflating manual breathing bag) available?		
	Frequency	Percentage
Yes	159	79.5
No	41	20.5
Is suction apparatus available?		
	Frequency	Percentage
Yes	200	100
No	0	0

Is AC power connected?		
	Frequency	Percentage
Yes	200	100
No	0	0
Is functional blood pressure monitor available?		
	Frequency	Percentage
Yes	199	99.5
No	1	0.5
Is functional electro cardiogram (ECG) monitor available?		
	Frequency	Percentage
Yes	199	99.5
No	1	0.5
Is pulse-oximeter monitor functional?		
	Frequency	Percentage
Yes	198	99
No	2	1
Is capnography monitor functional?		
	Frequency	Percentage
Yes	72	36
No	29	14.5
Not available	99	49.5
Is pressure adequate in the auxiliary cylinder?		
	Frequency	Percentage
Yes	141	70.5
No	33	16.5
Not available	26	13
If you are using central oxygen supply, is the pipe line pressure>50psig?		
	Frequency	Percentage

Yes	96	48
No	26	13
No central oxygen	78	39
Are the vaporizers adequately filled?		
	Frequency	Percentage
Not filled (minimum)	31	15.5
Filled more than half	131	65.5
Yes (filled to the maximum)	38	19
Is there a leak between the flow meters and common gas outlet?		
	Frequency	Percentage
No	200	100
Is the oxygen sensor calibrated?		
	Frequency	Percentage
Yes	152	76
No	41	20.5
Not functional	7	3.5
Is the scavenging system connected properly (functional)?		
	Frequency	Percentage
Yes	197	98.5
No	3	1.5
Is carbon dioxide absorbent exhausted?		
	Frequency	Percentage
Yes	168	84
No	32	16
Is there a leak in the breathing system?		
	Frequency	Percentage
Yes	1	0.5

No	199	99.5
Are the expiratory and inspiratory valves functional?		
	Frequency	Percentage
Yes	200	100
No	0	0
Is pre anesthesia checkout procedure documented?		
	Frequency	Percentage
Yes	164	82
No	36	18
Was anesthesia timeout done before delivery of anesthesia?		
	Frequency	Percentage
Yes	142	71
No	58	29

4.1.2 Adequacy of pre anesthesia machine check:

In this study, the adequacy of pre anesthesia machine check was found to be inadequate in all the cases as per the operational definition. The machine check list was not completed or responded up to the standard in all of the procedures performed.

Table 2 : adequacy of preanesthesia machine check at SPHMMC operating theatre.

	Frequency	Percent
Inadequate	200	100

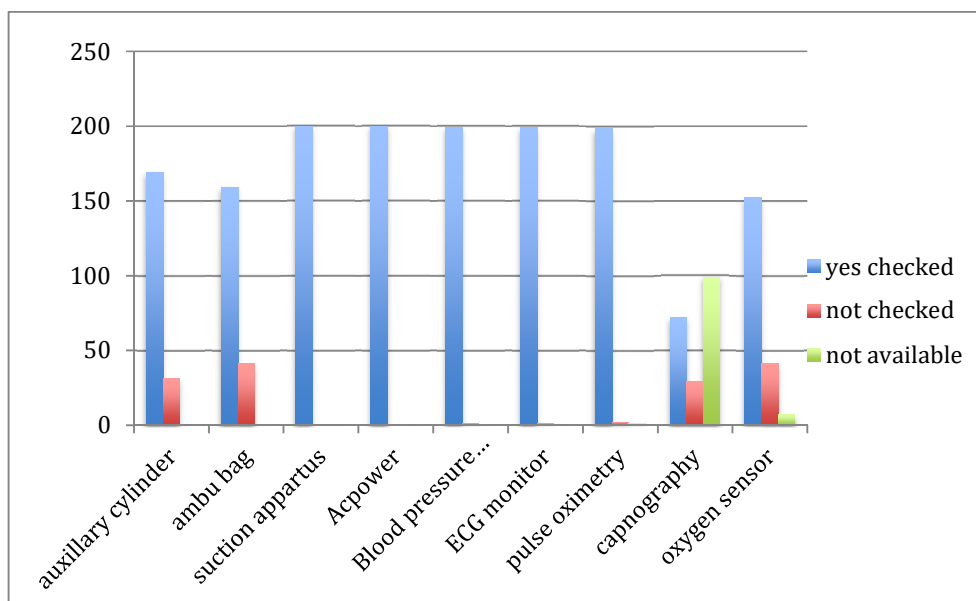


Figure 1: illustrating completeness of some of the items in PAC at SPHMMC operating theatre

4.1.3 Factors associated with the adequacy of pre anesthesia machine check:

In this study 83.5% of the participants who carried out the preanesthesia machine check had more than 2 years experience in anesthesia practise, and 99% of them did not refer to any checklist while caring out the preanesthesia checks.

Regarding the time that was needed to complete PAC was 5-10 minutes in 92% of the checks.

Table 3: factors associated with the adequacy of preanesthesia machine check in SPHMMC.

NO	variable	Category	Frequency	Percent
1	Year of practise	<1year	7	3.5
		1-2 years	26	13
		>2 years	167	83.5
2	Operating tables	ENT table	25	12.5
		Gynecology table	11	5.5

		Maxillofacial table	18	9.0
		Obstetric table	26	13.0
		Ophthalmology table	10	5.0
		Pediatric table	20	10.0
		General surgery table	19	9.5
		Hepato-billiary table	19	9.5
		Colorectal table	27	13.5
		Chest/plastic/vascular table	25	12.5
		Urology table	0	0
3	Refferd to checklist	Yes	198	99.0
		No	2	1.0
4	Time to complete PAC	<5 minutes	15	7.5
		5-10 minutes	184	92.0
		>10 minutes	1	.5
5	Sufficient time to complete PAC	no	4	2.0
		yes	196	98.0

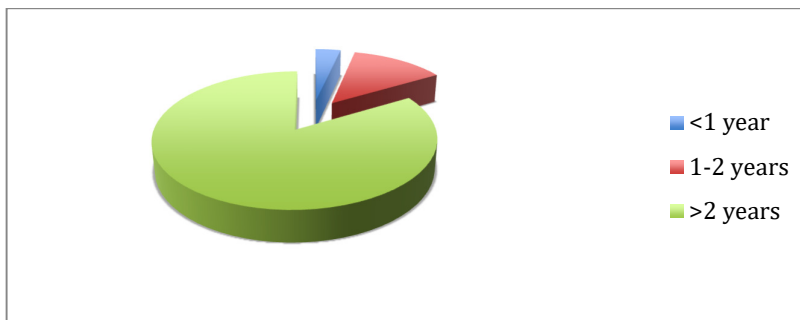


Figure 2: illustrates years of practise of the anesthesia providers who were performing PAC in SPHMMC operating theatre.

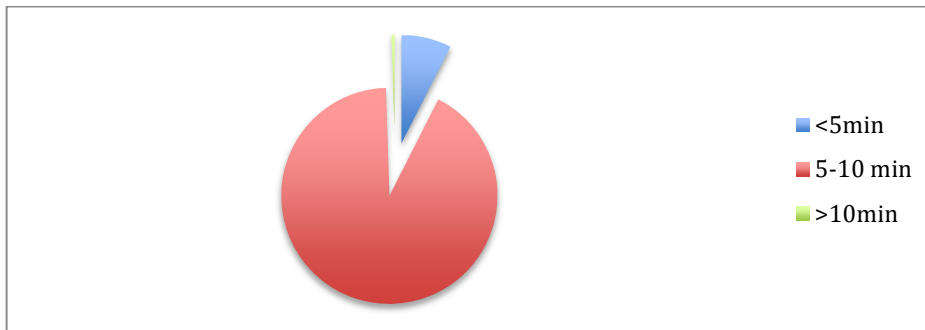


Figure 3: illustrates time needed to complete PAC in SPHMMC operating theatre

As demonstrated in the table 8 below, in the ordinal regression analysis, variables with a p-value of less than 0.05 were selected as factors significantly associated with the dependent variable that is the adequacy of preanesthesia machine check. Of all the variables assessed in this study, only the type of surgery/table (colorectal) was significantly associated with the level of adequacy of pre anesthesia machine check.

Table 4: ordinary regression analysis showed variables with significant p value

Variables	Score of pre anesthesia machine check (out of 15)									Odds ratio (95% CI)	p-value
	6	7	8	9	10	11	12	13	14		
Colorectal table	1	2	0	2	2	0	11	8	1	0.15	0.01
Other tables	5	7	14	11	41	35	25	29	5	1	

Table 5: Ordinary regression analysis of the associated factors involved in this study.

Variables	Estimate	Std Error	Wald	df	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Number of year of practice of the anesthesia provider <1 years	-4.513	1.015	19.778	1	.000	-6.502	-2.524
Number of year of	.520	.435	1.431	1	.232	-.332	1.373

practice of the anesthesia provider > 2 years							
Number of year of practice of the anesthesia provider 1-2 years	0 ^a	.	.	0	.	.	.
Type of surgery Table (ENT table)	-2.355	.608	14.985	1	.000	-3.548	-1.163
Type of surgery Table (gynecology table)	-7.498	.896	69.958	1	.000	-9.255	-5.741
Type of surgery Table (Maxillofacial table)	-3.412	.666	26.266	1	.000	-4.717	-2.107
Type of surgery Table (Obstetric table)	-3.527	.625	31.896	1	.000	-4.751	-2.303
Type of surgery Table (ophthalmology table)	-3.232	.766	17.788	1	.000	-4.734	-1.730
Type of surgery Table (pediatric table)	-4.552	.711	41.046	1	.000	-5.945	-3.160
Type of surgery Table (general surgery)	-3.288	.643	26.123	1	.000	-4.549	-2.027
Type of surgery Table (hepatobilliary)	-2.244	.643	12.202	1	.000	-3.504	-.985
Type of surgery Table (colorectal)	-1.896	.592	10.269	1	.001	-3.055	-.736
Type of surgery Table (chest/plastic vascular)]	0 ^a	.	.	0	.	.	.
How long did it take you to complete pre-anesthesia machine check (<5 minutes)	.069	.634	.012	1	.913	-1.173	1.311

How long did it take you to complete pre-anesthesia machine check (> 10 minutes)	-2.933	1.838	2.546	1	.111	-6.536	.670
How long did it take you to complete pre-anesthesia machine check (5-10 minutes)	0 ^a	.	.	0	.	.	.
Did you have sufficient time to complete the pre anesthesia machine check(No)	-.155	.977	.025	1	.874	-2.069	1.759
Did you have sufficient time to complete the preanaesthesia machine check (yes)	0 ^a	.	.	0	.	.	.

4.2 Discussion:

Performing adequate pre-anesthesia machine check before use is mandatory in modern day anesthesia care, providing anesthesia is becoming safe because of the advances in delivery of anesthesia drugs(e.g. inhalational drugs) but did not reduce the dependence on the anesthesia machine workstation such as gas delivery system and monitoring devices. Hence risks of machine failure or human factors continues to be remain an issue(9).

Many studies have addressed the potential risk related to inadequate pre-anesthesia machine checking, in which human error was responsible of 65% of the intraoperative adverse events(13)

Although few studies were performed recently, several of them indicated poor or inadequate machine checking before use including this current reference.

The results of this study is relatively poor in comparison to study that was done by H. Aytolign and his colleagues in Gondar hospital that showed poor compliance with the preanesthesia machine check and overall compliance of 87%, we used the same sample size of 200, but in their study they used the Gondar hospital pre-anesthesia machine checklist(11).

The findings in Gondar were comparable to study by S. Debas and his colleagues in Debre Berhan hospital in which they concluded a 71% of the preanesthesia machine checking events fully met the criteria according to their own checklist that was composed of 19 items, however the sample size was smaller and most of the observed preanesthesia checks were done before an emergency surgery(14).

In comparison to a study by Al Suhibani and his colleagues in Saudi Arabia king Fahad hospital in which the overall compliance was 98.3% fully met the criteria, and emphasized that the excellent improvement in their anesthesia service was due to presence of a protocol checklist and documentation of every pre-anesthesia machine checks(10). However in this study non of the anesthesia care providers were using a checklist and only 81% of the checks were documented.

In Australia an audit that was done in three hospitals concluded that there was poor compliance with the recommendations on checking the anesthesia machine before use, in which they concluded that the year of practice was not associated with the improvement in checking the anesthesia machine and detecting faults, rather there was improved performance in those who were extensively trained on how to check the anesthesia machine before use(6). In contrast those who were delivering anesthesia care in this study 83% of

them had more than 2 years experiences including anesthesia residents and MSc/BSc anesthetist but still no adequate pre anesthesia checks observed.

In the ordinal regression analysis, none of the associated factors addressed in this study was significantly associated with the inadequate pre anesthesia machine check. However, we did not conduct binary or multivariable regression as we don't have complete or adequate pre anesthesia machine checks to detect the significance of the associated factors.

Furthermore, in the current study most of the items that were not checked was not physically available, for example the auxillary cylinder was not available in 84% of the checks, ambu bag was not available in 20% of the checks and capnography was not available in 49% of the checks, which could contribute to the overall inadequacy of pre-anesthesia machine check.

4.3 Conclusion and Recommendation:

This research aimed to assess the adequacy of pre-anesthesia machine check before the start of elective surgery, and we concluded that it was not adequate per ASA recommendation.

Improving the pre-anesthesia machine check is a collective responsibility of the anesthesia providers and the authorities of the hospital.

Therefore we recommend that every anesthesia provider should adequately check the anesthesia machine before induction of anesthesia, because failure to check represents an error in anesthesia practice.

During this study some of the items were not available during the observations, hence we suggest these essential items should be provided in order to have a complete preanesthesia machine check for patients safety.

We also recommend SPHMMC to have practice policy and customized pre-anesthesia machine check checklist to be utilized by health professionals before every elective surgery. This might increase adherence to routine pre-anaesthesia machine check practice. Furthermore, we recommend multicentre well designed study with large sample size to generate robust evidence that could inform and guide safe anaesthesia practice.

4.4. Limitations:

This study has small sample size, and this study did not address the outcome of failure to check the anesthesia machine completely before use.

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Consent form:

I understand that participating in this survey is completely voluntary, and all the information provided and data collected during this study will be used solely for this research study's purpose.

I hereby give my voluntary consent for my participation in this research questionnaire as part of research study conducted by Dr. Aluat Chol William.

And I acknowledge that the results obtained from this research may be published in professional publications.

Questionnaire:**Part one:**

Choose yes or no on each of the following pre-anaesthesia check list component.

NO	Item		
	a. Is Auxiliary cylinder available?	Yes	No
	b. Is Ambo-bag (self inflating manual breathing bag) available?	Yes	No
	Is Suction apparatus available?	Yes	No
	Is AC power connected?	Yes	No
	Are the monitors functional?		
	a. Blood pressure monitor	Yes	No
	b. Electro-cardiogram	Yes	No
	c. Pulse oximeter	Yes	No
	d. Capnography	Yes	No
	Is pressure adequate on the spare oxygen cylinder?	Yes	No
	Is pipe line pressure >50 psig?	Yes	No
	Are the vaporizers adequately filled?	Yes	No
	Is there a leak between the flow meters and the common gas outlet?	Yes	No
	Is the oxygen sensor calibrated?	Yes	No
1.	Is the scavenging system functional	Yes	No
2.	Is carbon dioxide absorbent exhausted?	Yes	No
3.	Is there a leak in the breathing system	Yes	No
4.	Are the expiratory and inspiratory valves functional?	Yes	No
5.	Is pre-anesthesia checkout procedure documented?	Yes	No

15.	Was anesthesia time out done before delivery of anesthesia?	Yes	No
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Part two:

1.Number of year of practise of the anesthesia provider:

- a. Less than 1 year.
- b. 1-2 years.
- c. More than 2 years.

2.Type of surgery:

- a. Obstetric cesarean surgery
- b. Gynecology surgery.
- c. Paediatric surgery.
- d. Hepatobiliary surgery.
- e. Colorectal surgery.
- f. Thoracic surgery
- g. ENT surgery.
- h. Eye surgery.
- i. Urology surgery.

3.How long does it take you to complete pre-anaesthesia machine check?

- a. <5min.
- b. 5-10 min.
- c. >10 min

4.Did you have sufficient time to complete the pre-anaesthesia machine check?

- a. Yes
- b. No

5.1Did you refer to any checklist or manual when completing your pre-anaesthesia machine check?

- a. Yes.
- b. No.

5.2 If yes, can you provide which checklist or manual you used?

Assurance:

I agree to accept all the responsibilities for the scientific and ethical conduct of the research project. I will provide timely progress report to my advisor and seek the necessary advice and approval from my primary advisor in the course of the research. I will communicate timely to my advisors all stakeholder involved in the study including any source of funding for this research.

Name: Aluat Chol William.

Signature:

Date

Approval of primary advisor:

Name: Dr. Lemi Belay Tolu

Signature:

Date:

Approval of co- advisor

Name: Dr. Lemi Belay Tolu

Signature:

Date: