



Cross-sectional Study of Checking an Anesthetic Machine Parts and Instrument: Survey Study of Anaesthetic Technicians in Libya

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Abstract: Background: The anaesthetic machine (AM) is one of the most essential devices used by anaesthesiologist's, and understanding its characteristics and functions is a crucial component of anaesthetic practice. The pre-use check to ensure the correct functioning of AM and equipment is essential to patient safety. The check is included in the World Health Organization Surgical Safety Checklist. **Aims of this study:** To evaluate if the technicians perform sufficient check or not. In addition, if there were, any problems reported because of insufficient check. **Methodology:** Descriptive cross-sectional study used online questionnaire. Google Forms app was the best option available because of the global pandemic covid-19. Most questions in this study were multiple choice and some were short answers. **Results:** The total responses received are 53 from 18 different hospitals, the most from Zliten Hospital with 13 responses. The majority of participants' experience years were less than five years with 60.38% (n=32). Participants Most of the answers showed a middling presence of constantly checking. The highest always-checking rate was for ventilators with 81.12% (n=43). From the total number of participants, 45.28% (n=24) experience problems related to inadequate check of AM before anaesthesia. **Conclusion:** This study's results demonstrate that the standard of checking anaesthetic equipment before use is inappropriate as a 24 of them reported problems related to poor check .

Keywords: (Anaesthesia machine, Anesthesiologists, Checklist, Instrument, patient safety and technician)

Introduction

An anaesthesia machine (AM) is a medical device used to control the patient's ventilation and oxygen delivery and to administer inhalation anaesthetics [1]. The AM is one of the most important tools used by anaesthesiologist's, and understanding its characteristics and functions is essential. AM is subject to continuous change and innovation [2].

Broadly, the term AM apparatus or equipment is taken to mean the set of elements intended to provide medicinal gases and anaesthetics to a patient [3].

Components of the Anaesthetic Machine; AM has six basic subsystems: Gas supplies; including pipelines and cylinders, Gas flow measurement and control (flow meters), Vaporizers, Gas delivery presented as a breathing system and ventilator, Scavenging, and Monitoring. Functions of the Anaesthetic Machine; the machine performs four essential functions: as the following Provides oxygen (O₂), accurately mixes anaesthetic gases and vapours, enables patient ventilation., and minimizes anaesthesia-related risks to patients and staff [1-3].

Checking the Anesthetic Machine; daily standard systemic before use, AM checking is an essential procedure to ensure patient safety [4]. One checklist cannot satisfactorily test the integrity and safety of all existing AM due to their complex variations in design [5]. Many anaesthetic associations, including the American Association of Anaesthesiology (ASA) and the Association of Anaesthetists of Great Britain and Ireland (AAGBI), have published checklists. The issue with Statements: The proper check is required because patient and working-related equipment safety is crucial. Due to insufficient checks, there were several cases recorded in various regions of the world, and the patients' conditions put them in danger of losing their lives. This study was designed to evaluate whether the anaesthesia technicians perform adequate checking or not. If there were, any problems reported because of insufficient checks.

Methodology

Descriptive cross sectional study used online questionnaire to evaluate the pre-anaesthesia routine check of AM and equipment in Libyan hospitals, and also if there were any complications regarding inappropriate checks have been reported.

To achieve the study goal the Google form survey was used to gather data from participants (anaesthesia technicians). Google Forms can be utilized for biomedical surveys and may help in gathering information from a large sample within a short time [6].

The survey Link was online shared via e-mails and trusted social media sites for two months from March to May 2021.

Survey design:

The survey was designed based on the other anaesthesia community checklist protocol. This survey aimed to ask the participants about the AM checking they performed before anaesthesia. All questions in the study were short answer questions and multiple-choice questions, and all question's answers were required. Before starting small description was added to introduce ourselves, our work, and the general goal of our study.

Results and Discussion

Two months (March to May 2021) after sharing the survey the online survey was deactivated and ended receiving new participants. The total number of responses was 59 responses, six of the total responses were excluded because they came from unemployed technicians or the working place could not identify also one respondent was not from Libya.

Anaesthesia equipment is important for the safe conduct of anaesthesia, but equipment malfunction may also contribute to morbidity and mortality [7]. The AM has most often been involved in equipment-related morbidity [8]. Human factors were important causes of problems, and the AM was most often involved. Moreover, this has led to the extensive use of preoperative checklists [9]. As checking for AM must be performed before anaesthesia to sidestep any issues related to insufficient checking and humble preparation, this survey was created to study the checking of AM in Libyan hospitals. Google Form application was used to create the survey then, it was online shared. After two months, the survey was deactivated and responses were 59 in total. Six responses were excluded, and the results of 53 responses were used.

The survey questions analysis

1. General Section

The first section of the survey was general and asked about the experience of working as an anaesthetic technician and working place.

In the first question, the contributor's experience arranges into three groups (0-5), (5-10) and (more than 10). Most of the technicians who participated in this survey have experienced less than 5 years with 60.38%, which counts 32 of the total 53 participants. Other experience groups owned 32.08% and 7.55% respectively. As shown in Figure (1)

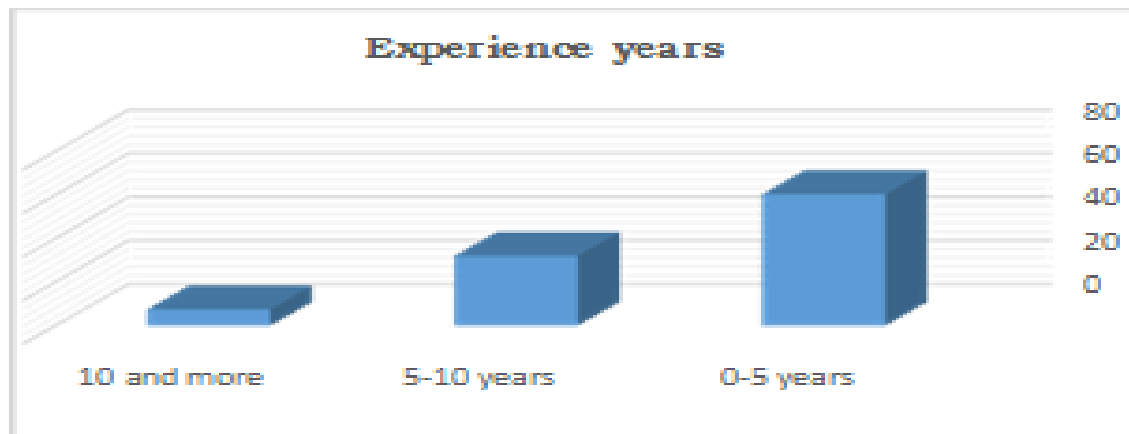


Fig. 1: Experience years

As the participants were from 18 various working locations, we obtained responses from several Libyan hospitals (both government and private), as shown in Table 1.

Table.1: The working place of participants and the count of responses from each working place.

Hospital	Count	Hospital	Count
Zliten medical center	13	Aljala Hospital Tripoli	1
Zawia Teaching Hospital	10	Surman General Hospital	2
Almarge Hospital	2	Derna Hospital	1
Alkalil Clinic	1	Ali Omer Askar Hospital	1
Musrata Medical Centre	2	Sabrath Teaching Hospital	2
Alhadba Hospital	4	Alkoms Hospital	1
Albasatin Clinic	2	Nawat Almostakbal Clinic	1
Tripoli Medical Center	2	Maslata Hospital	1
Aljala Hospital Benghazi	6	Sebha Hospital	1

In the first section, two questions were asked about the working place and experience of participants. This work does not study the relationship between the experience and the protocol of checking, those questions took place in this study to identify that all participants are anaesthesia workers.

Many cases reported have been published were related to inappropriate checking of Am and instruments, many of the cases put the patients in life-threatening situation.s

The examination rates of AM power supply were 43.4% always, 47.17% sometimes and 09.43% never check the power supply. Anaesthesia providers dependent on sophisticated electrically powered equipment such as the anaesthesia gas machine and monitors to safely care for their patients [10]. A massive power failure that adversely affects the operating room's ability to function is rare, and the

available related literature is somewhat limited [11]. All anesthesiologists are supposed to always check the power supply before performing any operation because all anaesthetic depend on the power supply.

1. Checking an Anaesthetic machine section

The second section of the survey represents 13 questions about the checking of AM. As presented in Tables 2 and 3.

Table.2: indicated the result of checking an Anaesthetic machine section (Q1-11).

Result	ALWAYS		SOMETIMES		NEVER	
	Per cent	Count	Per cent	Count	Per cent	Count
1. Check the power supply	43.40%	23	47.17%	25	9.43%	5
2. Check the gas cylinder	77.36%	41	13.21%	7	9.43%	5
3. Checking Pipelines	41.51%	22	43.40%	23	15.09%	8
4. Checking flowmeter result	58.49%	31	32.08%	17	9.43%	5
5. Checking the breathing system	90.57%	48	7.55%	4	1.89%	1
6. Checking the vaporizers	71.70%	38	22.64%	12	5.66%	3
7. Checking the Ventilator	81.13%	43	16.98%	9	1.89%	1
8. Checking the Suction machine	69.81%	37	26.42%	14	3.77%	2
9. Checking and configuration of monitor	83.02%	44	15.09%	8	1.89%	1

The result of the section questions was presented respectively as follows: The first question was about checking the power supply; the examination rates were close between (always 43.4% & sometimes 47.17%) and 9.43% of the technician was never checked. All anesthesiologists are supposed to always check the power supply before performing any operation because all anaesthetics depend on the power supply.

The second question was asked about the check the gas cylinder; the equivalent 77.36% of anaesthesia technicians always check, and this is a good percentage to avoid any risks associated with gas cylinders, 13.21% do sometimes check and never check 9.43%. One of the participating technicians informs us about the problem of a gas leak from the cylinder because of poor checking.

The third question was about the check of the pipeline; the equivalent of 41.51% of all participants always performed checks of pipelines, and, 43.40% do sometimes check and the never checking was 15.09%. Concerning the importance of routine inspection of the AM's flexible hose pipeline, a case report of a sudden beginning of persistent unusual sound in the operating room during surgery was shown to be caused by nitrous oxide leakage from the AM's flexible hose pipeline [12]. Another research revealed that gas pipelines, cylinders, Rotameters, vaporizers and ventilator disconnect alarms were rarely checked [13].

Flowmeter checking was performed as follows: 58.49% always check, so it is necessary to check it because it evaluates the rate of gas flow that passes through it. The percentage of sometimes checking is 32.08% the never was 9.43%.

The breathing system is considered one of the most important devices to be checked, so the percentage of technicians checking was always 90.57% and 7.55% sometimes checking and they never checking was so small only 1.89%. Described some problems related to the flowmeter as dirt or static electricity can cause a float to stick and misrepresents actual flow. The flowmeter must align properly in the vertical position to avoid inaccurate readings.

The breathing system is considered an important device to be checked, so our data shows 90.57% of technicians were always checking the breathing system. In one case report related to an unchecked breathing system, after the patient was anaesthetized and the resident attempted mask ventilation, no ventilating pressure could be achieved in the circuit and no gas moved with the sound of gas escaping from the system was heard and the machine was quickly inspected. An opened CO₂ canister was found and the top part contained no soda lime. Despite closing the circuit, no ventilation was possible [15].

There was 71.7% of anaesthetic technicians doing always check, 22.64% of them do sometimes check and the percentage of never check is 5.66%. Therefore, it is important to check it because it vaporizes anaesthetic fluids to deliver them to the patient. Regarding the vaporizer check or study, prove that there was 71.7% of anaesthetic technicians always check, 22.64% sometimes check and 5.66% never check the vaporizers. One problem mentioned by some participants was that the vaporizer was not filled as a result of an inappropriate AM check.

Research's studied vaporizers were approximately seven years old and had been maintained regularly by the Australian Datex-Ohmeda service center. As awareness has been reported because of, malfunctioning of the vaporizer attached to the AM they doubt that the fault was caused by, excessively long actuating spindles which were confirmed later by Datex-Ohmeda in four of the vaporizers.

In two of the vaporizers, the fault was in the upstream spindle. In one vaporizer, the problem involved the downstream spindle, and in the other, the spindle was unspecified [16]. It is important to check it because it vaporizes anaesthetic solutions to deliver them to the patient. Several case reports reported leak issues, with most of them having in common the inappropriate positioning of vaporizers on the AM. Others report inappropriate adjustments in the mounting system due to a missing rubber O-ring. Timely identification of this problem is facilitated by checking the anaesthetic machine with the vaporizer in the ON and OFF positions [17].

The percentage of ventilator non-examination is very low, and through the results, the examination rate was always recorded as 81.13% and sometimes 16.98%. In one case, the ventilator was inadvertently turned off during anaesthesia. This was a new anaesthetic machine, where the 'power button' protruded from the cabinet, and the anaesthetists inadvertently pushed it. The ventilator stopped and the patient's pulse oximeter reading decreased to 45% before the error was detected [9]. In the same manner, one technician who participated in our study said he faced the problem of a sudden unexpected ventilator stop, and he does not explain the reason for this.

In one case report, the ventilator did not work promptly; the airway pressure was increasing and the bag was empty while the ventilation with the Ambu-bag was normal. After checking, the AM anesthesiologists noticed a kinking in the hose connecting the ventilator chamber to the airway pressure release valve [18].

The sucking or suctioning device has a big role in the operation, it cleans and suctions foreign objects from the patient's mouth, for example (blood, broken teeth or vomiting), and so 69.81% of anaesthesiologist's always check. Moreover, 26.42% of them sometimes check the suction unit.

When we asked the technicians about the checking of the suction unit, 69.81% of them always check, and 26.42% of them sometimes check, As the sucking or suctioning device has a big role in the operation, the problem was mentioned by one technician is that the suction unite did not work and

another device was not reachable. Because he did not test the suction, unite before starting anaesthesia.

The monitors are important in measuring all body functions. The percentage of permanent examination is 83.02%, and the percentage of examination sometimes is 15.09%. As for the never check it was very little 1.89%. The monitors are important in measuring all body functions. Our data were shown 83.02% practice permanent examination and sometimes 15.09%.one participating technician signaled the loss of CO2 concentration from the monitor screen. A similar study of AM checking practice publicized that, only one of 40 anaesthetists questioned calibrated an oxygen analyzer [19]. In one case, the non-invasive arterial pressure readings were falsely high, and the patient received a large dose of volatile anaesthetic, while the patient, in reality, was severely hypotensive. This was related to technical failure including leaks from the tubing and cuff [9], as the authors mentioned this problem involved elements of human error.

As our result showed 71.7% always checked the airway instruments, 22.64% sometimes, and the never checking rate was 5.66%. One of the participants mentioned that he had a problem with airway instruments were not fully prepared. Between cases, checks sometimes performed were by 50.94% of technicians, just 34.85% were always checked, and never check was 13.21%. In similar data checking of equipment between cases was performed by 12.5% overall 40 anaesthetizes [19]. In addition, the researcher reported the case of an open CO2 absorber after the service of the machine had been performed between the cases [14]. The anesthesiologist did not check the AM before use in the upcoming case; this caused the unable to ventilate the patient during induction.

Table.3: indicated the result of checking an Anaesthetic machine section (Q12-13).

Result Q 12&13	YES		NO	
	Per cent	Count	Per cent	Count
12. Availability of Checking list in working place	41.51%	22	58.49%	31
13. Technicians facing problems related to AM checking	45.28%	24	54.72%	29

The 12th question asked about the presence of an anaesthetic machine checklist; for daily in your working place, 58.59% of the anaesthesiology technicians do not have a list of the mechanism of examination of the anaesthesia device in their workplace, compared to 41.51% who have a list of the examination mechanism at their place of Working. The next question asked about the problems that anaesthesia technicians had faced during anaesthesia 45.28% of all participants experience problems related to inadequate check of AM before anaesthesia.

Our study revealed that 58.59% of the technicians do not have a checklist of the anaesthesia devices in the workplace, in compare 41.51% who have a list of the examination mechanism at their place of work. The AM check has been included in the World Health Organization’s Surgical Safety Checklist. The pre-use AM check is recognized worldwide to ensure the correct functioning of anaesthetic equipment is essential to patient safety [20]. From a total number of participants, 45.28% of all experience problems related to inadequate check of AM before anaesthesia. This demonstrates that the standard of checking anaesthetic equipment before use is poor.

At the end of the survey, we asked the participants who faced problems about the problem they faced. Many problems mentioned by the participants related to inadequate checks. These problems are presented on the following list:

- 1 .Leak from an oxygen cylinder
- 2 .Anaesthesia failure
- 3 .Leaking of sevoflurane in surgical room
- 4 .Ventilator does not working suddenly
- 5 .Suction machine is not ready
- 6 .Leak in the breathing circuit
- 7 .There is leakage or exhaustion of gases cylinders
- 8 .Suction machine does not work
- 9 .Airway instruments were not ready
- 10 .Empty the sevoflurane vaporizer.
- 11 .The CO2 saturation does not appear on the monitor.

Conclusion

This study is the first to evaluate the AM checking and used instrument, performed by the anaesthesia technicians in several Libyan institutions with varying participant experience levels. The study's findings, the checking was always proceeding, although some of which stemmed from inadequate checking for AM. Developing a Libyan AM checklist is necessary to be used in all Libyan hospitals, to make the checking procedure more efficient and straightforward.

As limitations for this work, the COVID-19 world pandemic and the small number of participations responses.

Abbreviations and Acronyms

(AM) ANESTHEISA MACHINE

(ASA) American Association of Anaesthesiology

(AAGBI) Association of Anaesthetists of Great Britain and Ireland

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