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Original Research Article

Practice of Low Flow Anaesthesia and Volatile Agents Choices among Anaesthesia Providers at Muhimbili National Hospital and Muhimbili Orthopaedic Institute

Dr. H.J. MATHEW[1], DR. P. MWASAPI[1], DR.H. MGAYA[1], DR. E. LUGAZIA[1], Dr. Eric K Muhumba[3], Dr. Edwin M Muhondezi[3], Dr Richard T Mliwa[3], Dr. Abubakar R Hamis[3], Dr. Goodluck S Lema[3], Dr. Magdalena T Mbeyale[3], Dr Peter Kibunto[4*], Dr. Shilekirwa M Makira[3]

[1]Department of Anaesthesiology, School of Medicine, Muhimbili University of Health and Allied Sciences, P.O BOX 65001, Tanzania
[2]Department of Anaesthesia Muhimbili National Hopital- Mloganzila, P.O.BOX 65000, Tanzania
[3]Department of Surgery Muhimbili National Hopital- Mloganzila, P.O.BOX 65000, Tanzania
[4]Department of Orthopedic and Trauma Muhimbili National Hopital- Mloganzila, P.O.BOX 65000, Tanzania

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Abstract: With the availability of modern workstations and heightened awareness of the Health services cost and environmental effects of waste anaesthesia gases, anaesthesia providers worldwide are practicing low flow anaesthesia. In most developing countries Low Flow Anaesthesia is still underutilized due to lack of monitoring equipments and sufficient knowledge. Tanzania appears to have a paucity of studies on the prevailing practice pattern of fresh gas flow. Objective; The study aimed at assessing the practice of low flow anaesthesia and volatile agents choices among anaesthesia providers at Muhimbili national hospital and Muhimbili orthopaedic institute. *Methods:* A descriptive cross-sectional study was carried out for a period of 8 months involving 158 anaesthesia providers. A Structured questionnaire was used to collect data which included demographic, practice setting of Low Flow Anaesthesia, Workstations, scavenging, monitoring equipments, Volatile agents routinely used and preferred Agent. Data were analysed using the IBM Statistical package for social science's version 23.0. *Result:* Prevalence of Low flow anaesthesia was 27.2%, however, only 6% used the fresh gas flow of 1l/min – 500mls/min. All anaesthesia providers had workstations and only 2.3% displayed Minimum Alveolar concentration (MAC), 79.1% worked in theatre with functioning scavenging systems, 55.8% used capnography, 6.9% monitored inspiratory Oxygen and none of anaesthesia providers used Bispectral and Agent Analyzers. Isoflurane was the most routinely used inhalational agents (100%) followed by Sevoflurane (69%), then Halothane (32%). Desflurane still not available in these hospitals. *Conclusion:* Low flow anaesthesia is seldom practiced in our locality despite having strong evidence of attractive advantages in medical practice and ergonomics.

Keywords: Low flow anaesthesia, fresh gas flow, Volaatile gents.

INTRODUCTION

The routine practice of LFA has promising advantages and it's a duty for every Anaesthesia provider to be aware of these advantages that includes cost containment, Patient and theatre staff safety and reduction in environmental pollution. LFA was introduced by John Snow in 1850 and it was also well described in 1952 by Foldes. However didn't last long, was abandoned following the development of halothane and trichloroethylene which was incompatible with soda lime [1,2]. By definition (widely accepted) Low flow Anaesthesia is a technique that at least 50% of the expired gases are returned to the lungs after CO2 absorption, a fresh gas flow (FGF) of 500ml/min to ≤1000ml/min [3–5].

LFA has again gained popularity worldwide following advancement of workstations and introduction of low solubility agents, Sevoflurane and Desflurane. In south Africa Initiation of guidelines and 0028 code for LFA along with introduction of Desflurane and Sevoflurane in the market revived interest towards LFA according to Welch *et al.*, [6]. Carter *et al.*, reported that

***Corresponding Author:** Dr. Peter Kibunto
Department of Orthopedic and Trauma Muhimbili National Hopital- Mloganzila, P.O.BOX 65000, Tanzania

>90% anaesthesia providers were using LFA after initiation low flow board [7].

In developing countries, Tanzania included, Paucity of Advanced workstations, multi gas monitors, lack of initiatives and policy to promote LFA and scanty knowledge gained during residency/training impedes the implementation of Safe low flow anaesthesia [7]. Use sophisticated workstations equipped with multigas monitoring systems and other safety features has eliminated all uncertainties against the use of low flow techniques [2,8].

No matter how 'high we go'/ "low we go" a normothermic adult at rest needs a minimum of 250ml of O2 therefore LFA is within safety Window.

METHODOLOGY

Study Setting:

The study was a hospital based descriptive cross sectional study involving all Anaesthesia providers working in all MNH (Upanga and Mloganzila campus), and MOI operating theatres from July 2019 to February 2020.

Muhimbili National Hospital (MNH) is the national referral hospital, research Centre and university teaching hospital located in Dar Es Salaam. Currently there are two branches of Muhimbili national hospital to mention, Upangaand Mloganzila branches. Anaesthesia department at MNH Upanga together with Mloganzila Campus has 141 certified Anaesthesia providers and atleast 50 nurse anaesthesia student working together to provide anaesthesia services. More than 300 patients per week undergo surgery receiving general anaesthesia under inhalation Agents. Muhimbili Orthopaedic Institute (MOI) is a tertiary national referral and teaching hospital specialized in providing preventive and curative health services in Neurosurgery, Orthopaedic and Traumatology all over the country and from neighbouring countries. MOI has approximately 40 anaesthesia providers and variable number of residents who are involved in daily anaesthetic service.

Data Collection:

A total of 158 anaesthesia providers were interviewed by principle investigator and two research assistants. Data were collected using Structured questionnaires and checklists , it was a validated questionnaire tool adopted from past similar study with little modification. All Anaesthesiogists, Residents and Registrars were selected to fill the study questionnaire at the Data collector convenience. Questions aim at assessing the practice pattern of low flow Anaesthesia, the availability of recommended monitors for the practice of LFA and volatile Agents choices among Anaesthesia providers was provided. The checklist was used to confirms informations on monitors availability, FGF setting and choosev volatile agents.

Participants were given chances to fill questionnaire in other days and end of operation list and were identified depending on the place where were found on the day of the interview and were given only one chance to be interviewed. The outcome variables were practice of low flow anaesthesia technique and the choice of volatile Agents.

Data Processing and Analysis:

A Microsoft excel (office 2010) database were developed with logic checks for inconsistence to ensure data quality. The complete database was exported to IBM Statistical package for social science (SPSS) version 23 for cleaning and analysis. Data analysis was done by using statistical software IBM Statistical package for social science (SPSS) version 23. Proportion were determined for categorical variables and these percentages were used to summarize, Demographic data, practice setting of LFA, Availability of workstations, scavenging systems, minimum monitoring equipment, gas flow rate easier to use, volatile agents used routinely and volatile agent of choice**.** Pearson's Chi-square test and Fisher's exact test were used to determine association of some categorical variables with low flow anaesthesia and at P value < 0.05 the differences were considered statistically significant.

Ethical Clearance:

Ethical clearance and study approval was received from MUHAS Institutional Review Board and the executive directors of Muhimbili Ortopaedics institute and Muhimbili National Hospital.

RESULTS

Total questionnaires of 158 were returned, making a response rate of 100%. Most participants were nurse anaesthetists and residents and only 11 Anaesthesiologists comprising 7% of all anaesthesia providers. More than half of respondents (71.5%), were Nurse Anaesthetists.

Majority of anaesthesia providers had experience of ≤5 years (58.9%) and only 7% had experience more than 20 years. Half,50% of participants were from MNH. Male participants were 74.1% and the rest were female. Subspeciality of practice, 38.0% worked solely in orthopaedic anaesthesia but most of anaesthesia providers, 62.0% were rotating in different subspeciality according to duty schedule as summarized in **table 1.**

Table 1: Demographic characteristics of the study participants

Variable	Categories	Frequency (n)	Percentage (%)
Working experience (years)	≤ 5	93	58.9
	6 – 10	35	22.2
	11 – 15	13	8.2
	16 – 20	6	3.8
	≥ 21	11	7.0
	Total	**158**	**100**
Workplace	MNH	79	50.0
	MOI	59	37.3
	MNH Mloganzila	20	12.7
	Total	**158**	**100**
Gender	Male	117	74.1
	Female	41	25.9
	Total	**158**	**100**
Professional cadre	Anaesthesiologist	11	7.0
	Residents	21	13.3
	Anaesthesia registrar	6	3.8
	Nurse Anaesthests	120	75.9
	Total	**158**	**100**
Subspecialty	Surgical	57	36.1
	Obstetric Anaesthesia	15	9.5
	Paediatric Anaesthesia	11	7.0
	Orthopaedic anaesthesia	60	38.0
	Others (neurosurgery, critical care).	15	9.5
	Total	**158**	**100**

* MNH=Muhimbili nation hospital, *MOI=Muhimbili Orthopaedic Institute.

PREVALENCE OF LOW FLOW ANAESTHESIA

Regarding to the prevalence of LFA, 27.2% of anaesthesia providers routinely practiced low flow anaesthesia **[figure 1].**

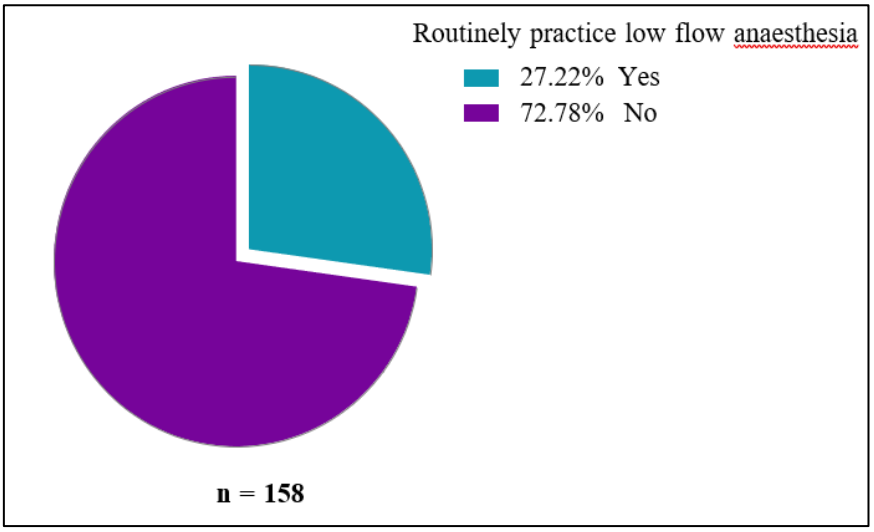

Figure 1: Routine practice of low flow Anaesthesia

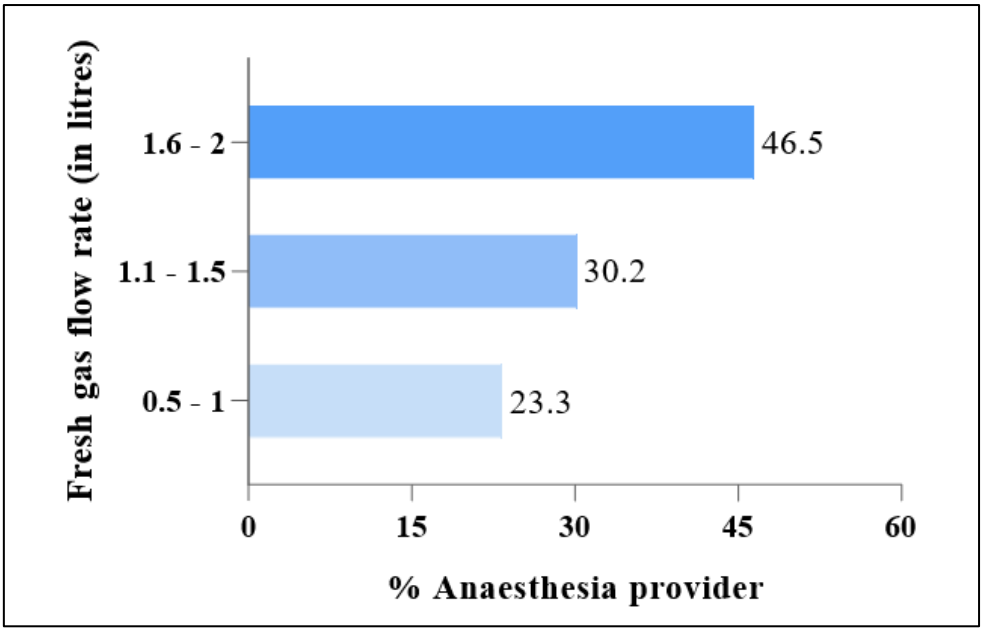

Figure 2: Fresh gas flow rates used during routine use of low flow anaesthesia

Only 23.3% of those claimed to practice LFA used fresh gas flow rate of 0.5-1l/min therefore the actual prevalence of low flow Anaesthesia is **6%**. Majority Anaesthesia providers (46.5%) who claimed to practice Low Flow Anaesthesia used fresh gas flow rate of ≥1.5l/mins, which doesn't tally with an acceptable definition of "low flow anaesthesia" [**Figure 2**].

Experience in anaesthesia services was compared with the routine practice of LFA. For those who routinely practice LFA, majority had experience of more than 10years (43.8%). The difference was statistically significant with a P value of =0.036 as shown in **[figure 3]**.

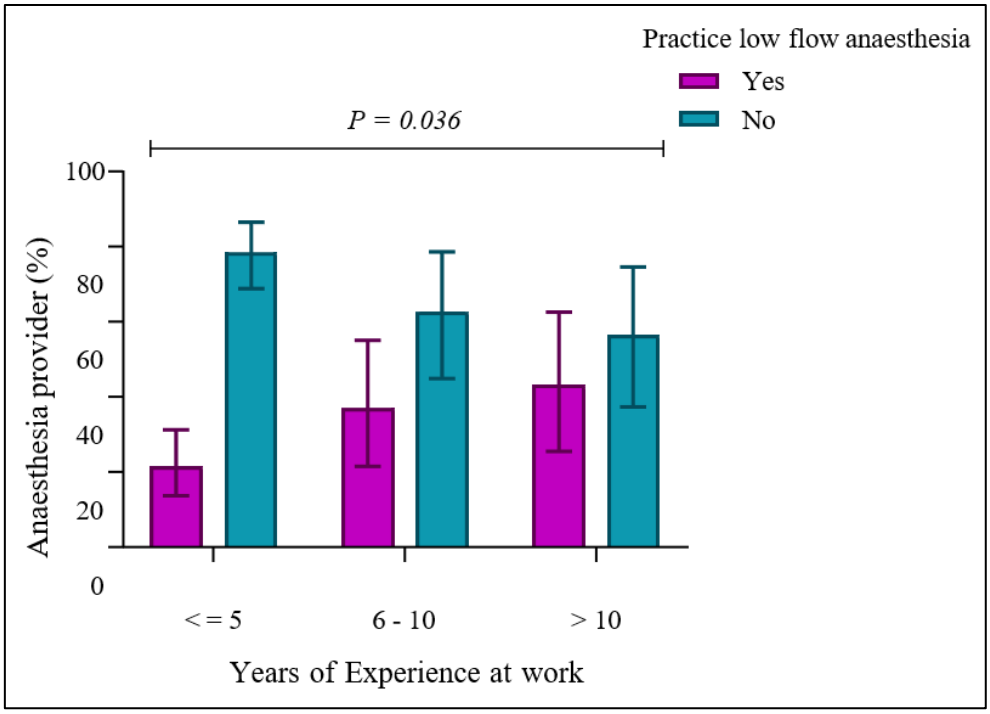

Figure 3: The Association of practicing low flow Anaesthesia among providers with years of Experience

Respondents from Muhimbili national hospital had the highest proportion (41.8%) for routine practice of low flow anaesthesia among study participant compared to MOI and Muhimbili. This difference among work place (study sites) was statistically significant with a P value = 0.002 as shown in **[figure 4].**

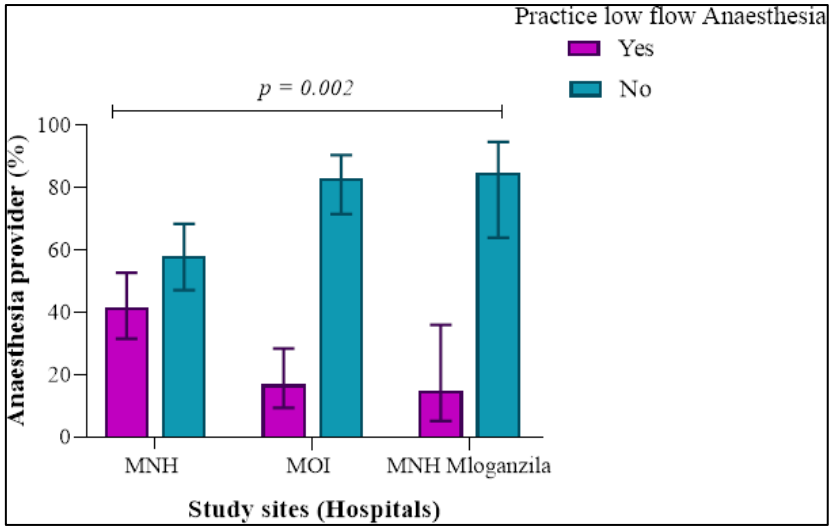

Figure 4: The Association of practicing low flow Anaesthesia among providers with the study sites (hospitals).

PRACTICE SETTINGS DURING CONDUCT OF LFA

Table 2 summarizes practice settings during the practice of LFA. Concerning time taken to reduce FGF from induction time 72.1% anaesthesia providers reduced FGF 10minutes after induction and **83.7% respondents reported** to reduce the FGF stepwise. Fraction of inspired oxygen (FiO2) used by respondents when implementing LFA was, FiO2 of 51%-60% was used by 30.2% and FiO2 of 30%-40% was used by 27.9% of respondents. The main carrier gas was mixture of oxygen and air, preferred by 90.7% of anaesthesia providers, while N2O was not used at all as a carrier gas. Regarding the easy FGF dial on flow meters, 48.9% of the population considered High FGF was simplest flow to be used a, 39.5% considered low FGF to be the simple flow. However to a general comment on LFA, 74.4% of respondents still considered LFA technique to be satisfactory for daily practice as summarized in **table 2.**

Table 2: Practicing characteristics of low flow anaesthesia among anaesthesia providers.

Variables	Categories	Frequency (n)	Percentage (%)
Reduce flow rate stepwise	Yes	36	83.7
Time to decrease flow after induction	10 minutes	31	72.1
	15 minutes	9	20.9
	>20 minutes	3	7.0
Fraction of inspired oxygen	30 – 40%	12	27.9
	41 – 50%	7	16.3
	51 – 60%	13	30.2
	>60%	11	25.6
Carrier gas of preference	Oxygen	4	9.3
	Oxygen and air N2O	39 0	90.7 0
LFA satisfactory	Yes	32	74.4
	High FGF	21	48.9
FGF easy to be used	Low FGF	17	39.5
	Minimal FGF	5	11.6

LFA=Low flow anaesthesia, FGF=fresh gas flow

AVAILABITY OF MONITORS, SCAVENGING ANDANAESTHESIA MCHINES

Table 3 summarizes the availability of monitors during the conduct of LFA. There were a total of 37 operating rooms with 37 anaesthesia Machines but 7 were not functioning properly, all providers (100%) had the opportunity to work in the theatre room with anaesthesia machine. Ten [10] workstations were displaying MAC value and only 2.3% were using it adequately. Concerning Scavenging systems, 79.1% of anaesthesia had the chance to work in the OT room with properly functioning scavenging system. Availability of monitors, which are functioning properly was, Oxygen Analysers [28], Agent analysers [3], Working and non-working Capnography (15 and 12 respectively) and no BIS. Concerning utilization of these monitors, Capnography by 55.8%, monitors oxygen Analysers were utilized by 6.9%, while none of Anaesthesia provider utilized Agent analysers **[Table 3].**

Table 3: Availability of workstations, scavenging systems and minimum Mandatory monitoring equipments and percentage of providers using them effectively

Type of equipment	MOI hospital	MNH hospital	MNH Mloganzila	Percent of anaesthesia providers using (%).
Workstations (Dragger, Mindrey and others).	9	16	12	100
Workstation with MAC	1	7	2	2.3
Oxygen Analyzer	5	11	12	6.9
Scavenging system	7	14	12	79.1
Capnography	5	8	2	55.8
Agent Analyzer	1	2	0	0
BIS	0	0	0	0

BIS= Bispectral index, MAC=Minimum Alveolar Ventilation.

VOLATILE AGENTS USED ROUTINELY

Isoflurane was volatile Agent routinely used by all anaesthesia providers (100%), Sevoflurane by 69% and Halothane by only 32% of anaesthesia providers. All respondents from all hospitals in the study had never used Desflurane [**Figure 5**].

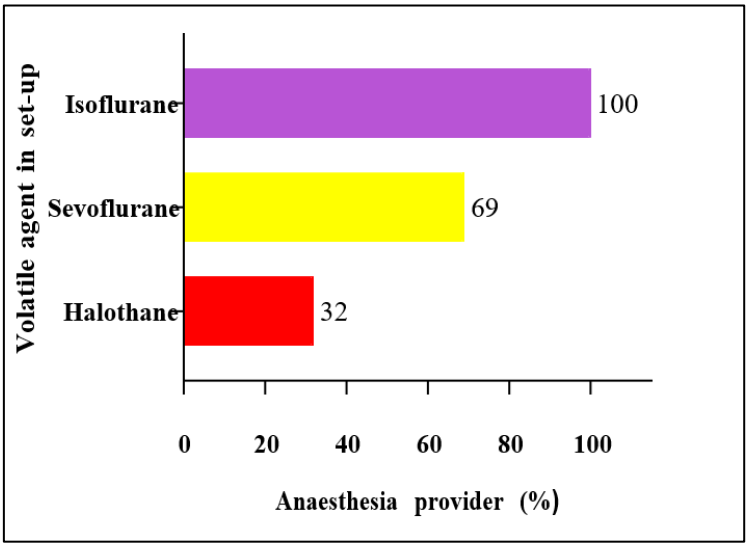

Figure 5: Volatile agents routinely used (Some opted more than one as "routinely used").

PREFFERED VOLATILE AGENTS

Regarding the volatile agent of preference when given the opportunity to choose, the responses were, Sevoflurane was most preferred by (55.7%) followed by Isoflurane by (42,4%), Halothane by (1.9%) and none preferred Desflurane. **[Figure 6**].

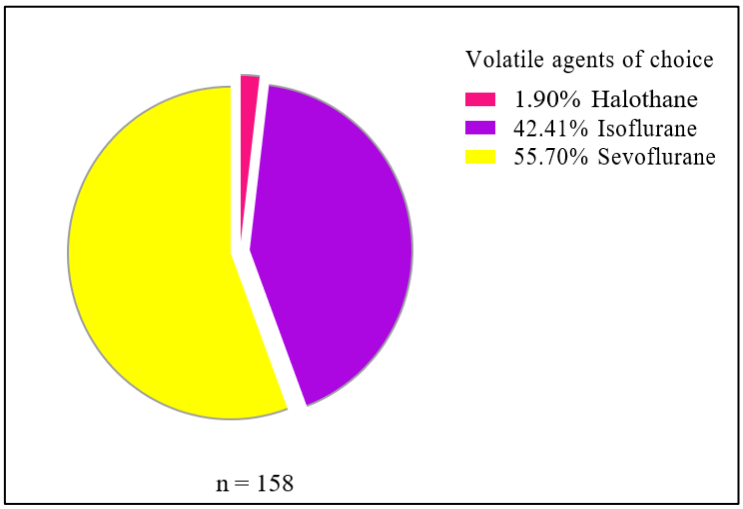

Figure 6

DISSCUSSION

This article reports on the prevailing practice patern and monitoring situation when using potent volatile anaesthetic agents in three tertiary hospitals in Tanzania, Muhimbili National hospital and Muhimbili orthopaedics institute. Also reports on the routinely used volatile agents. The Prevailing practice pattern was High flow anaesthesia used by 94% of anaesthesia providers.

Low flow anaesthesia was implemented by minority of providers accounting only by 6%, regardless of it known advantages over high flow anaesthesia Technique. Findings are the same with study done in Ghana in which the prevalence of LFA was 7% irrespective of majority (90%) being aware of health and environmental effects of in Waste anaesthetics gases [9].

Low Flow Anaesthesia deserves a prime place in the clinical anaesthesia practice because it results in reduction of hospital economic burden, avoiding theater and environment pollution, improves flow dynamic of inhaled, improving patient physiology as well as enhanced recovery after surgery as evidenced by several studies [10–12].

Working experience in Anaesthesia services and difference in hospitals setup, play an important role in influencing practice of LFA. This study results shows that, those with more than 10years of experience had highest proportion (43.3%) of routinely LFA practice consistent with study done in India whereby LFA was practice more by senior Anaesthesiologists [13]. Also most respondents (41.8%) who practiced LFA were from Muhimbili national hospital consistent with study done in Nigeria in which, LFA was restricted to only few tertiary hospitals [14].

There was inconsistency between the reported prevelance (27.2%) and setting of FGF of 500ml to ≤ 1l/min (6%), this is because even those who were using FGF of >1L/min and >2l/minutes reported to be implementing LFA. This discrepancy of analysis between true FGF setting of LFA and reported prevalence along with low prevalence indicates that there are gaps of knowledge on true concept of LFA. Several Studies have shown that expanding knowledge of LFA among anaesthesia providers and setting protocol fosters the prevalence of LFA in the country. In south Africa the introduction of 0028 code for LFA reinforced the practice of LFA [6]. In Europe and other countries there was escalation in the daily use of LFA as evidenced by 43% increase in application of LFA after training and CMEs [15–17]. Also The international standards for safe practice of anesthesia which were recommended by WFSA worldwide recommends that Adequate time and financial support should be available for professional training, both initial and continuing, to ensure that an adequate standard of knowledge, expertise, and practice is attained and maintained [18].

Availability of sufficient monitors is still a continuing problem in some countries, also some of the available anaesthesia machines are old-fashioned, this is in accordance to studies done in majour east Hospitals and other countries [19–22]. According to my survey, there was a shortage of recommended monitors when potent volatile agents is being used and shortage of Advanced workstations which displays MAC. Some Workstations had software for monitoring MAC, respiratory gas and BIS but plug in parameter modules and Gas sampling cables to enable displays were not installed.

To avoid incidences of light anaesthesia intraoperatively and complication following LFA, MAC monitoring together with respiratory gases monitoring are of paramount important. Respiratory gas analysis has become a mandatory standard monitoring in anaesthesia practice in theatres and ICU as recommended by the AAGBI for Standards of Monitoring during Anaesthesia [23, 24]. Practice of LFA is made easy if we monitor inspired and expired Concentration of O2 and other Anaesthetic gases.

Using high flow anaesthesia without scavenging impose huge health and environmental risk. Scavenging systems are highly recommended to reduce occupational exposure to WAG and prevent health related risks to OT personnel as 90% of inhalational agents are released as WAG [25]. Scavenging systems were abscent in some of the OTs as revealed by my survey consistent with previous survey done at MNH [20]. Only 79.1% respondents in my study had opportunity to work in OTs with properly functioning scavenging system.

Recommended maximum level of WAGs is, all halogenated anesthetics is 2ppm and N2O is 25ppm-50ppm [26], this is achieved by change of practice customs such as avoiding N2O use and using low flows [27, 28].

Routinely used volatile agents were different among study areas, at MNH and MNH Mloganzila routine volatile agents were isoflurane and sevoflurane, halothane is currently not used. At MOI they routinely used Isoflurane, sevoflurane and halothane. This study correlates with studies done in Ghana and Nigeria in which isoflurane was routinely used agents by 49.3% and 46.3% respectively while halothane was less chosen [9, 29].

However most anaesthesia provider preferred Sevoflurane (55.7%) results are consistent with various articles [9,14]. Desflurane is not available in all hospitals. From my study, the cost of volatile agents and stock availability affected the choice of Volatile agents, these reasons and many others not found in my study have been reported by several studies done in USA and other countries [30,31].

Study limitations

The findings of this study cannot be generalized to other hospitals outside MNH, MNH Mloganzila and MOI. In future, more information can be gathered by more institution based studies including private and government through out the country. Study involved anaesthesia providers with busy schedules, wide and changing range of staffs and Residents according to duty rosterand rotations respectively making data collection difficult.

CONCLUSSION

Low flow anaesthesia is seldom practiced in our locality despite having strong evidence of attractive advantages in medical practice and ergonomics. There is a lack of adequate monitoring facilities, advanced work stations and scavenging systems. Proper training is needed, highlighting how to perform LFA. Isoflurane is the most frequently used volatile anaesthetics, Halothane is becoming obsolete at MNH and desflurane still not available in our tertiary public hospitals.

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Conflict of interest: The author declares that there is no conflict of interest.

Authors' contributions: Both authors contributed equally towards the accomplishment of this work and have all read and approved the final version of the manuscript.

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