Optimum End Tidal Sevoflurane Concentration Required for Intravenous Cannulation in Children

Thesis

Submitted for Partial Fulfillment of Master Degree
(M.Sc.) in **Anesthesiology**

By

Omar Mohamed Mohamed Eltawansy
(M.B., B.Ch.)

Supervised by

Prof. Dr. Bassel Mohamed Essam Noureldin
Professor of Anesthesiology, Intensive Care and Pain Management
Faculty of Medicine - Ain Shams University

Prof. Dr. Eman Mohamed Kamal Abo Seif
Assistant Professor of Anesthesiology, Intensive Care and Pain Management
Faculty of Medicine - Ain Shams University

Dr. Mohamed Mohamed Abdel Fattah Ghoneim
Lecturer of Anesthesiology, Intensive Care and Pain Management
Faculty of Medicine - Ain Shams University

Faculty of Medicine - Ain Shams University
2020

بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

Acknowledgments

*First and foremost, I feel always indebted to **Allah** the Most Beneficent and Merciful.*

*My deepest gratitude to my supervisor, **Prof. Dr. Bassel Mohamed Essam Noureldin**, Professor of Anesthesiology Faculty of Medicine, Ain Shams University, for his valuable guidance and expert supervision, in addition to his great deal of support and encouragement. I really have the honor to complete this work under his supervision.*

*I would like to express my great and deep appreciation and thanks to **Dr. Eman Mohamed Kamal Abo Seif**, Assistant Professor of Anesthesiology, Faculty of Medicine, Ain Shams University, for her meticulous supervision, and her patience in reviewing and correcting this work.*

*I must express my deepest thanks to my **Dr. Mohamed Mohamed Abdel Fattah Ghoneim**, Lecturer of Anesthesiology, Faculty of Medicine, Ain Shams University, for guiding me throughout this work and for granting me much of his time. I greatly appreciate his efforts.*

Special thanks to my Parents, my Wife and all my Family members for their continuous encouragement, enduring me and standing by me.

Omar Mohamed Mohamed Eltawansy

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List of Abbreviations

Abb.	Full term
CI	*Confidence Intervals*
CO2	*Carbon Dioxide*
EC	*Effective Concentration*
ET sevo	*End Tidal Sevoflurane Concentration*
FGF	*Fresh Gas Flow*
GABA	*Gamma-Aminobutyric Acid*
HR	*Heart Rate*
HS	*Highly Significant*
IQR	*Inter-Quartile Range*
IV	*Intravenous*
LMA	*Laryngeal Mask Airway*
MAC	*Minimal Alveolar Concentration*
MDUDM	*Modified Dixon's Up and Down Method*
NMDA	*N-methyl-D-aspartate*
NS	*Nonsignificant*
PRA	*Probit Regression Analysis*
S	*Significant*
SD	*Standard Deviation*
TFA	*Trifluoroacetic Acid*

INTRODUCTION

Sevoflurane is an inhaled volatile anesthetic that is widely used in pediatric anesthetic practice. It is now the inhalation agent most commonly used for mask inductions in pediatric anesthesia, having largely replaced halothane for this purpose ***(Schwartz et al., 2004).***

Induction of anesthesia with sevoflurane has been reported to be safe, reliable, and well accepted by patients ***(De Hert and Moerman, 2015).*** Its characteristics include inherent stability; low flammability; non-pungent odor; limited irritation to airways; low blood or gas anesthetic solubility, which allows rapid induction of and emergence from anesthesia; minimal cardiovascular and respiratory side effects; and minimal end-organ effects ***(Delgado-Herrera et al., 2001).*** The muscle relaxant properties of sevoflurane allow insertion of a laryngeal mask airway (LMA) or endotracheal tube without a muscle relaxant, provided adequate concentrations of anesthetic are given ***(Aantaa et al., 2001).***

Inhalation mask induction is a cornerstone of pediatric anesthesia. Because of their natural aversion to needles, healthy children are usually anesthetized by mask prior to intravenous insertion. The early insertion of an intravenous access provides a means for administering fluids and drugs if an untoward event occurs during inhalational induction. However, Intravenous cannulation at lighter planes of anesthesia can lead to adverse respiratory and hemodynamic events ***(Schwartz et al., 2004).***

Placement of an intravenous cannula soon after the loss of eyelid reflex is possible with halothane but may lead to increased incidence of movement and laryngospasm with sevoflurane ***(Joshi et al., 2012).***

High concentration of Sevoflurane delivered for long duration not only has potential implication on child's hemodynamics and respiratory physiology but also leads to theatre pollution, increased anesthetic cost and significant health related issues amongst the anesthesiologists ***(Goel et al., 2019).***

AIM OF THE STUDY

The aim of this work is to evaluate the optimum end tidal concentration of Sevoflurane at which an intravenous cannulation can be successfully attempted without movement in pediatric patients after inhalational induction of general anesthesia using Sevoflurane.

REVIEW OF LITERATURE

Anesthesia Breathing System

Breathing system is defined as an assembly of components which connects patient's airway to anesthesia machine through which controlled composition of gas mixture is dispensed. It delivers gas to the patient, removes expired gas, and controls the temperature and humidity of the inspired mixture. It allows spontaneous, controlled, or assisted respiration. It may also provide ports for gas sampling, airway pressure, flow, and volume monitoring ***(Kaul and Mittal, 2013).***

The ideal breathing system

1. Supplies a continuous flow of anesthetic with oxygen—mixed with air or nitrous oxide—with a known concentration of each gas.

2. Prevents rebreathing of exhaled gases until the exhaled carbon dioxide is removed.

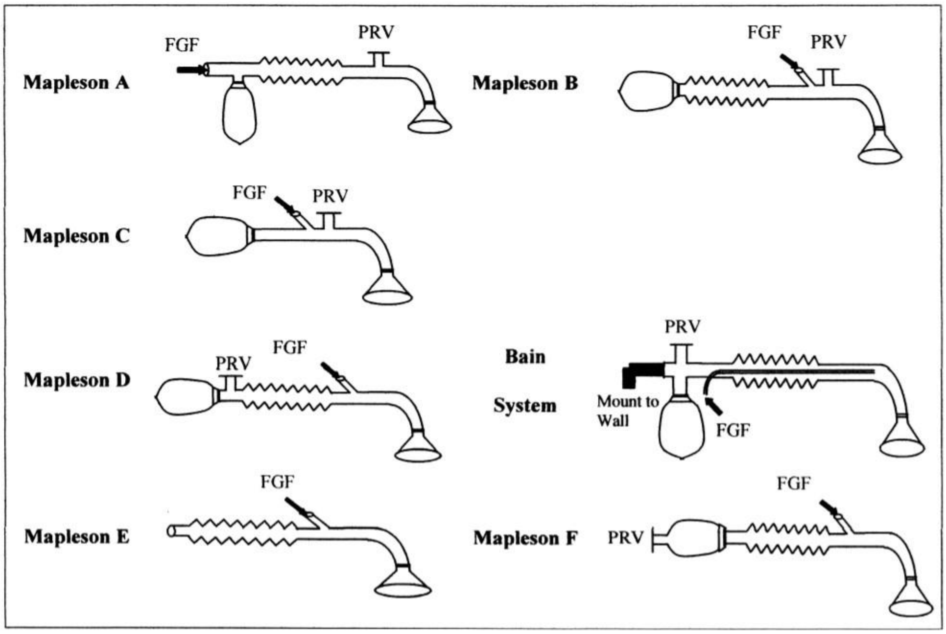
3. Provides breathing bags as a reservoir of anesthetic gas to be used in assisted or controlled ventilation.

4. Conserves respiratory humidity and heat (prolonged use of dry anesthetic gases can cause impaired function of the ciliated epithelium of the respiratory tract, induce inflammatory reactions, predispose the patient to

atelectasis or pneumonia, and decrease body temperature) and

5. Maximizes the cost-effectiveness of the anesthetics ***(Sutter and Boldt, 2000).***

Historically, the nonrebreathing (open) and the partial rebreathing (semi open) Mapleson systems (Figure 1) were used, meeting some of these criteria. Today, the circle system with absorbent soda lime to chemically eliminate the exhaled carbon dioxide is predominantly used (semi closed or closed) and can meet all these requirements when used appropriately ***(Sakai et al., 2005)***.



FGF = fresh gas flow; PRV = pressure-relief valve.

Figure 1: Mapleson systems ***(Sakai et al., 2005)***.

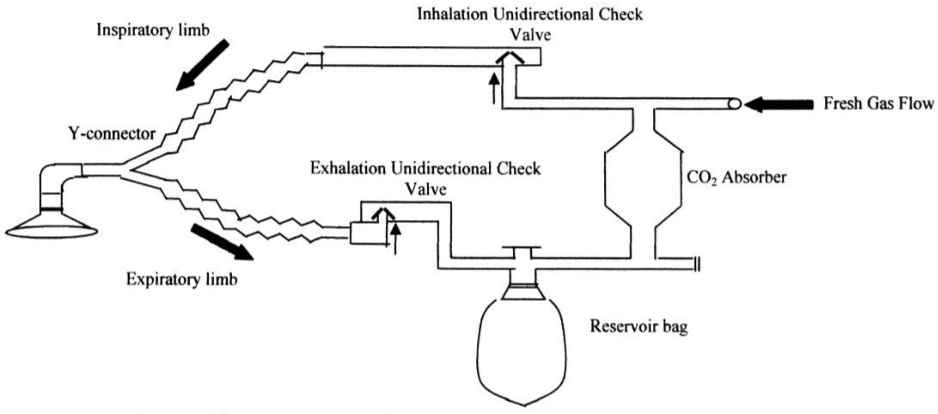


Figure 2: The circle system ***(Sakai et al., 2005)***. CO2 = carbon dioxide.

The fresh gas flow rate (i.e., the inflow rate of the vapor liquid anesthetics, oxygen, air, and nitrous oxide mixture) determines the efficiency of the circle system. At a moderate to very high fresh gas flow rate (2 to > 4 L/min), the adjustable pressure-limiting valves are open at times or all the time to discard the excess gas and carbon dioxide such that only portions or none of the exhaled gas is recycled (partial rebreathing– semi closed) (***Sutter and Boldt, 2000***).

At a low fresh gas flow rate (< 1 L/min), most of the exhaled air, including a significant amount of unused anesthetic, is recycled and returned to the patient after the exhaled carbon dioxide has been removed by absorbents, maximizing the advantage of this system. The potential risks associated with low flow anesthesia have resulted in avoidance of this technique by some anesthesiologists.

However, monitoring devices are available to reduce the potential risks. In a high-flow system, up to 90% of the unused volatile anesthetics can be wasted into the atmosphere, depending on the breathing system and the fresh gas flow rates used ***(Sutter and Boldt, 2000).***

Components of a Mapleson circuit

Breathing tubes

- Large bore, usually corrugated tubes, made of rubber or plastic.
- Corrugations increase flexibility and resistance to kinking.
- Clear plastic tubes are lightweight and low resistance.
- Act as a reservoir in certain systems.
- Have some distensibility but not enough to prevent excessive pressures from developing in the circuit.

Adjustable pressure limiting valve

- Also called as; pop-off valve, exhaust valve, scavenger valve, relief valve, expiratory valve, over-spill valve etc.
- This valve allows exhaled waste gases and fresh gas flows to leave the breathing system when the pressure

within the breathing system exceeds the valve's opening pressure

- It is a one-way, adjustable, spring-loaded valve.
- The spring adjusts the pressure required to open the valve.

Reservoir bag

- The reservoir bag is an important component of most breathing systems.
- Made of antistatic rubber or plastic.
- Accommodates fresh gas flow during expiration, acting as a reservoir available for use in next inspiration.
- Acts as a monitor of the patient's ventilatory pattern.
- Can be used to assist or control the ventilation
- Bag being the most distensible part of the breathing system, protects the patient from excessive pressure in the system.

Connectors and adaptors

- To connect various parts of breathing system.
- Extend the distance between patient and breathing system.