UPTAKE AND DISTRIBUTION OF INHALATIONAL ANAESTHETICS

THESIS

Submitted for the Partial Fulfilment of
Master Degree of Anaes thesia

BY

George Shafik Nashed

MB . B .ch

617.96
G . S

SUPERVISORS

Prof. Dr.
hia Hememi
of.of Anaesthesia
ı. Shams University

Prof. Dr.
Moh.Gafar Selim
Prof of Anaesthesia
Ain Shams University

Assist Prof. Dr.
Salah Showman
ASSIST Prof: of Anaesthesia
Military Medical Academy

Faculty of Medecine

Ain Shams University

1983

Central Library - Ain Shams University

To the memory of
my father

Central Library - Ain Shams University

الله

بسم الله الرحمن الرحيم

Central Library - Ain Shams University

Acknowledgement

Central Library - Ain Shams University

A C K N O W L E D G E M E N T

Thanks to God for completing this work. I would like to express ny deepest gratitude to Professor Dr. Yehia Hememi; Prof. of Anaesthesia, Ain Shams University, for his previous advice throughout ;he whole work.

My deep thanks and gratitude to Professor Dr. Mohamed Gaafar Selim, Prof. of Anaesthesia, Ain Shams University, for his unlimited ıelp and constant encouragement.

I am greatly indebted to Dr. Salah Showman, Assitant Professor of Anaesthesia, Military Medical Academy, for his valuable suggestions.

Great thanks to Dr. Makram Abdel Nour, Consultant of maesthesia, Military Medical Academy, for his great help.

Central Library - Ain Shams University

Introduction

Central Library - Ain Shams University

INTRODUCTION

Inhaled anaesthetics produce anaesthesia when their tension the brain reaches a certain level.

The level of anaesthesia produced ~~h~~is governed by the height anaesthetic tension in the brain, which is under control of the tendant anaesthetist.

The tension gradient between the inspired and alveolar gas is ilt up by three factors (Ventilation, uptake and concentration). e effect of ventilation in increasing the alveolar concentration of e anaesthetic agent is countered by the effect of the blood removing from the alveoli.

In this thesis, we will discuss the subject under three main adings, anaesthetic uptake, ventilation and the concentration effect, th special consideration of the effect of anaesthetics on air and ses in closed body cavities, and the effect of abnormalities of rdiopulmonary function, with added notes to placental transfer of haled anaesthetics.

Central Library - Ain Shams University

Contents

Central Library - Ain Shams University

C O N T E N T S

Central Library - Ain Shams University

UPTAKE AND DISTRIBUTION OF VOLATILE ANAESTHETIC AGENTS

Anaesthesia results from the development of an appropriate brain anaesthetic partial pressure. To achieve this brain partial pressure we administer a higher pressure from the anaesthetic machine. A difference exists between machine and anaesthetic circuit, between circuit and lungs, between lungs and arterial blood and finally between blood and body tissues.

These can be considered in a logical sequence of four interrelated steps:

1) The production and delivery of a suitable concentration of anaesthetic drug for inhalation.
2) The factors influencing distribution of the agent to the lungs.
3) Uptake from lungs.
4) Delivery of anaesthetic agent from circulation to brain.(Fig.1) (Wylie and Churchill-Davidson, 1979)

UPTAKE OF ANAESTHETICS FROM THE LUNGS

Uptake of anaesthetics from the lungs is product of three factors:

1) Solubility of the anaesthetic in blood.
2) Cardiac output.
3) The difference between the partial pressure of the agent in venous blood and its partial pressure in alveolar gas.

Central Library - Ain Shams University

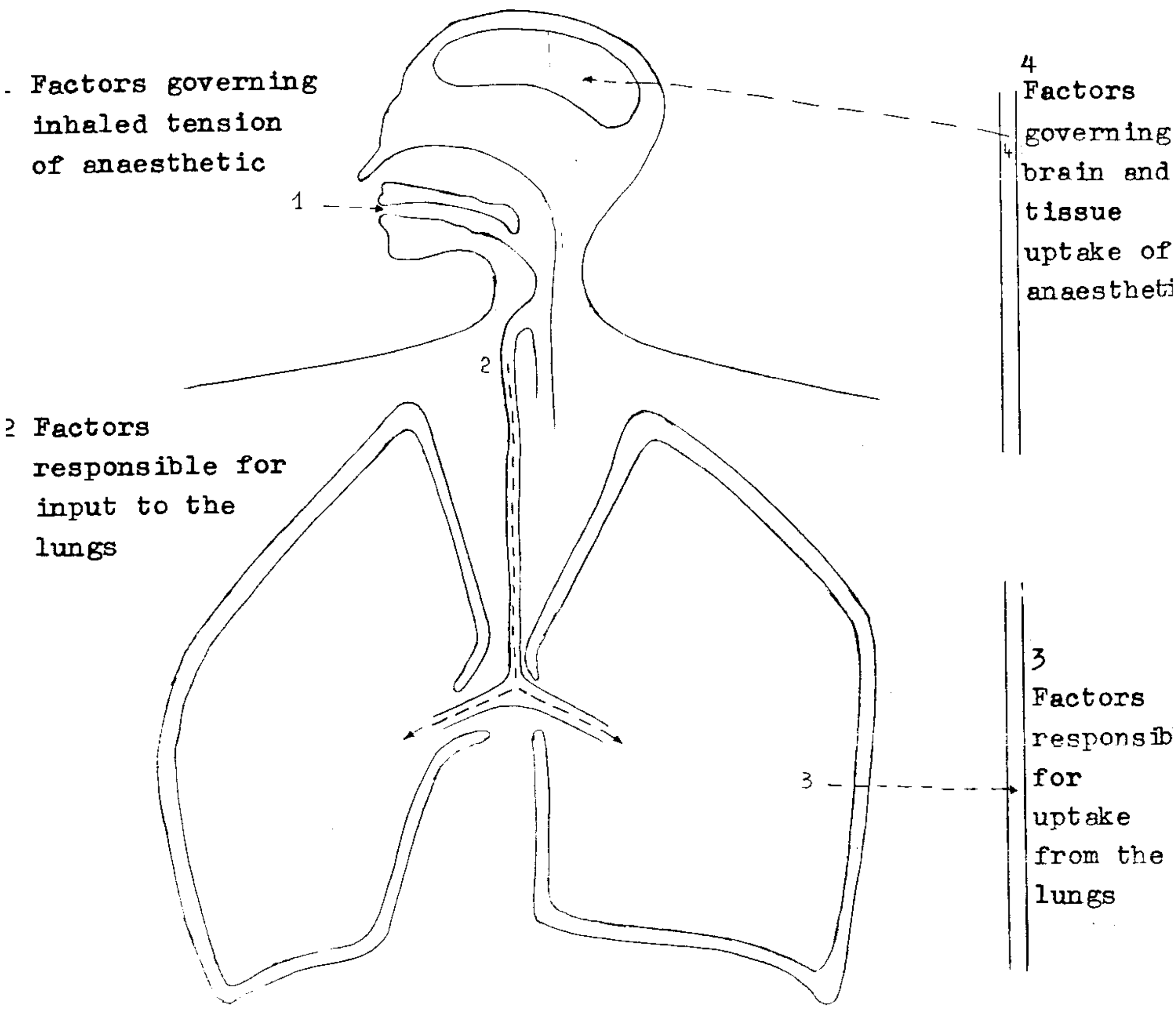


Fig. 1. Diagrammatic illustration of the four factors influencing the brain tension of volatile anaesthetic agents and gases. (Reproduced from Wylie and Churchill-Davidson, 1979)

Central Library - Ain Shams University

LUBILITY

Solubility is defined as the ratio of anaesthetic concentration isting in two phases when the two phases are in equilibrium. (Eger d Larson, 1964). The greater the blood / gas partition coefficient, e greater the uptake of anaesthetic and the slower the rate of crease in the alveolar concentration so a higher coefficients result slow inductions. (Table 1).

Anaesthetic gas	Blood/Gas	Brain/Blood
Cyclopropane	0.4 - 0.6	0.76
Nitrous Oxide	0.47	1.1
Isoflurane	1.4	2.6
Enflurane	1.8	1.4
Halothane	2.3	2.3
Chloroform	8.4	1.4
Trichloroethylene	9	1.7
Diethyl ether	12	1.0
Methoxyflurane	12	1.7

Table 1. Partition coefficients of some anaesthetic gases at 37°C. (Adapted from Eger, 1974)

Since solubility varies with temperature, the temperature at ιich the determination of solubility was made must also be stated. ɜregory and Eger, 1968).

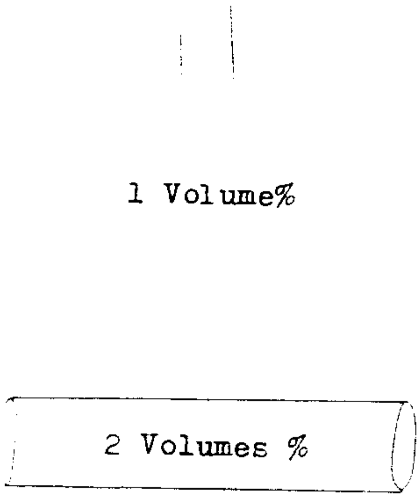
The Ostwald solubility coefficient, refers to a special partition ɔefficient. When one hundred per cent of a gas is equilibrated with a ιquid or tissue, the volume of gas dissolved per unit volume of liquid ɾ tissue is called the Ostwald solubility coefficient.

The Bunsen coefficient equal the Ostwald solubility coefficient ιmes 273 divided by absolute temperature at which the Ostwald coefficien as measured. (Eger, 1974).

Central Library - Ain Shams University

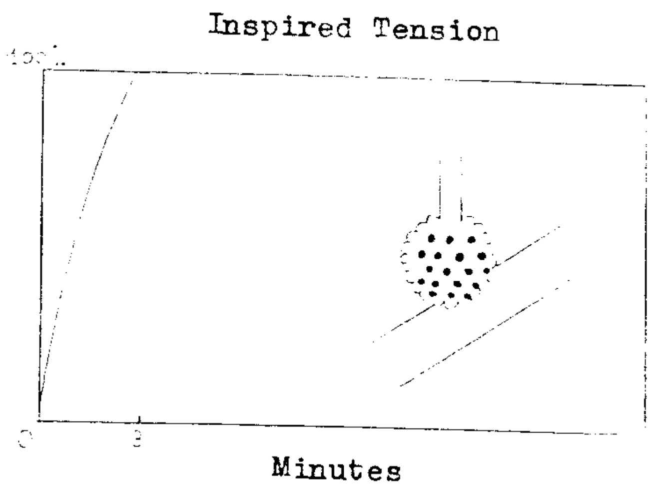
The importance of solubility in clinical practice is illustrated in the following example: If an anaesthetic is totally insoluble in blood (Blood/gas partition coefficient = 0) then none of it will be taken into the circulation consequently the alveolar concentration will rise. On the other hand if an anaesthetic has a low blood solubility, then only small quantities can be carried by the blood and both alveolar concentration and tension will rise rapidly. If the gas or vapour has a high solubility then large amounts can be absorbed by the blood stream, so that it is difficult for the alveolar concentration to rise rapidly. (Fig. 2).
(Wylie and Churchill-Davidson, 1979)

Central Library - Ain Shams University

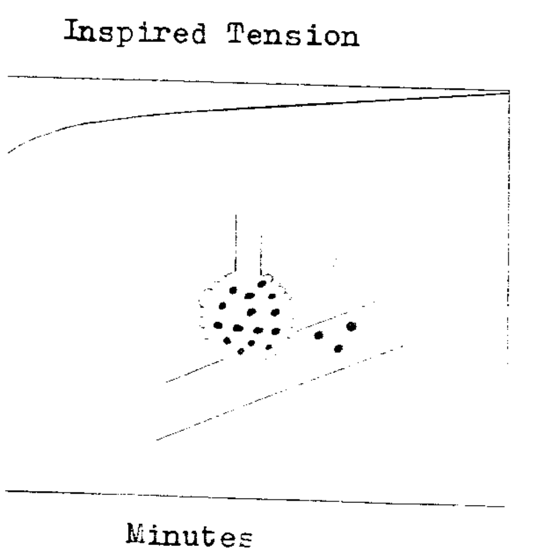


$$\frac{\text{Blood}}{\text{Gas}} = \frac{2}{1}$$

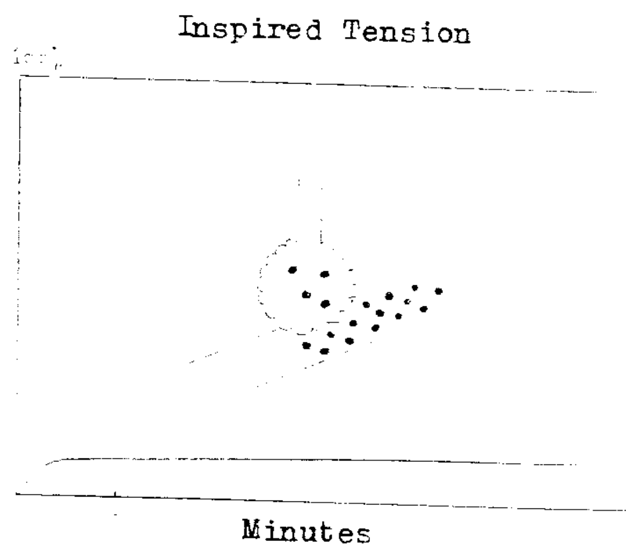
RTITION COEFFICIENT = 2



Rate of increase in alveolar tension of a gas which is totally insoluble in blood.



: increase in alveolar tension
is which is poorly soluble in
(e.g. N_2O).



Rate of increase in alveolar tension of gas which is highly soluble in blood. (e.g. Ether).

Fig. 2.
luced from Wylie and Churchill, 1979)

Central Library - Ain Shams University

CARDIAC OUTPUT

Because blood carries anaesthetic away from the lungs, the greater the cardiac output, the greater the uptake, and consequently the slower the rate of rise of alveolar level. (Yamamura, 1968). Thus induction of anaesthesia in a patient with a high cardiac output, as for example an extremely nervous or thyrotoxic patient, will take longer than usual when a soluble agent such as ether is used. In shock the reverse occurs and the unusually rapid rise in alveolar tension that results may lead to anaesthetics overdose, specialy with the more soluble agents.

VENOUS ANAESTHETIC LEVELS

The last factor which determines uptake is the anaesthetic partial pressure difference between alveolus and returning venous blood the larger this difference, the greater the uptake.

When all tissues are equilibrated with the alveolar anaesthetic partial pressure, there is no difference between anaesthetic partial pressure in the alveoli and in the returning venous blood, and uptake is zero regardless of the solubility or cardiac output. Complete equibilibration occurs only after an infinitly long anaesthetic time. (Gray, Nunn and Utting, 1979)

Central Library - Ain Shams University