Anesthetic Considerations for Major Burn Injury In Pediatric Patients

An Essay Submitted For Partial Fulfillment
Of Master Degree in Anesthesia

By

Muhammad Othman Ali Mehany

M.B.B.Ch. Faculty of Medicine – Ain Shams University

Supervised by

Prof. Dr. Azza Mohamed Shafeek Abd El-Mageed

Professor of Anesthesia and Intensive Care
Faculty of Medicine
Ain Shams University

Dr. Hadeel Magdy Abd El-Hameed Mohamed

Assistant Professor of Anesthesia and Intensive Care
Faculty of Medicine
Ain Shams University

Dr. Rafik Youssef Attalla Banoub

Lecturer of Anesthesia and Intensive Care
Faculty of Medicine
Ain Shams University

Faculty of Medicine
Ain Shams University
2015

Acknowledgement

First of all, I thank Allah *for blessing this work until it has reached its end, as a part of his generous helping throughout my life.*

I would like to express my deep gratitude and appreciation to ***Prof. Dr. Azza Mohamed Shafeek Professor*** *of Anesthesiology and Intensive Care Medicine, Faculty of Medicine, Ain Shams University for her continuous support and supervision.*

I would also like to express my gratitude to ***Dr. HadeelMagdyAbd El-Hameed,*** *Assistant Professor of Anesthesiology and Intensive Care Medicine, Faculty of Medicine, Ain Shams University for her continuous support and supervision.*

I would also like to express my gratitude to ***Dr. Rafik Youssef Attalla,*** *Lecturer of Anesthesiology and Intensive Care Medicine, Faculty of Medicine, Ain Shams University, for his continuous support and supervision.*

Contents

List of Abbreviations

ALT	Alanine transaminase
AST	aspartate aminotransferase
ATP	Adenosine triphosphate
BEAT	Bedside Assessment for Trauma
BSA	body surface area
BUN	blood urea nitrogen
CO	Carbon Monoxide
COHb	carboxy hemoglobin
ETT	endotracheal tube
FIO 2	Fraction of Inspired Oxygen
GFR	glomerular filtration rate
HBO	hyperbaric oxygenation
ICU	intensive care unit
IL	interleukin
LR	Lactated ringer
NMDA	N-methyl-D-aspartate receptor
PICCs	peripherally inserted central catheters
TBSA	total body surface area
TIVA	Total intravenous anaesthesia
TNF	tumor necrosis factor

List of Figures

List of Tables

Introduction

Major burn injury remains a significant cause of morbidity and mortality in pediatric patients. With advances in burn care and with the development of experienced multi-disciplinary teams, many children are surviving severe burn injury***(Alvarado et al, 2012).***

The majority of burns in this age group are from thermal injuries, either from contact with hot liquids or vapors, fires, or from direct contact with hot surfaces. Electrical burns usually cause tissue destruction by direct thermal damage and associated injuries. For chemical burns, the degree of injury depends on the chemical, its concentration, and the duration of exposure***(Shields et al, 2007).***

The severity of burn injury ischaracterized by the depth of the burn, thetotal body surface area **(TBSA)** that is involved, the location of burn injury, and the presence orabsence of inhalation injury**.** In neonates, a smaller TBSA is necessary for a severeburn due tothe immaturity of the organ systems and thesubsequent difficulty in maintaining homeostasis.***(Tekin et al, 2012).***

As members of the multi-disciplinary care team, anesthesia providers are called upon to care for these critically ill children. To provide resuscitation in the initial phase, safe anesthesia even for unstable patients during surgical procedures, and analgesic treatment during the rehabilitative period. For that reason, the anesthetic team must thoroughly understand the pathophysiologic abnormalities associated with burn injury. These abnormalities include metabolic derangements, neuro-humoral responses, massive fluid shifts, sepsis, and the systemic effects of massive tissue destruction ***(Caruso et al, 2012).***

Moreover, they must have special skills in resuscitation, airway management, critical care procedures, care of small children and access to expert advice in the management of non-burn co-morbidity. Knowledge of all of these factors combines to produce a successful outcome ***(Sharma and Parashar, 2010).***

Anatomic and Physiologic Differences Between Children and Adults

Young children do not have thesame physiologic reserves facing thermal injury as adults. Becauseof its physiologic characteristics, the skin barrier is particularlyimportant for the pediatric patient, as the body surface area **(BSA)**-to-weight ratio is greater than in adults. A child, whenburned, will depend more than any other traumatized patient onthe care of many specialists who need to coordinate their efforts toachieve full recovery. The pediatric patient will have similaritieswith his adult counterpart, but some aspects of his responses to injury are distinct ***(Alvarado et al, 2012).***

In adults the burn injury needs to be greater than 30% TBSA of 2^{nd}degree **Figure (1)** to be considered as major burn, in pediatric it needs only 15% of TBSA to be considered as major burn injury **Table (1).*(Tekin et al, 2012).***

Table (1): Definition of major burn injury in pediatric ***(Tekin et al, 2012).***

• Greater than 10% TBSA of third degree burns
• Greater than 15–20% TBSA of second degree burns
• Burn injuries involving the face, hands, feet, or perineum
• Inhalational burn injuries
• Chemical or electrical burns
• Burns with associated trauma
• Circumferential burns, especially of the chest
• Burns in children with concomitant disease

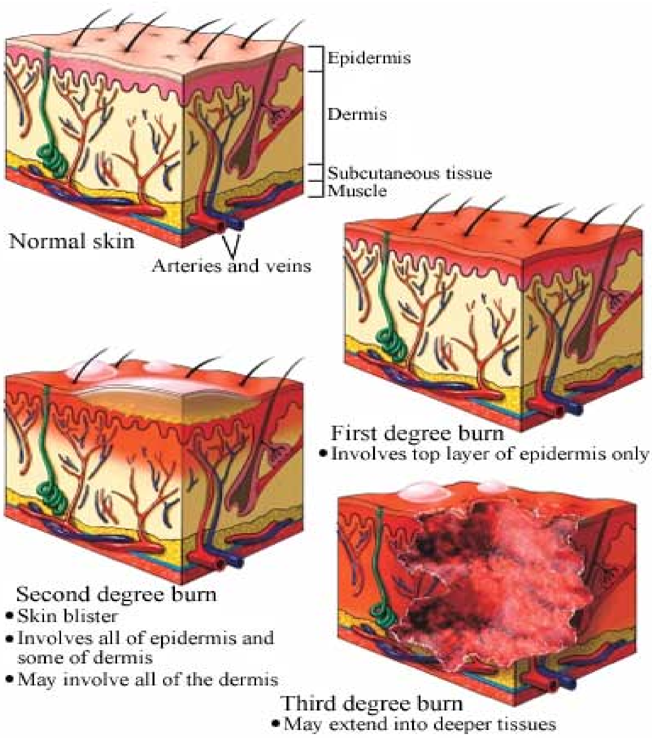

Figure (1): Depth of burn injury ***(Tekin et al, 2012).***

I) Anatomic Differences

Body Size

The most remarkable difference between children and adults is size, but the degree of difference and the variation even within the pediatric age group are hard to appreciate. It makes considerable difference whether body weight, height, or body surface area is used as the basis for size comparison. Body surface area is probably the most important, because it closely parallels variations in basal metabolic rate measured in kilocalories per hour per square meter ***(Susan, 2013).***

The caloric need in relation to BSA of a full-term infant is about 30 kcal/m^2 per hour. It increases to about 50 kcal/m^2 per hour by 2 years of age and then decreases gradually to the adult level of 35 to 40 kcal/m^2 per hour.For clinical use, however, BSA proves somewhat difficult to determine, although formulas **(Table 2)**and a nomogram such as that of Talbot **(Fig.2)** facilitates the procedure significantly***(Sion-Sarid et al., 2013).***

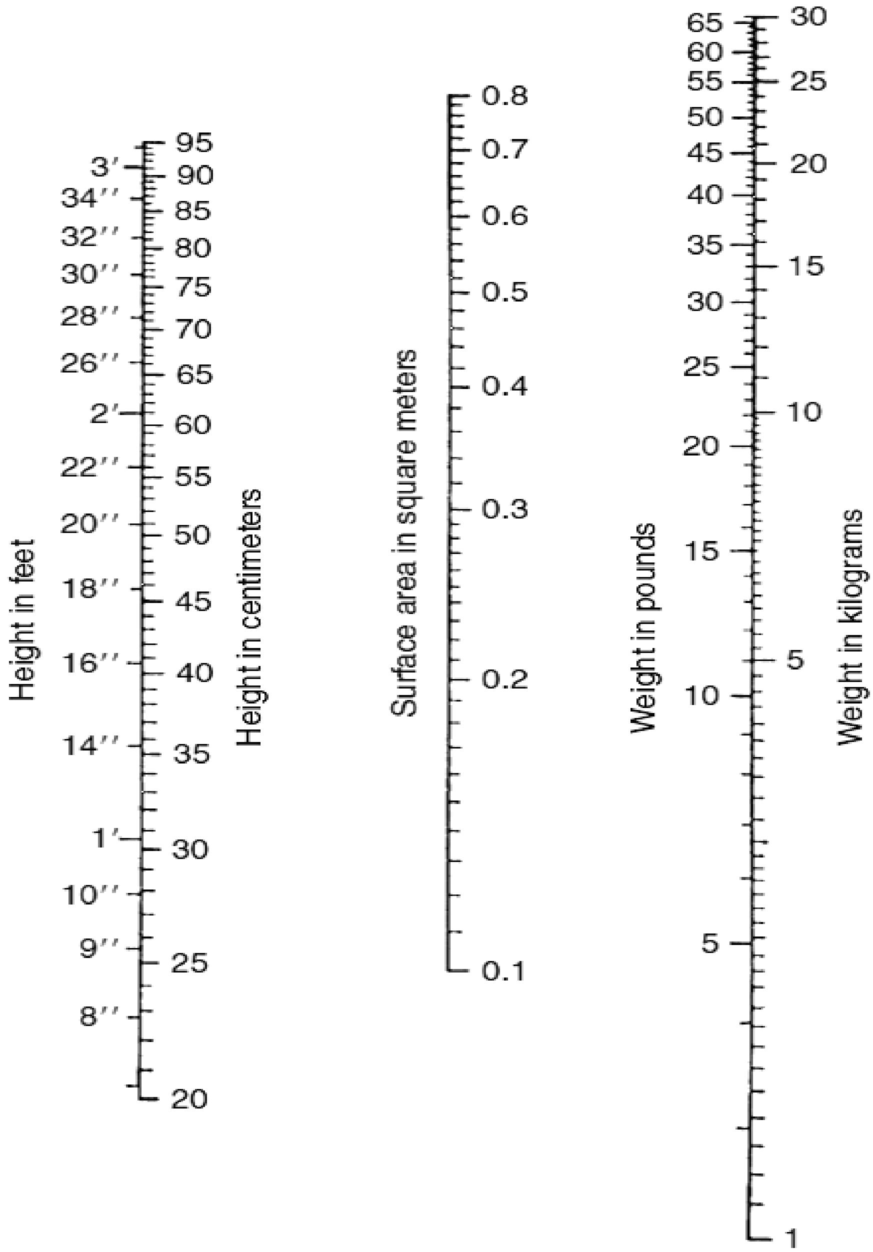
Height in feet
3′
34″
32″
30″
28″
26″
2′
22″
20″
18″
16″
14″
1′
10″
9″
8″
Height in centimeters
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
Surface area in square meters
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Weight in pounds
65
60
55
50
45
40
35
30
25
20
15
10
5
Weight in kilograms
30
25
20
15
10
5
1

Fig. (2): Body surface area nomogram of Talbot for infants and young children. ***(*Sion-Sarid *et al.*, 2013).**

Table (2): Commonformulas to calculate BSA***(*Sion-Sarid *et al.*, 2013)***

DuBois and DuBois	BSA (m^2) = 0.007184 x Height(cm)$^{0.725}$x Weight(kg)$^{0.425}$
Gehan and George	BSA (m^2) = 0.0235 x Height(cm)$^{0.42246}$x Weight(kg)$^{0.51456}$
Haycock	BSA (m^2) = 0.024265 x Height(cm)$^{0.3964}$x Weight(kg)$^{0.5378}$

The total body surface area (TBSA) that is involved in burn injury approximated by the rule of 9’s in adults; however, this rule is not accurate in children because a child’s head size is disproportionably larger than the body as compared with an adult. The TBSA for children of various ages can be approximated as shown in **(Fig.3)**. ***(Szyfelbein et al., 2013)***

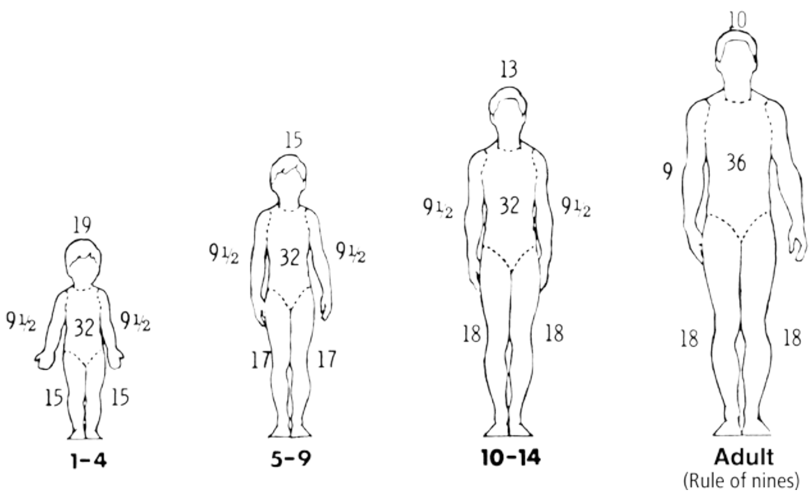

Fig (3): Approximation of total body surface area in pediatric and adult patients (**Szyfelbein et al, 2013)**.

Airway

The upper airway in children is markedly different from that of their adultcounterparts. Children have a larger tongue relative to the size of their mouth,and the mandible is shorter. The epiglottis is larger and narrower.This anatomical variation put the burned child at high risk of airway obstruction***(Adewale, 2009)*.**

The narrowest part of the infant airway is the cricoid cartilage, compared tovocal cords in adults. This circumferential cartilaginous ring is slightly smallerthan the glottis. An endotracheal tube may be passed through the vocal cords,but careless advancement may traumatize the subglottic airway ***(Ángela et al., 2012).***

II) Physiologic Differences

Cardiovascular System

In newborns, the heart rate may have a wide variation that is within normal limits .The mean heart rate in newborns in the first 24 hours of life is 120 beats per minute. It increases to a mean of 160 beats per minute at 1 month, after which it gradually decreases to 75 beats per minute at adolescence. Mean systolic blood pressure in neonates and infants rises from 65 mm Hg in the first 12 hours of life to 75 mm Hg at 4 days and 95 mm Hg at 6 weeks. There is little change in mean systolic pressure between 6 weeks and l year of age; between 1 year and 6 years, there is only a slight change, followed by a gradual rise. **(Table 3)*****(Lemson et al, 2011)***.

The resting cardiac output is two to three times adult values. The relatively large cardiac output may reflect the higher metabolic rate and oxygen consumption compared with adults. And although the stroke volume of neonates is usually fixed and the cardiac output usually increases by increasing heart rate only, the neonate can increase stroke volume up to a point according to the Frank-Starling relationship if the afterload is kept low ***(Andropoulos, 2010).***

Table (3): Normal heart rate and systolic blood pressure as functions of Age***(Lemson et al, 2011).***

Age Group.	HeartRate (beat/min)	Systolic Blood Pressure(mmHG)
Neonate	120-160	60-75
1-6 months	110-140	65-85
6-12 months	100-140	70-90
1-2 years	90-130	75-95
3-5 years	80-120	80-100
6-8 years	75-115	85-105