

PULSE OXIMETRY IN COMPARISON TO ARTERIAL BLOOD OXYGEN SATURATION IN RESPIRATORY DISTRESS IN NEONATES

Thesis By

Marwa Mohamed Mohamed Moro

(M.B., B.Ch)

Submitted for Partial Fulfillment of the MSc Degree in Pediatrics

Under Supervision of

Dr. Samiha Samuel Wissa Doss

Professor of Pediatrics

Faculty of Medicine- Cairo University

Dr. Dalia Sayed Mosallam

Lecturer of Pediatrics

Faculty of Medicine- Cairo University

Dr. Enas Abdallah Ali

Lecturer of Pediatrics

Faculty of Medicine- Cairo University

Faculty of Medicine

Cairo University

2010

Acknowledgement

First of all I thank God for all his giving throughout my life, I thank my family for their continuous support through all the hard and difficult times.

I would like to express my deepest gratitude and thanks to Prof. Dr. Samiha Samuel Wissa Doss Professor of Pediatrics and Chest, Faculty of Medicine- Cairo University, who gave me the honor of working under her supervision and follow up of the progress of this work..

I wish to express my deepest thanks and gratitude to Dr. Dalia Sayed Mosallam, Lecturer of Pediatrics, Faculty of Medicine- Cairo University, for guiding me all through this thesis and revising all my work so I give her all my sincere thanks for her effort and time .

I wish to thank Dr., Enas Abdallah Ali, Lecturer of Pediatrics, Faculty of Medicine- Cairo University, for her great help & for setting the guidelines which I followed throughout this thesis, revising it and all her valuable notes and encouragement.

Dedication

*To my Father and my Mother who
taught me the principles and patience*

To my husband who support me

*To my daughters Razan and
Renad*

To all my professors and colleagues

Contents

	Page
Introduction	1
Aim of the work	
Review of literature	
• Respiratory distress in neonates	4
• Pulse Oximetry	50
• Arterial blood gas	78
Patients and methods	91
Results	97
Discussion	110
Summary	116
Conclusion	118
Recommendations	119
References	120
Arabic summary	

List of tables

Table no	Title	Page
1	Classification on aetiology of persistent pulmonary hypertension in newborn	24
2	Simplified summary of some of the major newborn respiratory conditions	30
3	Degree of Respiratory Distress According to Downes' Scoring System	31
4	Silverman Anderson retraction Score	32
5	ABG Score	33
6	laboratory evaluation for RD in neonates	34
7	Guidelines for monitoring oxygen saturation levels by pulse oximetry	37
8	Timing of surfactant administration	43
9	Comparison with the new generation pulse oximeters	72
10	Factors associated with change pO_2	80
11	list of some of the causes in which (A-a) Po_2 change	80
12	Causes of changes in anion gap	81
13	Difference between arterial and venous blood gases	89
14	Reference ranges for arterial and "arterialized" capillary blood pO_2	90
15	Descriptive data of gestational age, delivery route, maternal illness and medical history of mothers	98
16	Descriptive data of neonates' gender and weight	101
17	Descriptive data of neonates' weight	101
18	Descriptive data of neonates' vital signs	102
19	Descriptive data of ABG	102
20	Descriptive data of SpO_2	102
21	Descriptive data of blood picture analysis	103
22	Descriptive data of Down score	103
23	Descriptive data of chest radiographic findings	103
24	Descriptive data of diagnosis and complications	104
25	Descriptive data of Oxygen devices	105

26	Pearson's correlation coefficient results for the correlation between PO ₂ and SpO ₂ in the whole sample	106
27	Pearson's correlation coefficient results for the correlation between PO ₂ and SpO ₂ in neonates with RDS	106
28	Pearson's correlation coefficient results for the correlation between PO ₂ and SpO ₂ in neonates with diagnoses other than RDS	107
29	Pearson's correlation coefficient results for the correlation between SpO ₂ and different variables in the whole sample	108
30	Means, standard deviation (SD) values and results of Student's t-test for comparison between SpO ₂ in boys and girls	108
31	Means, standard deviation (SD) values and results of Student's t-test for comparison between SpO ₂ in neonates who were delivered through NVD or C.S.	108
32	Means, standard deviation (SD) values and results of Student's t-test for comparison between SpO ₂ in neonates with and without RDS	109

List of figures

		Page
1	Curve reflects findings from lungs obtained at postmortem from an infant with hyaline membrane disease	8
2	Schematic outlines the pathology of respiratory distress syndrome	10
3	Chest radiograph of an infant with respiratory distress syndrome of the newborn	12
4	Chest radiograph of an infant with meconium aspiration syndrome	18
5	Chest radiograph of an infant with transient tachypnea of the newborn	21
6	Diagnostic approach to RD	30
7	Management of Neonatal Respiratory Distress	46
8	Management of Deliveries with Meconium-Stained Amniotic Fluid	47
9	Schematic structure of Haemoglobin	53
10	The Oxyhaemoglobin Dissociation curve	56
11	Sensor device	60
12	Oxygen saturation measured via pulse oximetry	64
13	Disposable low-pressure adhesive attachment clip for sensor placement at the ear lobe.	64
14	A handheld pulse oximeter	65
15	Typical measurement through the finger nail	65
16	Masimo SET (signal extraction technology).	73
17	The principle difference between	76

	transmission and reflectance pulse oximetry	
18	Pie chart representing delivery route in the studied group	99
19	Bar chart representing maternal illness in the studied group	99
20	Bar chart representing mothers' medical history in the studied group	100
21	Pie chart representing gender distribution in the studied group	101
22	Pie chart representing CRP findings in the studied group	103
23	Pie chart representing prevalence of RDS in the studied group	104
24	Pie chart representing Oxygen devices used in the studied group	105
25	Scatter diagram showing positive correlation between SpO ₂ and PO ₂ in the whole sample	109
26	Scatter diagram showing positive correlation between SpO ₂ and PO ₂ in neonates with RDS	109

List of Abbreviations

Abbreviation	Meaning
(A-a) pO ₂	Alveolar-arterial oxygen gradient
A/C	assist/control
ABG	Arterial blood gas analysis
AC	pulsatile component
AGA	Appropriate for gestational age
AR	Arterial blood
BE	The base excess
BPD	bronchopulmonary dysplasia
C -XR	Chest X-ray
CBC	Complete blood count
CHD	Congenital Heart Disease
CNS	Central nervous system
CO Hb	carboxyhemoglobin.
COPD	Chronic obstructive lung disease
CPAP	Continuous Positive Airway Pressure
CRP	C-reactive protein
DC	non-pulsatile components
DKA	Diabetic ketoacidosis
DST	Discrete Saturation Transform Algorithm
ECG	Electrocardiography
FIO ₂	fraction of inspired oxygen
FRC	functional residual capacity
GBS	group B streptococci
GIT	Gastrointestinal tract
HCO	Bicarbonate
HFOV	High-frequency oscillatory ventilation
HMD	Hyaline Membrane Disease
HR	heart rate
HRPO	High resolution pulse oximetry
IEM	Inborn Errors of Metabolism
IPPV	Intermittent positive pressure ventilation
IV	Intravenous
LEDs	Light emitting diodes
MAS	Meconium Aspiration Syndrome
MetHb	methemoglobin
NICU	Intensive Care Unit
NV	Nasal ventilation
O ₂ Hb	oxyhaemoglobin

PaCO ₂	Arterial carbon dioxide partial pressure
PCV	packed cell volume
PDA	patent ductus arteriosus
PO	Pulse oximetry
pO ₂	Partial oxygen pressure
PPHTN	Persistent Pulmonary Hypertension of the Newborn
PSV	pressure support ventilation
PTV	Patient-triggered ventilation
RD	Respiratory distress
RDS	Respiratory distress syndrome
RHb	Reduced haemoglobin or deoxyhaemoglobin
RPO	Reflectance pulse oximetry
RTA	Renal tubular acidosis
RV	Venous blood
SaO ₂	Arterial oxygen saturation
SD	Standard deviation
SET	Signal Extraction Technology
SIM	synchronized intermittent mandatory ventilation
SpO ₂	Saturation of peripheral oxygen
TPO	Traditional pulse oximetry
TTN	Transient Tachypnoea of the Newborn PPHN
USG	ultrasonography
V/Q	ventilation-perfusion

ABSTRACT

OBJECTIVE. Our aim was to define the relationship of PaO₂ and pulse oxygen saturation values in newborn with respiratory distress to evaluate whether pulse oxygen saturation value related to PaO₂. **METHODS.** Prospective comparison of PaO₂ and pulse oxygen saturation values in 80 patient was performed. The PaO₂ measurements were obtained from blood gas analyzer; simultaneous pulse oxygen saturation values were recorded. **RESULTS.** We evaluated PaO₂/ pulse oxygen saturation values in 80 neonates. Of the 80 samples, 30 (37.5 %) of cases were breathing supplemental oxygen by CPAP, 27 (33.7 %) of cases were on nasal prong, 21 (26.3 %) were on ventilator and 2 (2.5 %) were on head box. A mean pulse oxygen saturation of (90.7 ± 7.1%) and the mean PaO₂ of (64.9 ± 15.9) mmHg. there was a statistically significant positive (direct) correlation between PO₂ and SpO₂. An increase in PO₂ is associated with an increase in SpO₂ (p<0.001). **CONCLUSIONS:** pulse oximetry measured from neonates and infants with respiratory distress syndrome shows statistically significant positive (direct) correlation with PO₂ .

KEY WORDS

PULSE

RESPIRATORY

ARTERIAL

INTRODUCTION

Respiratory distress syndrome (RDS) of the newborn, also known as infant RDS is an acute lung disease present at birth. It is a syndrome caused in preterm infant by developmental insufficiency of surfactant production and structural immaturity in the lung. It can also result from a genetic problem with the production of surfactant associated proteins. RDS affects about 1% of newborn infants and is the leading cause of death in preterm infants. The incidence decreases with advancing gestational age (*Rodriguez et al., 2002*).

High-risk infants require prompt attention by a neonatal resuscitation team (*Cole, 2006*).

Despite greatly improved RDS treatment in recent years, many controversies still exist. Neonates are given warm, moist oxygen. This is critically important, but needs to be given carefully to reduce the side effects associated with too much oxygen (*Courtney, 2007*).

Pulse oximetry is a non invasive, medical device that indirectly measures the oxygen saturation of a patient's blood, it is often attached to a medical monitor so staff can see a patient's oxygenation at all times. Most monitors also display the heart rate. Portable, battery-operated pulse oximeters are also available for home blood-oxygen monitoring (*Brand et al., 2002*).

Pulse oximetry is not invasive, easy to use, has no side effects, is accurate and allows continuous monitoring and is the preferred method of oxygen monitoring in neonates (*Mower et al., 1997*).

An arterial blood gas (ABG) is a blood test that is performed using blood from an artery. ABG testing is used to determine the pH of the blood, the partial pressure of carbon dioxide and oxygen (PaO_2), and the bicarbonate level (*Baillie, 2008*).

Portable pulse oximeters are now widely available for the assessment of arterial oxygenation, and the United State Medicare Program considers saturation readings to be acceptable substitutes for arterial PO_2 in selecting patients for long-term oxygen therapy. Current oximeters are reasonably accurate (plus or minus 4 or 5 percent of the co-oximetry value) in assessing patients for desaturation during exercise, for sleep studies, and for in-home monitoring (*Pierson, 2007*).

AIM OF THE WORK

Our aim was to define the relationship of PaO_2 and pulse oxygen saturation values during routine clinical practice.