Impact of PICU Admission on Neurocognitive Function in Children

Thesis

Submitted for Partial Fulfillment of Master Degree

In Pediatrics

By:

Sara Mohamed Nabil Al-Saeed

M.B, B.Ch, 2012

Faculty of Medicine – Ain Shams University

Under Supervision of

Prof. Rasha Hussein Aly

Professor of Pediatrics

Faculty of Medicine - Ain Shams University

Dr. Ahmed Rezk Ahmed

Lecturer of Pediatrics

Faculty of Medicine - Ain Shams University

Dr. Raghda Mohamed Hesham Zaitoun

Lecturer of Pediatrics

Faculty of Medicine - Ain Shams University

Faculty of Medicine

Ain Shams University

2019

سورة البقرة الآية: ٣٢

Acknowledgment

First and foremost, I feel always indebted to **ALLAH,** *the Most Kind and Most Merciful.*

I'd like to express my respectful thanks and profound gratitude to **Prof. Rasha Hussein Aly,** *Professor of Pediatrics Faculty of Medicine - Ain Shams University for her keen guidance, kind supervision, valuable advice and continuous encouragement, which made possible the completion of this work.*

I am also delighted to express my deepest gratitude and thanks to **Dr. Ahmed Rezk Ahmed,** *Lecturer of Pediatrics Faculty of Medicine - Ain Shams University, for his kind care, continuous supervision, valuable instructions, constant help and great assistance throughout this work.*

I am deeply thankful to **Dr. Raghda Mohamed Hesham Zaitoun,** *Lecturer of Pediatrics Faculty of Medicine - Ain Shams University, for her great help, active participation and guidance.*

Sara Mohamed Nabil Al-Saeed

List of Contents

List of Tables

List of Tables Cont...

List of Figures

List of Abbreviations

Abb.	Full term
ARDS	Acute respiratory distress syndrome
BAL	bronchoalveolar lavage
CAP	Community-acquired pneumonia
CHC	Chronic health condition
C-TONI-2	Comprehensive Test of Nonverbal Intelligence, Second Edition
DAS-II	Differential Ability Scales, Second Edition
DAS-II	Differential Ability Scales, Second Edition
DKA	Diabetic ketoacidosis
DM1	Diabetes mellitus
DP-3	Developmental Profile 3
GCC	Gulf Corporation Council Countries
HAP	Hospital-acquired pneumonia
HCC	Hospital da Crianca Conceicao
HRQoL	Health-related quality of life
ICU	Intensive care unit
ICUs	Intensive care units
ISPAD	International Society for Pediatric and Adolescent Diabetes
JUSH	Jimma University Specialized Hospital
KBIT-2	Kaufman Brief Intelligence Test, Second Edition
Leiter-III	Leiter International Performance Scale, Third Edition
NBL	Non-bronchoscopic lavage
PICU	Patients admitted to the pediatric ICU
PIQ	Performance Intelligence Quotient
QOL	Quality of life
RIAS	Reynolds Intellectual Assessment Scales

List of Abbreviations Cont...

Abb.	Full term
SB-5	Stanford Binet Intelligence Scales, Fifth Edition
SIT-R3	Slosson Intelligence Test-R3
TIQ	Total Intelligence Quotient
UNIT	Universal Nonverbal Intelligence Test
VIQ	Verbal Intelligence Quotient
VIQ	Verbal IQ
WASI-II	Wechsler Abbreviated Scale of Intelligence, Second Edition
WISC-V	Wechsler Intelligence Scale for Children, Fifth Edition
WJ IV-COG	Woodcock Johnson IV Tests of Cognitive Abilities
WNV	Wechsler Nonverbal Scale of Ability
WPPSI-IV	Wechsler Preschool and Primary Scale of Intelligence, Fourth Edition
WRIT	Wide Range Intelligence Test

INTRODUCTION

Patients admitted to the pediatric ICU (PICU) often have complex conditions. Respiratory illnesses are the most common diagnoses. Trauma, post-surgical care, infection, and fluid and electrolyte derangements are also reported as frequent diagnoses in unplanned PICU admissions. Childhood-onset chronic conditions, including congenital heart abnormalities, cerebral palsy, and chromosomal abnormities, have been reported in 53% of children admitted to PICU ***(Krmpotic and Lobos, 2013).***

Increasing numbers of patients survive a critical care admission, but many of them develop morbidities, including cognitive impairments, that have devastating consequences. Cognitive impairment affects 10–62 % of ICU survivors, with most studies reporting deficits in a third to half of patients. Variability in the prevalence of cognitive impairments across studies is explained by heterogeneity in assessments (questionnaires, cognitive screening tests, or neuropsychological test batteries) and variable follow-up intervals. While some patients have prior cognitive impairment, critical illness results in de novo cognitive deficits in previously healthy individuals ***(Wolters et al., 2013).***

New or worsening cognitive impairment appears more prevalent in the critically ill than in other hospitalized patients. For example, one study found significantly higher odds of cognitive impairment after severe sepsis, compared to hospitalized patients without sepsis**.** It is unclear if a "dose

response" exists pertaining to the relationship between severity of illness and severity of cognitive impairment, although numerous studies have found that traditional markers of illness severity are not predictive of cognitive deficits or cognitive decline ***(Iwashyna et al., 2010)***.

Cognitive impairments occur regardless of diagnosis on admission to the ICU. In cases of profound critical illness such as ARDS and sepsis, cognitive impairments occur in 20–56 % of ARDS survivors ***(Herridge et al., 2016)*** and 16–40 % of patients with sepsis ***(Maley and Mikkelsen, 2016).***

Post-ICU cognitive impairments occur in the domains of attention, processing speed, memory, and executive function, but important other domains, such as language, have received less study. Cognitive impairments across multiple domains suggest that critical illness results in diffuse brain injury ***(Hopkins et al., 2016).***

Cognitive impairment is a serious problem, with devastating consequences for ICU patients and their families, which needs increased recognition and action from both clinicians and researchers ***(Jackson et al., 2012).***

It can thus be inferred that several studies have already documented the occurrence of persistent cognitive dysfunction among adult patients who have received intensive care for life threatening illnesses, yet little is known about it in children.

Aim of the Work

The aim of this work is to study the impact of admission to a pediatric intensive care unit (PICU) on children's neurocognitive performance.

Chapter 1

COGNITIVE DEVELOPMENT IN CHILDREN

Cognitive development is a field of study in neuroscience and psychology focusing on a child's development in terms of information processing, conceptual resources, perceptual skill, language learning, and other aspects of brain development and cognitive psychology compared to an adult's point of view. In other words, cognitive development is the emergence of the ability to think and understand. It can also be called intellectual development. There are several main types of theories of child development. Stage theory (Piaget's cognitive development theory), focus on how children progress through qualitatively different stages of development. Sociocultural theory (Lev Vygotsky's theory), emphasize how other people and the attitudes, values, and beliefs of the surrounding culture, influence children's development ***(Blackemore & Choudhury, 2006)***.

Jean Piaget was a major force in the establishment of the field of cognitive development. Piaget proposed four stages of cognitive development: the *sensorimotor*, *preoperational*, *concrete operational* and *formal operational* period***(Booth & Siegler, 2006)***.

Piaget's Theory of cognitive development:

Piaget believed that all children progress through these aformentioned four stages and that do so in the same order. During each stage of cognitive development there is a unique level of analysis, internal organization and understanding of environmental information and events. Piaget's theory shows that the child's understanding is dependent on the stage that he/she has reached and teachers ought to take this into account when they teach learners at different levels of intellectual development ***(Bukatku & Daehler, 1995).***

The four stages of cognitive development according to Piaget:

1) The sensorimotor Stage (from birth to 2 years):

The sensorimotor stage is the first stage in the growth and development of a child. It is the stage where the child acquires language, which enhances their social and intellectual development. The child's schema is simple and limited to what the child can explore through the body and senses ***(Lazarus, 2010).***

2) The preoperational stage (ages two to about seven years):

In this stage the child is able to reason and give a logical train of thoughts. The child uses objects and symbols to represent something that exists in a concrete form. For example, a child would play with a car as if was a real car. This

stage also represents the development of semiotic functions, which further develops his/her language. Children's vocabulary increases and their sentences progress from one and two word phrases to complete full sentences. During this stage the child's language, thinking, imagination and problem solving develop faster as child can work with images and symbols. The child can recognize the properties of objects even if these objects changed around and look different. The child at this stage finds it too difficult not to accept the evidence in front of their eyesChildren can take in other points of view, and take into account more than one perspective. The pre-operational stage child can be characterized by the, animism, egocentrism, transductive reasoning, syncretism, lack of decentering, lack of classification, lack of seriation and conservation skills and the rapid acquisition of language ***(Lazarus, 2010).***

3) The concrete operational stage(from seven to eleven years):

In this stage the child is capable of using logical processes of reasoning on the basis of concrete evidence. Children who attain formal operations are said to reason in terms of theories and abstractions, as well as concrete realities. It is in this stage that problem solving and reasoning is powerful enough to last the rest of life. The child is capable of creating logical structures that explain his or her physical experiences. Abstract problem solving is also possible at this stage. For example, arithmetic equations can be solved with numbers, not just with objects. The child becomes capable of