Intensive Care Unit Acquired Weakness and Recovery From Critical Illness

Essay

Submitted for Partial Fulfillment of Master Degree in General Intensive Care

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2017

Abstract

Introduction: Intensive care unit-acquired weakness (ICU-AW) is an increasingly complication of survivors of critical illness. It should be suspected in the presence of a patient with a flaccid tetraparesis or tetraplegia with hyporeflexia or absent deep tendon reflexes and difficult to weaning from mechanical ventilation in the absence of different diagnoses. Important risk factors are age, sepsis, illness duration and severity, some drugs (neuromuscular blockers, steroids). Electrophysiological studies have shown an axonal damage of involved peripheral nerves (critical illness polyneuropathy). However, muscle can also be primitively affected (critical illness myopathy) leading to ICUAW with inconstant myopathic damage patterns in electromyographic studies. Mixed forms can are present (critical illness polyneuromyopathy. Although the pathophysiology remains obscure, the hypothesis of an acquired channelopathy is substantial. Electroneuromyography is crucial for diagnosis. Muscular and nerve biopsy are necessary for diagnosis confirmation. Aggressive treatment of baseline disease, prevention, through avoiding or minimizing precipitating factors, strict glycemic control, and early rehabilitation combining mobilization with physiotherapy and muscle electrical muscle stimulation, are the keys to improving recovery of the affected individuals.

Objectives: The aim of this essay is to review the incidence, risk factors, pathophysiology of intensive care unit acquired weakness as well as its management to improve outcome of ICU survivors.

Data soursees: Med line database (PubMed. Medscape. Science Direct0, and all materials available in the internet till 2017.

Study Selection: This search presented 120 articles. The articles studied the types, pathophysilogy, recovery ,and prevention of Intensive Care Unit Acquired Weakness (ICUAW).

Data Extraction: If the studies did not fulfill the inclusion criteria they were excluded study quality assessment included whether ethical approval was gained eligibility, criteria specified appropriate controls ,adequate information and defined assessment measure.

Conclusion: ICU acquired weakness (ICUAW) represents a severe and frequent complication of critical illness. It is believed that ICUAW can affect more than half of all ICU patients. This major neuromuscular complication of critical illness is associated with increased rates of morbidity and mortality, markedly affecting both short-term and long-term clinical outcomes in critically ill patients**.**

Key words: ICU acquired weakness, Critical illness polyneuropathy, Critical illness myopathy.

First of all, thanks to Allah whose magnificent help was the main factor in completing this work.

No words can express my deep sincere feelings Towards **Prof Dr. Amr Essam El-Din Abd El-Hamid,** Professor of Anesthesia and Intensive Care Medicine and Pain Management, Faculty of Medicine-Ain Shams University for his continuous encouragement, guidance and support he gave me throughout the whole work. It has been a great honor for me to work under his generous supervision.

I would like to express my deepest appreciation, respect and thanks to **Prof Dr. Waleed Abdalla Ibrahim Ahmed**,lecturer of Anesthesia and Intensive Care Medicine and Pain Management, Faculty of Medicine-Ain Shams University, for his continuous guide in all aspects of life beside his great science, knowledge and information.

I would like to express my deepest appreciation, respect and thanks to **Dr. Mohammed Mahmoud Maarouf,** Lecturer of Anesthesia and Intensive Care Medicine and Pain Management, Faculty of Medicine-Ain Shams University, for his continuous guide in all aspects of life beside his great science, knowledge and information.

Last but not least, sincere gratitude to ***My Family*** for their continuous encouragement and spiritual support.

Contents

List of Abbreviations

ACTH : Adrenocorticotropic hormone

AKT : Aserine-threonine protein kinase

ARDS : Acute respiratory distress syndrome

BNB : Blood nerve barrier

CHF : Congestive heart failure

CIM : Critical illness myopathy

CINM : Critical illness neuromyopathy

CIP : Critical illness polyneuropathy

CMAPs : Compound motor action potentials

COPD : Chronic obstructive pulmonary disease

CSF : Cerebrospinal fluid

CT : Computed tomography

DM : Diabetes mellitus

ECMO : Extracorporeal membrane oxygenation

EEG : Electroencephalography

EMG : Electromyography

FoxO : Forkhead box O

FVC : Forced vital capacity

ICU : Intensive care unit

ICUAW : Intensive Care Unit Acquired Weakness

IGF-1 : Insulin-like growth factor 1

IL-1β : Interleukin-1β

MIP : Maximum inspiratory pressure

MRC : Medical Research Council

MRI :Magnetic resonance imaging

MUPs :Motor unit potentials

MuRF1 : Muscle-specific RING finger protein-1

NF-KB : Nuclear factor-KB

NMBAs : Neuromuscular blocking agents

NMES : Neuromascular electrical stimulation

nNOS : Neuronal Nitric oxide synthase

NO : Nitric oxide

PCIS : Post-intensive care syndrome

PGCa : Proliferator-activated receptor coactivatore-1a

PI3K : Phosphatidylinositol-3 kinase

PICS : Post-intensive care syndrome

PMCA : Plasma membrane Ca^{2+} ATPase

PTSD : Post-traumatic stress disorder

ROM : Range of motion

ROS : Reactive oxygen species

RyR1 : Ryanodine receptor calcium release channel

SERCAs : Sarcoplasmic reticulum Ca21-ATPase channels

SIRS : Systematic inflammatory response syndrome

SNA : Sympathetic nerve activity

SNAPs : Sensory nerve action potentials

SR : Sarcoplasmic reticulum

TNFα : Tumor necrosis factor-α

UPS : Ubiquitin–proteasome system

VO_2 : Oxygen delivery

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Introduction

Intensive Care Unit Acquired Weakness (ICUAW) has been recognized as an important and persistent complication in survivors of critical illness. ICUAW is clinically detected weakness in critically ill patients in whom there is no possible etiology other than critical illness ***(Lee and Eddy, 2012)***.

Intensive care unit acquired weaknesses are classified into: Critical Illness Polyneuropathy (CIP). Critical Illness Myopathy (CIM), and critical illness polyneuromyopathy; patients with CIM are further sub-classified according to histopathology to cachectic myopathy, thick filament myopathy, and necrotizing myopathy ***(Stevens et al., 2009)***.

The exact incidence of ICUAW is unknown; estimates range from 33% to 57% of patients staying in ICU for longer than seven days. It is characterized by profound muscle weakness, diminished or absent deep tendon reflexes and is associated with delayed weaning from mechanical ventilation, suggesting a possible relationship between limb and respiratory neuromuscular involvement ***(Johnson, 2007)***.

The importance of ICUAW is supported by the observation that muscle wasting and weakness are among the most prominent long-term complications of survivors of acute respiratory distress syndrome (ARDS) ***(Puthucheary et al., 2010).***

In addition, a strong association appears to exist between acquired weaknesses and protracted ventilator dependence, an important determinant of ICU length of stay ***(Herridge, 2002).***

Aim of the Essay

The aim of this essay is to review the incidence, risk factors, pathophysiology of intensive care unit acquired weakness as well as its management to improve outcome of ICU survivors.

Chapter 1:

Types and Pathophysiology of Intensive Care Unit Acquired Weakness

Intensive Care Unit Acquired Weakness (ICUAW) is syndrome of generalized limb weakness that develops while the patient is critically ill and for which there is no alternative explanation other than the critical illness itself **(*Lee and Eddy, 2012*)**.

Over the past decade, studies have revealed that a significant proportion of survivors of critical illness suffer from profound neuromuscular weakness and consequent impairment in functional status and quality of life. Immobility, deep sedation, and inflammation likely contribute to the development of intensive care unit acquired weakness (ICUAW***) (Fan, 2013).***

The first reported cases of flaccid paralysis from peripheral neuropathy following sepsis was documented by Bolton et al., in 1984, in patients unable to wean from mechanical ventilation. Since then numerous case series and observational studies of ICUAW have led to an

explosion in the number of terms used to describe this syndrome **(*Bolton, 2005).***

ICUAW is clinically detected weakness in critically ill patients in whom there is no etiology other than critical illness. Patients with ICUAW are then classified into those with critical illness polyneuropathy (CIP), critical illness myopathy (CIM), critical illness neuromyopathy (CINM). Those with (CIM) are further subclassified histologically into: cachectic myopathy, thick filament myopathy, and necrotizing myopathy ***(Stevens et al., 2009).***

ETIOLOGY OF ICUAW:

Prolonged immobility leads to decreased muscle protein synthesis, increased muscle catabolism, and decreased muscle mass, especially in the lower extremities. These changes manifest as reduced cross-sectional muscle area and decreased contractile strength. More over, there is a general shift from slow twitch (type I) to fast twitch (type II) muscle fibers, leading to reduced muscle endurance. Experiments in healthy volunteers reveal that muscle atrophy begins within hours of immobility, resulting in a 4–5% loss of muscle strength for each week of bed rest ***(Puthucheary et al., 2010).***