

**THE IMPLEMENTATION OF AN
INDIVIDUALISED CONTINUOUS POSITIVE AIRWAY
PRESSURE PROGRAMME
IN
PREPARATION
OF THE INTUBATED ADULT PATIENT
FOR EXTUBATION**

CANDIDATE

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A dissertation submitted to the Faculty of Health Sciences, University of Witwatersrand, Johannesburg, in fulfilment of requirements for the degree of Masters of Science.

Johannesburg 2012

DECLARATION

I, Wilma A Erasmus, declare that this dissertation is my own work and is submitted for the degree of Masters of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

A handwritten signature in black ink, appearing to be 'W.A. Erasmus', written on a light-colored background.

Signature

07.day of March 2012

ABSTRACT

Background

The detrimental effects of prolonged mechanical ventilation (MV) on the respiratory muscles, especially the diaphragm, are well documented and it is crucial that MV should be discontinued as soon as possible to prevent added complications and additional risks to patients with critical illness. The spontaneous breathing stage of MV can be managed as a rehabilitation and conditioning phase for the respiratory muscles due to the fact that the respiratory muscles are more active during this stage of MV. Weaning strategies that provide insufficient respiratory work, too high a respiratory muscle load or insufficient respiratory muscle rest may lead to respiratory muscle fatigue and consequently failed weaning and extubation. The aim of this research project was to develop an individualised continuous positive airway pressure (CPAP) weaning programme and test its effects on the outcomes of extubation in the adult ventilated patient.

Method

An experimental, prospective, non-randomised, sequential study of two groups of subjects was performed. Forty eight subjects [group one: n =24 (control) and group two: n = 24 (intervention)], who were mechanically ventilated for longer than 48 hours, in an open adult, general intensive care unit were recruited. Subjects in the control group were weaned according to the standard weaning programme of the test setting at the time; and those in the intervention group were weaned according to an individualised CPAP programme. This weaning programme was developed utilising three principles of muscle rehabilitation namely; daily stepwise progression, sufficient rest and recovery periods and adapted to the individual needs and progression of each subject. Objective measurements such as the rapid shallow breathing index (RSBI), RSBI rate and the maximum inspiratory pressure (MIP) were used to determine the subjects in group two's readiness for a spontaneous breathing trial. The primary outcomes assessed were time spent in the different stages of MV, rate of failure to sustain spontaneous breathing in stage 3 of MV, successful extubation and mortality rate.

Results and Discussion

The difference in rate of failure to sustain spontaneous breathing between the two groups was statistically significant ($p = 0.01$) with 10 events of failure in group one and three in group two. The rate of successful extubation from MV between groups one and two was 70.8% and 91.7%

respectively ($p=0.52$). The mortality rate was 33.3% for group one and 8.3% for group two ($p = 0.02$).

The difference in the total time spent on MV (days) did not differ significantly (group one = 8.6 (± 0.40) days; group two = 9.3 (± 0.32) days; $p = 0.75$).

The results yielded from this study suggest that the use of a multidisciplinary team model and an individualised CPAP programme aids successful extubation from MV as the success rate was much higher in the intervention group than in the control group without adding additional time on MV.

Conclusion

Results from this study showed that the implementation of an individualised CPAP programme during the spontaneous breathing stage of MV may improve the outcomes of extubation in adult ventilated patients.

Keywords: prolonged mechanical ventilation, continuous positive airway pressure, respiratory muscle testing, extubation, rapid shallow breathing index, rapid shallow breathing index rate, maximum inspiratory pressure, low frequency fatigue.

DEDICATION

This dissertation is dedicated to my mother: **Annetjie van Rooyen** (02/01/1928 – 16/10/1988) who believed that education and knowledge is the only inheritance that nobody can ever take away from anyone.

“Dankie, Mamma dat jy altyd in my geglo en my altyd ondersteun het.”

ACKNOWLEDGEMENTS

I would like to thank the following people:

- My supervisor Dr Heleen van Aswegen for her encouragement aswell as her constructive supportive criticism and help during the last 3 years.
- My co-supervisor Dr Shelley Smollgruber for her gentle and supportive help.
- The staff of the Physiotherapy Department of The University of the Witwatersrand for their encouragement.
- The staff and management of Cosmos Life Hospital Adult ICU, Witbank, South Africa for their help, patience and dedication during the research period.
- Sister Corne Potgieter for her help as Research Assistant in the data collection.
- The staff of Erasmus Physiotherapists Inc. for their help, support, encouragement and patience during the research period.
- Peta-Schmidt and Amanda Orme for their assistance in perusing the dissertation and their help in grammar and spelling corrections.
- Prof P Bekker for the South African Medical Research Council for his help with the statistical analysis.
- The South African Society of Physiotherapy for funding assistance.
- Last but not least my wonderful husband, Nicky Erasmus for his patience, love and support.

FUNDING

Financial support for this study was received from the following institutions:

1. South African Society of Physiotherapy Research Foundation Fund.
2. Erasmus Physiotherapy Incorporated, Witbank.

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LIST OF ABBREVIATIONS

10RM	- Ten Repetition Maximum
ABG	- Arterial Blood Gases
AHCPR	- Agency for Health Care Policy and Research
ARDS	- Acute Respiratory Distress Syndrome
ARV	- Anti Retroviral
ATC	- Automatic Tube Compensation
ATP	- Adenosine Triphosphate
ATPase	- Myosin Adenosine Triphosphate
b/min	- Breaths per Minute
b/min/l	- Breaths per Minute per Litre
BP	- Blood Pressure
CI	- Confidence Interval
CIM	- Critical Illness Myopathy
CIP	- Critical Illness Polyneuropathy
cmH ₂ O	- Centimetre of Water
CMV	- Controlled Mechanical Ventilation
COPD	- Chronic Obstructive Pulmonary Disease
CPAP	- Continuous Positive Airway Pressure
DAPRE	- Daily Adjustable Progressive Resistive Training
DNA	- Deoxyribonucleic Acid
ELISA Test	- Enzyme-Linked Immunosorbent Assay Test
f/V _T	- Frequency to Tidal Volume
FiO ₂	- Fraction of Inspired Oxygen
FT	- Fast Twitch
H ₂ O	- Water
HAP	- Hospital Acquired Pneumonia
HFF	- High Frequency Fatigue
HIV/AIDS	- Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HR	- Heart Rate
ICU	- Intensive Care Unit
IMST	- Inspiratory Muscle Strength Training
Krebs's Cycle	- Tricarboxylic Acid Cycle

ℓ/minute	- Litres per Minute
M	- Mean
MIP	- Maximum Inspiratory Pressure
mmHg	- Millimetre Mercury
MSV	- Maximum Sustainable Ventilation
MV	- Mechanical Ventilation
MVV	- Maximum Voluntary Ventilation
n	- Number of Subjects
O ₂	- Oxygen
PaCO ₂	- Partial Pressure of Carbon Dioxide in Arterial Blood
PaO ₂	- Partial Pressure of oxygen in Arterial Blood
Pdi	- Transdiaphragmatic Pressure
PEEP	- Positive End Expiratory Pressure
Pemax	- Maximum Expiratory Pressure
Pes	- Oesophageal Pressure
Pga	- Gastric Pressure
Pimax	- Maximum Static Inspiratory Pressure
REM	- Rapid Eye Movement
RR	- Respiratory Rate
RSBI	- Rapid Shallow Breathing Index
RV	- Residual Volume
S _a O ₂	- Saturation of Haemoglobin with Oxygen in Arterial Blood
SBT	- Spontaneous Breathing Trial
SD	- Standard Deviation
ST	- Slow Twitch
VAP	- Ventilator Associated Pneumonia
VC	- Vital Capacity
VO _{2max}	- Oxygen Consumption and Maximum Exertion
Vti	- Inspiratory Tidal Volume
WOB	- Workload of Breathing

LIST OF NORMAL VALUES

Heart Rate	:	60 - 100/min
Maximum Expiratory Pressure	:	100 cm/H ₂ O
Maximum Inspiratory Pressure	:	-100 to - 70 cmH ₂ O
Partial Pressure of Carbon Dioxide in Arterial Blood	:	35 - 45mmHg
Partial Pressure of Oxygen in Arterial Blood	:	80 - 100mmHg
Respiratory Rate	:	10 - 20/min
Rapid Shallow Breathing Index	:	< 100b/min/l
Rapid Shallow Breathing Index Rate	:	< - 20% of RSBI
Saturation of Haemoglobin with Oxygen in Arterial Blood	:	95%-98%
Oxygen Consumption and Maximum Exertion	:	> 25ml/kg/min
Inspiratory Tidal Volume	:	10ml/kg
Workload of Breathing	:	0.3 - 0.5kg.m/min

DEFINITIONS

Stages of Mechanical Ventilation Weaning Used in This Study

Stage 1: Maximum mechanical ventilation support stage: Starts from the time of intubation, with maximum mechanical ventilation support, according to the needs and symptoms of the patient.

Stage 2: Weaning stage: Starts with the progressive weaning of the level of assisted breathing support provided, by gradually decreasing pressure support, ventilator rate, fraction of inspired oxygen, trigger flow and/or positive end expiratory pressure and redirecting the work to the patient.

Stage 3: Spontaneous breathing stage: Spontaneous breathing can be achieved by putting the patient on a T-piece with oxygen flow-by (without the support of airway pressure) or a T-piece with oxygen flow-by with a PEEP valve attached to the end of the oxygen tubing or on continuous positive airway pressure (CPAP) mode on the ventilator, alternated with periods of assisted mechanical ventilation.

Stage 4: Extubation or liberation from mechanical ventilation: Extubation from mechanical ventilation is done by either extubation or by continuous tracheal oxygen mask and/or T-piece without any mechanical ventilatory support