The profile of a surgical ICU in a public sector tertiary hospital in South Africa

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Opgedra aan Susan, Cobus en Christi

DECLARATION

"I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it for any degree or examination at any university. This study has been approved by the research Ethics Committee of the Faculty of Health Sciences, University of Stellenbosch, protocol number 2003/055/N."

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My colleagues

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Pectora roborant cultus recti

ABSTRACT

Objective: To describe the baseline data of a surgical ICU in South Africa before the implementation of an evidence-based physiotherapy practice protocol. ***Design:*** Prospective cohort observational study ***Setting:*** Ten-bed closed surgical unit in a university affiliated tertiary hospital. ***Patients:*** All adult ICU admissions from 16 June - 30 September 2003. ***Measurements:*** The patient's clinical data including demographic information, admission diagnosis, surgery classification and co-morbidities were recorded on admission to the unit. APACHE II score was calculated. The physiotherapy techniques, positions and functional activities used, the frequency and duration of physiotherapy treatment sessions, the provision of after-hours service and the diagnosis of pulmonary complications were also recorded daily. The time of mechanical ventilation was calculated and the number of re-intubations documented. The ICU length of stay or mortality was recorded. ***Results:*** 160 patients were admitted. Patients were 49 +/- 19.95 years of age. The mean APACHE II score was 12.3 +/ 7.19 and a 12.3% mortality was observed. Thirty seven percent of patients were admitted to the unit following elective surgery. Patients stayed in the unit for 5.94 +/- 6.55 days. Hypertension was the most frequent co-morbidity found in this cohort (42%), and 21% of patients tested, tested positive for HIV. Co-morbidities had no significant association with ICU LOS or mortality. Nine hundred and twenty seven physiotherapy records were obtained. Students were responsible for 39% (n=366) of treatment sessions, the unit therapist for 34% (n=311) and the on-call therapists for 27% (n=250). Despite routine daily physiotherapy for all patients in the unit, 39% (n=62) developed excessive secretions, 30% (n=48) of patients developed pneumonia and 27% (n=43) of patients were diagnosed with basal atelectasis. Nineteen patients (12%) died in the ICU. Patients spent a mean of 5.94 (SD 6.55) days in the unit. One hundred patients (63%) were ventilated. Almost a third of ventilated patients (31%) were intubated more than once. The patients spent a mean time of 3.8 days (SD 6.30) on the ventilator every time they were re-intubated. The development of pulmonary complications significantly increased the time on the ventilator and the LOS. ***Conclusions*****:** This baseline study of a surgical ICU presents a picture of a unit providing care comparable to first world environments. The picture of the physiotherapy service provided in this unit is of a "traditional" service based neither on the available evidence regarding the prevention or management of pulmonary complications, nor on the incorporation of early rehabilitation into the management of mechanically ventilated adult patients in ICU.

ABSTRAK

Doel: Om die basis lyn van ‘n chirurgiese intensiewe sorg eenheid in Suid Afrika te beskryf voor die implementering van ‘n bewysgesteunde fisioterapie protokol in die eenheid. ***Studie struktuur:*** Prospektiewe kohort observerende studie. ***Eenheid:*** Tien bed geslote eenheid in ‘n tertiêre opleidingshospitaal. ***Pasiënte:*** Alle volwasse pasiënte opgeneem in die eenheid tussen 16 Junie en 30 September 2003. ***Meetings:*** Demografiese data, diagnose met opname, chirurgie klassifikasie en ko-morbiditeite is aangeteken by opname. APACHE II is bereken. Die fisioterapie tegnieke, pasiënt posisies en funksionele aktiwiteite gebruik in behandelingssessies, die frekwensie en duur van behandelingssessies, die verskaffing van na-ure diens aan die eenheid asook die komplikasies gediagnoseer is daagliks aangeteken. Die tyd wat pasiënte geventileer is asook die aantal kere geher-intubeer is bereken. Die tydsduur van eenheid verblyf asook mortaliteit is aangeteken. ***Results:*** 160 pasiënte is opgeneem, met ‘n gemiddelde ouderdom van 49 +/- 19.95. Die gemiddelde APACHE II telling was 12.3 +/ 7.19 en die mortaliteit was 12.3%. Sewe en dertig persent van pasiënte is opgeneem na elektiewe chirurgie. Pasiënte bly in die eenheid gemiddeld vir 5.94 +/- 6.55 dae. Hipertensie was die mees algemene ko-morbiditeit (42%), en 21% van die pasiënte wat getoets is, het positief getoets vir HIV. Ko-morbiditeite het geen beduidende verband getoon met die tyd in die eenheid of mortaliteit nie. 927 Fisioterapie rekords is aangeteken. Studente was verantwoordelik vir 39% (n=366) van die behandelingssessies, die eenheid terapeut vir 34% (n=311) en die op-roep fisioterapeute vir 27% (n=250). Ten spyte van daaglikse roetine fisioterapie behandeling van alle pasiënte in die eenheid het 39% (n=62) oormatige sekresies ontwikkel, 30% (n=48) is met pneumonie gediagnoseer en 27% (n=43) met basale atelektase. Negentien pasiënte (12%) is dood in die eenheid. Die tydsduur van eenheid verblyf was 5.94 (SD 6.55) dae. Een honderd pasiënte (63%) is geventileer. Byna een derde (31%) van pasiënte is geher-intubeer. Met elke her-intubasie het die pasiënte gemiddeld 3.8 (SD 6.30) dae langer op die ventilator gebly. Pulmonale komplikasies het beide die tydsduur in die eenheid as op die ventilator betekenisvol verleng. ***Gevolgtrekkings:*** Hierdie basislyn studie beskryf ‘n eenheid waar pasiënte mediese sorg ontvang soortgelyk aan eerste wêreld lande. Die fisioterapeutiese diens wat gelewer word is egter nie gebasseer op die nuutste bewyse in die literatuur nie. Nog, in die voorkoming of in die behandeling van pulmonale komplikasies, nog in die vroëere inkorporasie van rehabilitasie in die hantering van volwasse pasiënte in ‘n intensiewe sorg eenheid.

CHAPTER 1

INTRODUCTION

1.1 Preface

Global economic and social policies have an increasing impact on the provision of healthcare services (Benatar 2004). Despite the worldwide explosion of scientific knowledge and technology over the past few decades the disparity in health and wealth between nations is widening (Benatar *et al* 2003). The increasing technological competence is not resulting in a more even distribution of health between nations. Factors that are impacting on the provision of healthcare include rapid population growth, the emergence of new infectious diseases including HIV/AIDS, ecological degradation associated with modern consumption patterns, massive shifts of people around the world and numerous local and regional wars (Benatar *et al* 2003). The impact global economic policies have on the provision of healthcare internationally, are causing service providers, policy makers and clinicians to make difficult decisions about various aspects of the services that are provided (Povar *et al* 2004).

Following the successful political transition of the South African society, the country is now faced with the challenges of social transition and more specifically healthcare reform (Benatar 1997). The Government's drive to reform healthcare is based on a framework of a district based approach to primary care. However, providing a free primary healthcare service for all is resulting in resources being withdrawn mainly from academic medical centres (Benatar 1997). In the Western Cape the public health sector has seen a 24.4% downsizing of hospital beds and a 27.9% downsizing of personnel (Benatar 2004). According to the draft paper on the Strategic and Service Delivery Improvement Plan of the Western Cape Health Department (2000) there has been a 19% downsizing of beds in Tygerberg Hospital (TBH) and a 28.8% cut in personnel over the past 4 years. Currently there are 15 fulltime posts and one 5/8 physiotherapy post available in TBH which is a 1385 bed tertiary hospital. This hospital has 8 specialized independently functioning ICU's namely burns, cardiothoracic, medical, coronary,

neurosurgery, neo-natal, pediatric as well as a surgical unit. The adoption of the 2010 Health Care Plan by the Provincial government of the Western Cape will have even more far reaching implications for service delivery within the public service which will be discussed in 1.2.

Physiotherapy departments providing a service in the public sector need to determine how best to manage their resources to ensure maximum patient care within the constraints of a limited therapist : patient ratio. In order to do so it is necessary to determine which areas of physiotherapy practice are essential for the best outcome of patients. This research project was developed to explore the provision of physiotherapy services to patients in the surgical ICU.

This chapter contains a motivation for the comprehensive research project that is to be conducted in the surgical ICU over the next few years and will include a brief outline of the four phases of the comprehensive project. This thesis is a report of phase one. A summary of the outline of the thesis will also be presented in this chapter.

1.2 Health Care Plans for the Western Cape

The 2010 Healthcare Plan is a strategic document developed by the provincial government of the Western Cape, based on restructuring plans initiated in 1994, in an effort to improve the quality of the health service in the province while at the same time bringing expenditure to within budget. Following a consultation process of two years the broad framework of Healthcare 2010 was approved by the cabinet of the Western Cape in March 2003 (2010 Healthcare). The aims of this plan are three fold namely:

- To reshape the public health services in the Western Cape to focus on primary-level services, community based services and preventative care;
- To expand the delivery of specialist services within the regional hospitals to make these more cost effective and more accessible to patients;
- To adequately support these services with well equipped secondary institutions and highly specialized tertiary services.

> In his budget speech of 2004/2005 the honourable Minister of Health Mr Pierre Uys, acknowledged the resistance of healthcare practitioners to the implementation of this plan but state "…Healthcare 2010 requires many people to adopt their approach and their habits…it is a challenge that all role-players have to rise to in co-operation with one another for the benefit of the people we have to serve together."

It is proposed that the plan be implemented gradually over the next six years, with a significant part of Tygerberg Hospital targeted to function as a secondary hospital from 2006/2007 (Budget Speech 2004/05). This has potentially far reaching implications for intensive care services, as the proposed changes will necessarily lead to a restructuring and relocation of personnel which will have implications for the staffing of the ICU. Only 2% of services will be provided in a tertiary environment, which is the accepted level at which a Level 1 ICU is to function (Mathivha 2002).

The care of patients in an ICU implies great cost and strain on already depleted funds in the public health sector (Jacobs & Noseworthy 1990); therefore services that are provided in the critical care of patients must be based on sound scientific evidence. This leads to the question of what the state of the evidence is for physiotherapy service in an ICU.

1.3 Physiotherapy Service in ICU

In a review article on evidence based physiotherapy practice in ICU, Stiller (2000) questioned the scope of physiotherapy in the acute care setting and was "hesitant" to provide guidelines for routine multimodality physiotherapy intervention in ICU stating "…current lack of evidence does not allow a firm directive to be made regarding the benefits, risks, and costs associated with the provision of routine multimodality respiratory physiotherapy to all intubated ICU patients receiving mechanical ventilation" (Stiller 2000:1809). Due to the lack of evidence for the routine physiotherapy management of patients in ICU, this author recommended that units independently decide on the level of involvement and the primary role of the physiotherapist within the unit.

This lack of evidence has led to a lack in the standardization of the role and the responsibilities of the physiotherapist in the intensive care setting (Norrenberg & Vincent 2002). Despite this the physiotherapist is still regarded as an integral member of the multidisciplinary team involved in the management of patients in the ICU by both the European Society of Intensive Care Medicine ESICM (Ferdinande *et al* 1997) and the American College of Critical Care Medicine (1999). Both these task forces however make it clear that not all their recommendations were based on sound scientific evidence but "…rather express the consensus of opinion leaders involved in intensive care medicine" (Ferdinande *et al* 1997).

Two surveys that have been published on the scope of physiotherapy in the ICU with the aim of identifying the primary role of the physiotherapist in this setting confirm the lack of standardization of the role and the responsibilities of physiotherapists between units (Jones *et al* 1992, Norrenberg & Vincent 2000).

The lack of evidence for the routine provision of multimodality physiotherapy service to all patients in an ICU (Norrenberg & Vincent 2002, Stiller 2000), is not unique to the physiotherapy profession, as there is a lack of evidence for much of the clinical practice routinely employed in the ICU (Cook *et al* 1996). This has in part contributed to the developing interest in outcome research as a method of obtaining evidence for "best practice" for the medical (Rubenfeld *et al* 1999) and respiratory management of patients (Kollef 1998). The effect of selected physiotherapy techniques in the critical care setting evaluated through randomized controlled trials (RCT) described in the literature, have primarily been undertaken in first world populations mainly Australia and Western Europe (Stiller *et al* 1996, Ntoumenopoulos *et al* 1998, Ntoumenopoulos *et al* 2002, Barker & Adams 2002). However these findings might not be relevant within the unique environment of the Western Cape as it is unclear whether the specific health profile of the population will affect their outcome from ICU.

1.4 Western Cape Health Profile

According to the Strategic and Service Delivery Improvement Plan (SSDIP) of the Provincial Government of the Western Cape Department of Health Draft Paper (2000):

- Tuberculosis (TB) is the predominant communicable disease in the Western Cape. This province has the highest TB rates nationally and amongst the highest in the world;
- The rising HIV epidemic is likely to augment the burden of TB disease as evidence shows that 15-20 % of tuberculosis patients are HIV-infected;
- More than half of South African males (52%) and 17% of women over the age of 18 years were reported to smoke in 1996. In the Western Cape a markedly higher proportion of women (45%) smoke compared to the national rate of 17%. These rates are the highest amongst Coloured women, almost reaching 60%.

The implementation of the 2010 Healthcare Plan, the lack of standardisation of physiotherapy service in ICU and the unique health profile of the Western Cape leads to the following question: ***Will the implementation of a physiotherapy protocol in a surgical intensive care unit, based on the current available evidence of best practice, influence the outcome of patients?***

1.5 The Comprehensive Research project

A systematic approach was adopted to answer this question. The four phases of the comprehensive project are outlined briefly.

Phase 1

Phase One is a baseline study to document the profile of the surgical ICU at Tygerberg Hospital (TBH). This baseline study was completed in two separate research projects.

The *first part* of the baseline study was to determine the current profile of the intensive care unit. This included a description of the demographics and the severity of illness of patients, certain aspects of the medical, physiotherapeutic and nursing management of these patients, and the outcomes of patients from ICU. The results of the first part of the baseline study are presented in this Masters Thesis.

The *second part* of the baseline study was to determine the survival rate and quality of life of the same cohort of patients twelve months after discharge from the unit. This study is currently being conducted and will be submitted as a thesis for a second Masters Degree in Physiotherapy by another candidate.

Phase 2

Phase Two will include the development of an evidence based physiotherapy practice protocol. The protocol will be developed in consultation with the physiotherapy department at TBH and other members of the multidisciplinary team involved in the surgical ICU at TBH. It is estimated that the development and implementation of the protocol will run over a period of two years.

Phase 3

Phase Three will consist of a re-evaluation of the unit after the implementation of an evidence based physiotherapy practice protocol, using the same measures described in this thesis.

Phase 4

In Phase Four the effect of the implementation of an evidence based physiotherapy practice protocol on the functioning of the physiotherapy department and the multidisciplinary team involved in the surgical ICU will be evaluated. Data will be obtained inter alia through structured interviews of all the team members involved.

1.6 Structure of Masters Thesis

This thesis presents the first part of the baseline study in the form of eight chapters, five of which will be in article format. Due to the scope of the study and the vast amount of data collected it was decided to only report on a limited portion of the data. The rest of the data will be published in later articles and used in the evaluation of an evidence-based physiotherapy practice protocol.

This decision necessarily has four implications:

- For the purpose of clarity and demonstrated rigor, the articles are longer than would be accepted by any journal. They will be revised before submission for publication.

- Articles will be submitted to a variety of journals, therefore the introduction, methodology and discussion sections will contain a fair amount of duplication. This was necessary for clarity and so that the articles could be independent documents.

- The bibliography of each of the five articles and the comprehensive bibliography included in this Master's Thesis is based on a modified Harvard system as prescribed by the Department of Physiotherapy, University of Stellenbosch. This will be modified as necessary on submission of the articles to the various journals.

- The methodologies described in chapters 7 and 8 are only relevant to the data that is reported in the specific article. The entire methodology including all the data extraction sheets will therefore be described in Chapter 5.

This Masters Thesis is structured as follows:

Literature Review

The literature review is presented as three independent articles. Each of the articles is presented in a different chapter.

Chapter 2: *Outcomes research in ICU: An aid in defining the role of physiotherapy*

Chapter 3: *Outcomes research in ICU*: *What do physiotherapists measure?*

Chapter 4: *Outcomes research in ICU: Factors influencing patient outcome from ICU*

Chapter 5: Methodology

This chapter contains a detailed account of the methodology used in this baseline study. Not all the variables described in this chapter will be discussed *(refer to p6).*

Results and Discussion

The results of the study and the discussion of the results are presented as two independent articles. Each of these articles is presented in a different chapter.

Chapter 6: *Outcome evaluation of a surgical ICU - a baseline study*

Chapter 7: *A baseline study to determine the clinical course, physiotherapy intervention, and outcome of patients from a surgical ICU*

Chapter 8: Conclusions and Recommendations

CHAPTER 2 Review Article

OUTCOMES RESEARCH IN THE ICU- AN AID IN DEFINING THE ROLE OF PHYSIOTHERAPY

SUMMARY

This is the first of three papers that examine the potential value of outcomes research in assisting to define the role of the physiotherapist in the critical care environment. This paper explores the concept of outcomes research, how it has been used in ICU, and the importance of patient-centered outcomes in the evaluation of a provided service. Quality indicators that have been identified to reflect the performance of a unit, which include access measures, complication measures, process measures and outcome measures, are discussed. The outcome measures that are regarded as true reflections of successful interventions in an ICU, such as mortality, time on the ventilator, length of stay, health-related quality of life and quality of death are highlighted.

INTRODUCTION

"In attempting to arrive at the truth, I have applied everywhere for information, but in scarcely an instance have I been able to obtain hospital records fit for any purpose of comparison. If they could be obtained, they would enable us to decide many questions. They would show subscribers how their money was being spent, what amount of good was really done with it or whether the money was not doing mischief rather than good" (Florence Nightingale, Notes on a hospital, 1873).

Over a century ago Florence Nightingale recognised the value of hospital records for making economy-related decisions in providing optimal patient care. Within the critical care environment, the past two decades have seen the emergence of outcomes research as a method of obtaining, implementing and re-evaluating evidence in the continuous evolution of best practice (Chatburn 2001).

An Intensive Care Unit (ICU) is defined as a distinct organisational and geographic entity with specific characteristics, located in a hospital. The objectives of such a unit are the monitoring and support of failing vital functions in critically ill patients, in order to apply adequate diagnostic measures and medical and/or surgical therapies to improve outcome. (Ferdinande *et al* 1997).

The cost of running these units accounts for up to 1% of the entire gross domestic product of the USA (Rubenfeld *et al* 1999). In the USA, an estimated 30% of the acute care hospital budget is spent on a mere 10% of patients requiring intensive care medicine (Brilli *et al* 2001). In the Western Cape we have seen the adoption of the Provincial Government's 2010 Economic Health Plan that will have far-reaching implications for service delivery in the Western Cape. The vision of this plan is for 90% of all patient contact to be at district level, 8% at secondary level and 2% at tertiary level. A resultant restructuring of involved personnel is therefore also envisaged. Economic changes affecting the provision of health care are global issues affecting all stakeholders in the health care industry, namely patients, service providers and funders. The complexity of modern ICUs and the increasing cost associated with the care of patients who are placed in such units are placing the onus on all involved to implement "best practice".

In a review article evaluating the evidence for the effect of physiotherapy in the intensive care environment, Stiller (2000:1811) states that "there is only limited evidence concerning which individual physiotherapy techniques are effective", and this author suggests that the effect of physiotherapy on broader outcomes should be evaluated.

Despite the lack of evidence, both the European Society of Intensive Care Medicine (ESICM), and the American College of Critical Care Medicine (ACCCM) recommend, in published guidelines on minimal requirements of an ICU, that one dedicated physiotherapist per 12-bed ICU is desirable (Ferdinande *et al* 1997), while it is considered essential, according to a report from ACCCM (1999), that a respiratory therapist[1] be available to the ICU at all times. Both these task forces, however, make it clear that not all their recommendations are based on sound scientific evidence but "… rather express the consensus of opinion leaders involved in intensive care medicine" (Ferdinande *et al* 1997). Currently, the physiotherapist is thus still regarded as an integral member of the interdisciplinary team involved in the management of patients in the ICU.

This "consensus of opinion leaders" might be challenged by a recent survey conducted by Jones (2001) to investigate the perceptions of medical personnel in regard to physiotherapy. For this study, a questionnaire was sent to the directors of ICUs in the UK, Australia, Canada, South Africa and Hong Kong, to determine their perceptions of physiotherapy services. The response rate was 53% (54/101). While 79% of the directors rated the services provided by physiotherapists as either outstanding or very good, nearly 60% of these directors considered that the physiotherapists' work could be performed through other disciplines.

Though evidence for the effectiveness of much of the clinical practice routinely employed in the ICU is still lacking (Cook *et al* 1996), this is not unique to the physiotherapy profession (Stiller 2000). This lack of hard evidence in the critical care setting has, in part, contributed to the developing interest in outcomes research as a

[1] Respiratory therapists are commonly employed in North America. They treat and care for patients with breathing disorders. Their scope of practice is broader than that of a physiotherapist working in the specialist field of cardiopulmonary medicine, but chest physiotherapy techniques are included in the spectrum of techniques used by these therapists, according to the Bureau of Labour Statistics, U.S. Department of Labour.

method of obtaining evidence for "best practice" for the medical (Rubenfeld *et al* 1999) and respiratory management of patients (Kollef 1998).

To determine the potential value of outcomes research as a research methodology within the speciality of cardiopulmonary physiotherapy, a literature review was conducted to answer the following questions:

1. What is outcomes research?
2. Which outcome of patient care in ICU is accepted as a measure of effective practice?

METHODOLOGY

A literature search was performed accessing the following databases:

- Medline
- Cinahal
- Web of Science
- Cochrane
- PeDro
- Ebscho

The following keywords were used:

Outcome measures; Outcome research; ICU; Critical Care; Physiotherapy; Physical Therapy; Evidence Based Medicine; Quality indicators.

The references of all retrieved articles were screened and the relevant articles were obtained.

OUTCOMES RESEARCH

Thirty years have passed since Cochrane first published his views on health care (Wijetunge & Baldock 1998). He advocated that the limited resources available for health care should be used equitably to provide care of proven benefit. He promoted randomised controlled trials (RCTs) as the most reliable source of evidence on which to base these decisions. Although this method is still regarded by the majority in the

medical fraternity as the gold standard in determining the efficacy of interventions (Glass 1999), it has become increasingly evident that RCTs are not always the most appropriate method of obtaining evidence (Sackett *et al* 1996).

The following difficulties with RCTs in the critical care environment have been noted by various authors (Rubenfeld *et al* 1999; Chatburn 2001; Kollef 1998):

- It takes a long time to complete the RCT because the efficacy of an intervention on a very specific pathology in a very small patient population is evaluated;
- There is a vast number of questions within the critical care environment that need to be answered within a limited time frame;
- The cost involved in completing these trials is very high; and
- The ethical issues involved in withholding current acceptable practice to complete a true randomised controlled trial, is controversial (Glass 1999).

In a workshop organised by the American Thoracic Society on Outcomes Research in Critical Care, outcomes research was defined as a "difference in focus" (Rubenfeld *et al* 1999). In contrast to RCTs, outcomes research focuses on the effects of care on end points that are important to patients and society, and not on physiologic variables alone (Rubenfeld *et al* 1999).

Although a specific definition for outcomes research is still lacking (Kollef 1998) there seems to be widespread acceptance of the fact that outcomes research is used to formulate clinical guidelines, to assess the quality of medical care and to inform health policy decisions (Rubenfeld *et al* 1999; Kollef 1998; Chatburn 2001).

Observational outcomes research can be used to identify associations between exposure and outcome. This exposure is defined broadly in outcomes research and can include such diverse aspects as medication, structure of the unit, socio-economic status. As a research methodology, observational studies have to adjust for confounding variables[2] that could influence the results. An observed outcome can be due to a confounding variable that obscures the true causal association when none exists.

[2] A confounding variable is an independent risk factor for disease and must be associated with the exposure under study, but is not recognised as a mediator in the causal pathway.

A good example of the influence of a confounding variable on a causal relation was revealed in a study reported by Kollef (1993), on the effect of gender on outcome. In this study it was found that females admitted to the ICU had an increased mortality. On further analysis however, it was evident that the women were admitted to the unit with higher APACHE II scores. The women were just "sicker" than the men and thus presented with a poor outcome.

Since observational research does not use randomisation to control for confounding variables, they are subject to bias. Biases, however, do not always invalidate a study (Rubenfeld *et al* 1999). Identifying and minimising the effects of these confounding variables thus constitute a large part of the design and analysis of data in outcomes research. Chatburn (2001) discusses the use of outcomes research as a continuous system of quality improvement, and uses the following diagram as a means of clarifying the process.

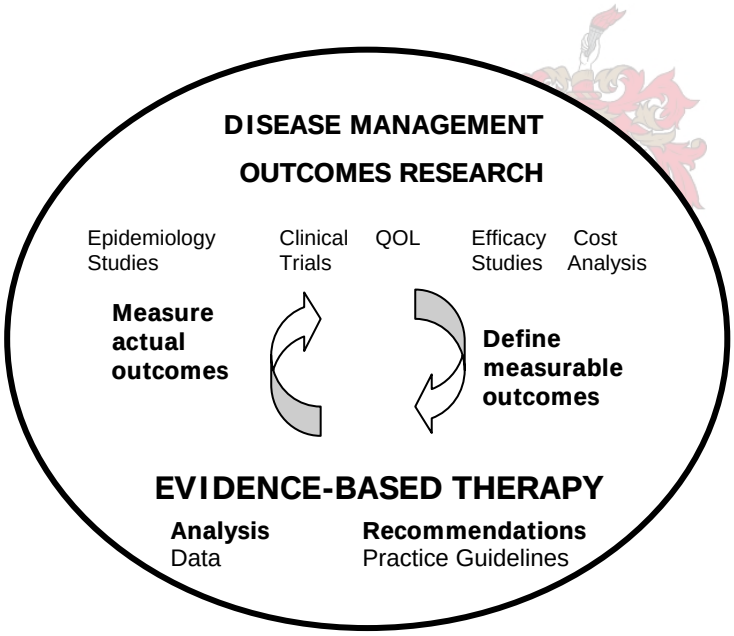


Diagram 1: Disease management expressed as a continuous quality improvement cycle showing the interaction of plans (created by research outcomes studies) and implementations (evidence based guidelines) through goals (desired outcomes) and measured results (actual outcomes) from Chatburn 2001 **Outcomes research in respiratory care**. *Respiratory Care* 46(11) :1217

In outcomes research, three different control groups have been used to compare the outcome of an intervention. The following control groups have been reported:

- **Baseline** data from the same hospital before and after implementation of changed practice (Kotagel *et al* 2002).
- **Literature** using the data of published research and comparing the outcomes of patients to the outcomes in the unit where a new practice was implemented (O Chan *et al* 2001).

- **Multi-centre** studies have also been reported where the outcomes of patients are compared, using the data from the unit where a new practice is implemented and comparing it to other centres where the practice is different (Bristow *et al* 2000).

THE SCOPE OF PHYSIOTHERAPY WITHIN AN ICU

Two studies evaluating the scope of physiotherapy in the ICU, with the aim of identifying the primary role of the physiotherapist in this setting, have been published to date. Jones (1992) conducted a study in Australia, Hong Kong and the UK. In this study a questionnaire was sent to the head physiotherapist in 78 ICUs in those countries. A 79% response rate was achieved.

A similar study was conducted by Norrenberg and Vincent (2000), who sent questionnaires to the physician members of the European Society of Intensive Care Medicine (ESICM) in 17 Western European countries. These physicians were requested to hand the questionnaire to the responsible physiotherapist in the unit. In contrast to the study by Jones *et al* (1992), the response rate in this study was very poor (22% n=460).

While different questionnaires were used in the two studies and the time frame between the two studies might have influenced the results, the following variations in results were observed. Only the highest and lowest score for each is documented below.

- Mobilisation and or passive movement were used in 100% of Western European units and in only 31% of units in Hong Kong.
- Respiratory therapy – defined as a combination of postural drainage, chest percussion, vibration, or breathing exercises – was used in 98% of units evaluated in both studies.
- Airway suctioning was used in 95% of Australian units but only 70% of West European units.
- Non-invasive ventilation was used in 46% of units in Western Europe and only 6% in Australia.

- Manual hyperinflation was used in 92% of units in Australia and in only 31% of units in Hong Kong.
- Considerable variation between countries was observed in terms of the availability of physiotherapy service as no units in Hong Kong offer a 24-hour on call service. In contrast to this 97% of units in the UK offer a 24-hour on call service and 80 - 90% of all units offer a weekend service.
- Physiotherapists were involved in weaning of patients in 22% of units in Western Europe. The study by Jones (1992) did not look at this aspect.

From the results of these two studies it is clear that the services provided and the techniques employed by physiotherapists vary considerably between countries. In contrast to these published surveys, observational research could present physiotherapists with the tools to link their involvement in the ICU to patient outcome, thus assisting the profession to clarify their role within the intensive care environment.

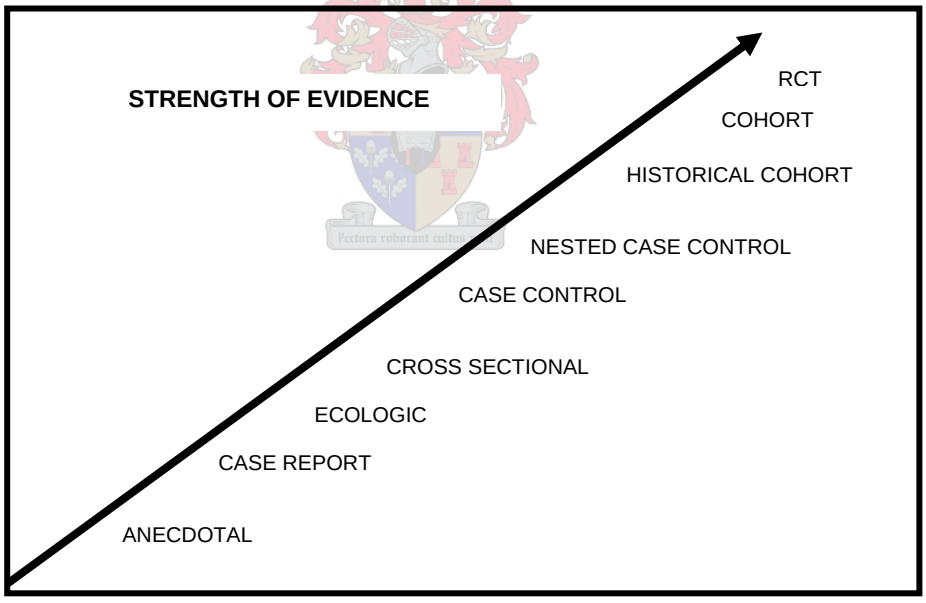


Diagram 2: Hierarchy of study structures (Coetzee D 2001 Epidemiology Notes, US.)

A well-designed cohort study provides strong evidence to report on the association between a variable and an outcome *(diagram 2).* Despite limitations present in observational study designs as previously discussed, these investigations do show trends, and repetition of these trends in further studies will add to the reliability of the results.

WHAT TO MEASURE?

Clancy & Eisenberg (1998) refers to outcomes research as the study of end results of health services that take patients' experiences, preferences and values into account. Clinical research has in the past focused primarily on physiological variables or survival as the main outcome of any intervention.

Physiological variables, for example expiratory flow rate, changes on chest x-ray (CxR), PaO2:FiO2, were documented to describe and attempt to understand the physiologic process of disease (Hough 1996; Smith & Ellis 2000). It is becoming increasingly clear that these physiological measurements do not necessarily translate to clinical effect. Lim *et al* (2002), for example, found a significant increase in the rate of atelectasis of patients undergoing a left pleurotomy. This was, however, not associated with an increased length of stay (LOS) for these patients.

Physiological measures are also increasingly being questioned by patients, their families and society (Rubenfeld *et al* 1999) and a growing need exists for outcomes of medical interventions to be relevant them. These so-called "patient-centred outcomes" include measures like quality of life following discharge, functional status, freedom from pain, etc. (Glass 1999; Combes *et al* 2003; Lipsett *et al* 2000; Rubenfeld *et al* 1999).

Quality indicators

As consumers, funders and regulatory agencies (Pronovost *et al* 2001) demand evidence regarding the quality of care patients are receiving, the demand for indicators of quality management of patients in the critical care patient population is likely to grow (Pronovost *et al* 2001). In a review article published by Berenholtz *et al* (2001), the measures that could be used as indicators of successful interventions in ICU were grouped into the following categories: access measures, complication measures, process measures and outcome measures. The utilisation of these measures is still in the developmental phase. The results of a pilot trial suggests that the quality of care that a patient is receiving in a specific unit can be measured by systematically documenting different measures that have previously been linked to patient outcome in either observational or experimental studies (Pronovost *et al* 2003).

Examples of access and complication measures will be reported, while process and outcome measures, which may prove to be more relevant for physiotherapists, will be discussed in greater detail.

The following are examples of **access measures**:

- Rate of delayed admissions: number of admissions to ICU delayed > 4 hours / total number of ICU admissions
- Cancelled surgical cases: number of cancelled surgical cases due to a lack of ICU beds / total number of OR cases.

The following are examples of **complication measures**:

- Unplanned ICU re-admission: number of patients who had an unplanned ICU re admission within 48 hours of discharge / total number of patients discharged from the unit
- Rate of resistant infections: number of patients who developed resistant infections in the ICU / total ICU patient days.

Process Measures

The following is an example of a process measure:

- Prevention of ventilator associated pneumonia (VAP): number of ventilator days on which the head of the bed was elevated > 30 degrees / total number of ventilator days.

The process measure to monitor effective prevention of VAP is based on the study done by (Drakulovic *et al* 1999). In this RCT it was shown that nursing a patient in a semi-recumbent position would result in a 26% absolute reduction in the risk of developing VAP. By systematically documenting a patient position, quality control could thus be ensured.

This measure provides a vehicle for physiotherapy intervention in the ICU to be regarded as an indicator of quality. The work of Mackay & Ellis (2002) and Ntoumenopoulos e*t al* (2002) needs further scrutiny. Both these studies used different methods of determining a clinically relevant pulmonary complication and relating that to physiotherapy intervention.

Ntoumopolous *et al* (2002) used the clinical pulmonary infection score (CPIS). This score, first described by Pugin *et al* (1991), uses six variables, namely CXR, white cell count, tracheal aspirate, temperature, amount and colour of secretions and PaO2:FiO2 ratio, to determine the presence of VAP. Using this score made it possible to demonstrate an independent association between physiotherapy intervention and the development of VAP. Further linking of these findings to costing could be beneficial for the profession.

Mackay and Ellis (2002) developed their own scoring system *(Table 2.1).*

Table 2.1: Scoring system for pulmonary complication (Mackay and Ellis 2002)

Any *three* of the following respiratory signs occurring within the same day, in the first 14 days after surgery: 1. Auscultation changes (decreased breath sounds, crackles, wheezes, bronchial breathing) that were additional to those found prior to surgery. 2. Temperature over 38 degrees Celsius. 3. Chest radiograph changes consistent with collapse, consolidation or atelectases. 4. Increase in amount and/or changed colour of sputum produced, compared to what the patient reports as usual (preoperatively) for them.

However, no significant difference in the rate of pulmonary complications with an increased number of physiotherapy interventions could be established. This might be indicative of the sensitivity of this scoring system in identifying a pulmonary complication.

Mackay and Ellis (2002) also developed a mobility scale with high inter- and intra-rater reliability *(Table 2.2).*

Table 2.2: Mobility indicators Mackay and Ellis (2002)

Mobility Indicators ▪ First day patient sat out of bed ▪ First day patient walked ▪ First day patient was able to walk 30 meters

Using these indicators they were able to show a significantly faster mobilisation of patients following surgery with more intensive physiotherapy, i.e. increased number of treatments. Linking this faster mobilisation to patients' health related quality of life (HRQL) may again be promising in providing the profession with evidence for our continued role in ICU.

Pronovost *et al* (2003) suggested that process measures might be even be more valuable than outcome measures when measuring the quality of care within a unit. In contrast to these newly proposed quality indicators, outcome measures are accepted measures used to describe the outcome of an intervention, and will be discussed in detail.

Outcome Measures

An outcome measure can be described as a measurement used to document the success of an intervention. This success can be described from the service provider's or the patient/family's perspective. Different authors categorise outcomes differently. Chatburn (2001), for example, described the following measures to be used in outcomes research in critical care:

Clinical:	Clinical events, e.g. development of nosocomial pneumonia
	Mortality
Economic:	Direct medical cost – hospital or outpatient visits
	Indirect medical cost – work loss or restricted activity days
Patient centred:	Symptoms, e. g. dyspnoea (Modified Borg Scale)
	Health Related Quality of Life
	Functional status
	Patient satisfaction

The more traditionally accepted measures of outcome (Rubenfeld *et al* 1999) are mortality rate, ICU length of stay (LOS), days on mechanical ventilation, health-related quality of life (HRQL), and quality of death. Each of these specific measures will be discussed in greater detail.

Mortality

Mortality has been used as the ultimate measure in the intensive care setting for many years, as the patients admitted to intensive care units usually suffer life-threatening diseases (Rubenfeld *et al* 1999). As it is still regarded as being a sensitive, appropriate and meaningful measure of outcome for ICU intervention (Livingston *et al* 2000; Parkhe *et al* 2002; Morales *et al* 2003), it will be discussed first. Different time points have been described when using mortality as an outcome measure, namely death in the unit, time to death and death at fixed points (Rubenfeld *et al* 1999).

The problem of measuring death only in the unit or in the hospital is that it is not always a true reflection of the outcome of the ICU intervention. Patients may be transferred to a ward after no further active management of the patient is decided upon, or transferred to another facility where the outcome is unknown. In these scenarios, the intervention failed, but measuring at the time of transfer is not sensitive enough to accurately reflect the patient outcome.

Measuring mortality at fixed times could potentially overcome the above-mentioned problem. The time of measuring the mortality could, however, either be too short, in cases where patients are still in the unit at, say, 30 days, or, if measured too late, e.g. one year after the incident, the cause of death can be due to other factors unrelated to ICU management

Survival time, i.e. time to death, could be the most sensitive measure. In this case a cohort of patients is followed until death, recording the survival time from discharge from the unit.

ICU length of stay (LOS)

This is the length of time that the patient spends in the intensive care unit and has direct costing implications for funders. An increased LOS has also been linked to the development of complications like nosocomial pneumonia (Bochicchio *et al* 2004) and has been shown to affect the mortality, HRQL and function of a patient following ICU discharge (Combes *et al* 2003; Lipsett *et al* 2000).

In a study by Lipsett *et al* (2000), the survival and functional outcome of patients following prolonged ICU stay was evaluated. In this study, prolonged ICU stay was defined as six days or longer. A cohort of 128 patients that had been admitted to a surgical ICU during the period 1 July 1996 to 30 June 1997 and had had a prolonged ICU stay, were followed up until one year after discharge from the ICU.

A sickness impact profile (SIP) was completed by a trained interviewer at three-, six-, nine- and twelve-month intervals. One hundred and twenty-seven of the patients in the original cohort could be followed up. Only one patient was lost to follow up. The following observations were made:

- Forty-one point four percent of patients did not survive ICU stay.
- Of the survivors (58.6%) 45.3% were still alive one year after discharge from the unit.
- The SIP score improved serially over the 12 months, with a high SIP score consistent with a good functional outcome, comparable with baseline data, showing at 12 months.
- The total cost per ICU stay for one-year survivors was calculated at $282 618 .00.

Decreased LOS in an ICU is to the benefit of the patient and saves on immediate medical cost. In 1998 the average cost of ICU care in the USA was calculated at $1 565 per day (Heyland *et al* 1998). The following practices have been associated with a decreased LOS:

- The use of practice guidelines (Eagle *et al* 1990)
- The use of protocols for patient care (Kollef *et al* 1997)
- Organisational changes within the unit (Carson *et al* 1996)

Time on ventilator

Increased time of mechanical ventilation has been associated with the following complications: ICU-acquired paresis and development of nosocomial infections. These complications affect both the patients' chances of recovery and the cost of ICU intervention.

A prospective multi-centre study examining the clinical incidence of ICU-acquired neuromuscular disorders undertaken by De Jonghe *et al* (2002) found that the following variables were independently associated with the development of ICUAP:

- Female gender (OR 4.66; 95% CI 1.19 – 18.30)
- Number of days with dysfunction of two or more organs (OR 1.28; 95%CI 1.11 – 1.49)
- Duration of mechanical ventilation (OR 1.10; 95% CI 1.00 – 1.22)
- Administration of cortico steriods before day 1 (OR 14.90; 95%CI 3.20 – 69.80)

In a prospective cohort observational study completed over a one-year period by Bochicchio *et al* (2004), the data of 714 trauma patients were collected and the incidence of pneumonia in this patient population was documented. For the purpose of their study, they classified the pneumonias into three groups, using the time from admission to the unit in order to classify the three groups:

- **Group one** – the community-acquired pneumonia (CAP) group developed pneumonia in less than three days after ICU admission,
- **Group two** – early nosocomial pneumonia (ENP) group developed pneumonia between four to six days after admission and
- **Group three** – the late nosocomial pneumonia (LNP) group only developed pneumonia after seven days.

In total, 204 pneumonias (N=714) were diagnosed, of which 125 (61%) were ventilator associated. Of these, LNP accounted for the majority of pneumonias (37%). Both ICU and ventilator LOS were significantly higher in the ENP and LNP groups. Mortality was the highest in the CAP group (16%). This suggests that patients that develop pneumonia within the first three days are at a greater risk of death, but if they develop the pneumonia after three days they are likely to have an increased LOS and time on the ventilator.

Quality of death

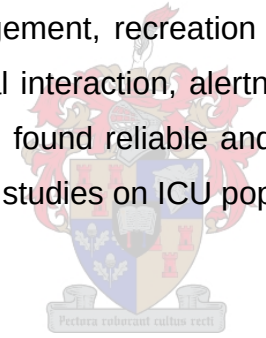
Quality of death is increasingly being recognised in the literature as an important measure of quality and should be evaluated from the perspective of patients, family and staff members (Kollef 1999; Rubenfeld *et al* 1999). When assessing the quality of care at the end stage of life, the quality of communication between critical care staff

members and the patient and/or family members is an important outcome. The need also exists to determine the concordance between the patient's expressed wishes and the actual treatment received. The development of relevant tools to access this outcome is only in the development phase (Rubenfeld *et al* 1999).

Health-related quality of life (HRQL)

As we move beyond survival as the sole measure of ICU outcome, the importance of functional outcomes and quality of life of patients following intensive care is increasingly being raised in the literature (Lipsett *et al* 2000; Roos *et al* 2002). The two standardised measures used most in literature to describe patients HRQL are the Sickness Impact Profile (SIP) and the SF36.

The SIP was developed by Bergner in the late seventies to assess the functional status of patients. It consists of 136 items grouped into 12 categories representing sleep and rest, eating, work, home management, recreation and pastimes, ambulation, mobility, body care and movement, social interaction, alertness behaviour, emotional behaviour and communication. It has been found reliable and valid for use in critically ill patients and has been used in numerous studies on ICU populations (Lipsett *et al* 2000; Gardner & Sibthorpe 2002).



The Medical Outcomes Survey Short Form (SF36) is the other form that is reported on in the literature evaluating patients HRQL. In a prospective survey completed on a convenient sample by Welch *et al* (1999) the SF36 was found to be internally consistent and correlated well with the six-week and six-month functional outcome. In a pilot study completed by Chaboyer *et al* (2002), the SF36 form was found to be more reliable and easier to score than an ICU -specific health status instrument.

During the 2002 Brussels Round Table Conference on "Surviving Intensive Care", the following recommendations were made (Angus & Carlet 2003):

- Future clinical trials of ICU therapies should include long-term follow up of survival, HRQL, morbidity, functional status and cost of care.
- SF36 and EuroQOL EQ-5D are the best suited instruments to measure HRQL in the intensive care population.

With a gradual shift towards early rehabilitation within the ICU environment now becoming evident in literature (Nava & Ambrosio 2000; Nava 1998) the evaluation of HRQL could be an outcome measure that proves to be sensitive for physiotherapy intervention.

CONCLUSION

Currently physiotherapists are still regarded as integral members of the ICU team (Ferdinande *et al* 1997), but this role is being questioned (Stiller 2000). Outcomes research is recognised by critical care specialists as a cost-effective method of determining what works in the real world (Rubenfeld *et al* 1999), and it offers physiotherapists the tools that might aid in defining and clarifying our role within the critical care environment. This review highlights the following two aspects:

1. Daily systematic documentation of physiotherapy interventions related to accepted outcome measures by clinicians has the potential to lay the groundwork for multi-centre observational studies within the speciality of cardiopulmonary physiotherapy.

2. When designing research, it is important to measure outcomes that are regarded as important to patients/families and funders.

The only way for physiotherapists to convince administrators of the value of physiotherapy in the ICU, is to report on patient centred outcomes (Nava & Ambrosio 2000). In the second part of this review we will explore the important question concerning which outcomes physiotherapists are utilising within the critical care environment, and identify standardised documentation formats that could potentially form the basis of a large database within the speciality of physiotherapy in the ICU.

REFERENCES

American College of Critical Care Medicine of the Society of Critical Care Medicine 1999 Critical Care services and personnel: recommendations based on a system of categorization into two levels of care. *Critical Care Medicine* 27:422-426

Angus DC & Carlet J 2003 Surviving intensive care: a report from the 2002 Brussels Roundtable. *Intensive Care Medicine* 29(3):368-377

Berenholtz SM, Dorman T, Ngo K, Pronovost P 2002 Qualitative review of intensive care unit quality indicators. *Journal of Critical Care* 17(1):1-12

Bochicchio GV, Joshi M, Bochicchio K, Tracy K, Scalea T 2004 A time dependent analysis of ICU pneumonia in Trauma patients. *Trauma* 56(2):296-303

Brilli RJ, Spevetz A, Branson RD, Campbell GM, Cohen H, Dasta JF, Harvey MA, Kelley MA, Kelly KM, Rudis MI, St Andre AC, Stone JR, Teres D, Weled BJ; American College of Critical Care Medicine Task Force on Models of Critical Care Delivery 2001 Critical care delivery in the ICU: defining clinical roles and best practice model. *Critical Care Medicine* 29(10):2007-2019

Bristow PJ, Hillman KM, Chey T, Daffurn K, Jaques TC, Norman SL, Bishop GF, Simmons EG 2000 Rates of in-hospital arrests, deaths and ICU admissions: the effect of a medical emergency team. *Medical Journal of Australia* 173(5):236-240

Carson SS, Stocking C, Podsadecki T, Christenson J, Pohlman A, MacRae S, Jordan J, Humphrey H, Siegler M, Hall J 1996 Effects of organizational change in the medical ICU of a teaching hospital: a comparison open and closed formats. *Journal of the American Medical Association* 276(4):322-328

Chaboyer W, Foster M, Creamer J 2002 Health Status of ICU survivors: a pilot study. *Australian Critical Care* 15(1):21-26

Chatburn R 2001 Outcomes Research in Respiratory Care. *Respiratory Care* 46(11):1215-1225

Clancy CM & Eisenberg JM 1998 Outcomes research: measuring the end results of healthcare. *Science* 282:245-246

Combes A, Costa M, Trouillet J, Baudot J, Mokhtari M, Gibert C, Chastre J 2003 Morbidity, mortality and HRQL of patients requiring >= 14 days of mechanical ventilation. *Critical Care Medicine* 31(5):1373-1381

Cook D, Sibbald W, Vincent J, Cerra F 1996 Evidence based critical care medicine: what is it and what can it do for us? Evidence Based Medicine in Critical Care Group. *Critical Care Medicine* 24:334-337

De Jonghe B, Sharshar T, Lefaucher J, Durand-Zaleski I, Boussarsar M, Cerf C, Renaud E 2002 Paresis acquired in the ICU; A prospective multicentre study. *Journal of the American Medical Association* 288(22):2859-2867

Drakulovic MB, Torres A, Bauer T 1999 Supine body position as a risk factor for nosocomial pneumonia in mechanical ventilated patients. *Lancet* 354:1851-58

Eagle KA, Mulley AG, Skates SJ 1990 LOS in ICU; effects of practice guidelines and feedback. *Journal of American Medical Association* 264:992-997

Ferdinande P & Members of Task Force of the European Society of Intensive Care Medicine 1997 Recommendations on minimal requirements for Intensive Care Departments. *Intensive Care Medicine* 23:226-232

Florence Nightingale website at the University of Minnesota http://www.mrs.umn.edu/~sungurea/introstat/history/w98/Nightengale.html *(Accessed 11 May 2004)*

Gardner A & Sibthorpe B 2002 Will he get back to normal? Survival and functional status after intensive care therapy. *Intensive and Critical Care Nursing* 18:138-145

Glass D 1999 Clinical outcomes research: the international perspective. *Current Opinion in Anaesthesiology* 12(2):217-220

Heyland DK, Konopad E, Noseworthy TW, Johnston R, Gafni A 1998 Is it "worthwhile" to continue treating patients with prolonged stay (>14 days) in the ICU? An economic evaluation. *Chest* 114(1):192-198

Hough A 1996 Physiotherapy in Respiratory Care 2nd Edition. Chapman & Hall. London p 170

Jones A 2001 Intensive care physiotherapy - medical staff perceptions. *Hong Kong Physiotherapy Journal* 19:09-16

Kollef MH 1993 Do age and gender influence outcome from mechanical ventilation? *Heart Lung* 22:442-449

Kollef MH, Shapiro S, Silver P, St John R, Prentice D, Sauer S, Ahrens T, Shannon W, Baker-Clinkscale D 1997 A randomized controlled trial of protocol-directed versus physician-directed weaning from mechanical ventilation. *Critical Care Medicine* 25(4):567-574

Kollef MH 1998 Outcomes research as a tool for defining the role of respiratory care practitioners in the Intensive Care Unit Setting. *New Horizons* 6(1):91-98

Kollef MH 1999 Improving outcomes in the ICU setting. *Chest* 115:1490-1492

Kotagel UR, Robbins JM, Kini MK, Schoetker PJ, Atherton HD, Kirshbaum MS 2002 Impact of a bronchiolitis program. *Chest* 121(6):1789-1797

Lim E, Callaghan C, Motalleb-Zadeh R, Wallard M, Misra N, Ali A, Halstead JC, Tsui S 2002 A prospective study on clinical outcome following pleurotomy during cardiac surgery. *The Thoracic and Cardiovascular Surgeon* 50(5):287-291

Lipsett P, Swaboda S, Dickerson J, Ylitalo M, Gordon T, Breslow M, Campbell K, Dorman T, Pronovost P, Rosenfeld B 2000 Survival and functional outcome after prolonged Intensive Care Unit stay. *Annals of Surgery* 231(2):262-268

Livingston BM, MacKirdy FN, Howie JC Norrie JD 2000 Assessment and performance of five intensive care scoring models within a large Scottish database. *Critical Care Medicine* 6:1820-1827

Mackay M & Ellis E 2002 Physiotherapy outcomes and staffing resources in open abdominal surgery patients. *Physiotherapy Theory and Practice* 18:75-93

Morales IJ, Peters SG, Afessa B 2003 Hospital mortality rate and LOS in patients admitted at night to the intensive care unit. *Critical Care Medicine* 31(3):858-863

Nava S 1998 Rehabilitation of patients admitted to a respiratory intensive care unit. *Archives of Physical and Medical Rehabilitation* 79:849-854

Nava S & Ambrosino N 2000 Rehabilitation in the ICU: The European phoenix. *Intensive Care Medicine* 26:841-844

Ntoumenopoulos G, Presneill J, McElholum M, Cade JF 2002 Chest physiotherapy for the prevention of ventilator associated pneumonia. *Intensive Care Medicine* 28:850-856

O Chan PK, Fischer S, Stewart TE, Hallett DC, Haynes-Gay P, Lapinsky SE, Mac Donald R, Mehta S 2001Practicing evidence-based medicine: the design and implementation of a multidisciplinary team-driven extubation protocol. *Critical Care* 5:349-354

Parkhe M, Myles PS, Leach DS, Maclean AV 2002 Outcome of emergency department patients with delayed admission to ICU. *Emergency Medicine* 14:50-57

Pronovost PJ, Miller MR, Dorman T, Berenholtz SM, Rubin H 2001 Developing and implementing measures of quality of care in the intensive care unit. *Current Opinion in Critical Care* 7(4):297-303

Pronovost PJ, Berenholtz SM, Ngo K, McDowell M, Holzmueller C, Haraden C, Resar R, Rainey T, Nolan T, Dorman T 2003 Developing and pilot testing quality indicators in the ICU. *Journal of Critical Care* 18(3):145-155

Pugin J, Auckenthaler R, Mili N, Janssens JP, Lew PD, Sutter PM 1991 Diagnosis of ventilator associated pneumonia by bacteriologic analysis of bronchoscopic and nonbronchoscopic "blind" bronchoalveolar lavage fluid. *American Review of Respiratory Disease* 143:1121-1129

Roos R, Van Aswegen H, Eales C 2002 Perceived effort of functional activities after a period of mechanical ventilation. *South African Journal of Physiotherapy* 58(4):33-36

Rubenfeld G, Angus D, Pinsky M, Curtis R, Connors A, Bernard G and the Members of the Outcomes Research Workshop 1999 Outcomes Research in Critical Care. Results of the American Thoracic Society of Critical Care Assembly Workshop on Outcomes Research. *American Journal of Critical Care Medicine* 160:358-367

Sackett D, Rosenberg W, Muir G, Haynes BA, Scott Richardson W 1996 Evidence-based Medicine: What it is and isn't. *British Medical Journal* 312:71-72

Smith M & Ellis E 2000 Is retained mucus a risk factor for the development of postoperative atelectasis and pneumonia? *Physiotherapy Theory and Practice* 16:69-80

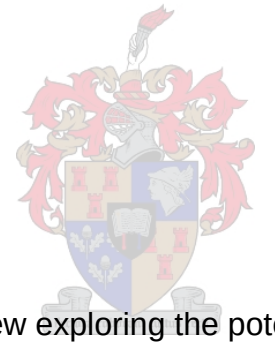
Stiller K 2000 Physiotherapy in ICU. Towards an evidence based practice. *Chest* 118:1801-1813

Welch CH, Thompson K, Long-Krug, S 1999 Evaluation of patient perceived health status using the Medical Outcomes Survey Short Form 36 in an intensive care unit population. *Critical Care Medicine* 27(8):1466-1471

Wijetunge A & Baldock GJ 1998 Evidence-based intensive care medicine. *Anaesthesia* 53:419-421

CHAPTER 3 Review Article

OUTCOMES RESEARCH IN THE ICU- WHAT DO PHYSIOTHERAPISTS MEASURE?



SUMMARY

This is the Second Part of a review exploring the potential value that outcomes research could hold for defining the role of the physiotherapist within the critical care environment. In Part One, the research methodology, identified quality indicators and outcome measures that are accepted as a measurement of the effect of interventions in the ICU were discussed. In this Second Part we will explore the relevance of the questions asked and outcomes measured in physiotherapy research over the past five years.

INTRODUCTION

An intensive care unit (ICU) is defined as a distinct organisational and geographic entity, with specific characteristics, located in a hospital. The objectives of such a unit are the monitoring and support of failing vital functions in critically ill patients, in order to perform adequate diagnostic measures and medical and/or surgical therapies to improve outcome. (Ferdinande *et al* 1997).

The cost of running these units accounts for up to 1% of the entire gross domestic product of the USA (Rubenfeld *et al* 1999), and in this country an estimated 30% of the acute care hospital budget is spent on a mere 10% of patients requiring intensive care medicine (Brilli *et al* 2001). Although economic changes effecting the provision of health care are global issues, the adoption of the 2010 Health Care Plan by the Provincial Government of the Western Cape has far reaching implications for service delivery within the public service. Given this changing aspect of health care it is paramount that we in the physiotherapy profession redefine priorities in the service we provide. It is therefore essential that the profession determines how best to manage the physiotherapy resources in the public sector to ensure maximum patient care whilst at the same time being accountable for the spending of taxpayers' money. In order to do so, it is necessary to determine which areas of physiotherapy intervention are essential to the optimum outcome for the patient. In a review article evaluating the evidence of physiotherapy in the intensive care environment, Stiller (2000:1811) states "… there is only limited evidence concerning which individual physiotherapy techniques are effective", and "… the role of physiotherapy in the ICU will continue to be questioned until it has been shown to have a favourable impact on broader outcomes…".

"Evidence based medicine is the conscientious, explicit and judicious use of best current evidence in making decisions about the care of individual patients" (Sackett *et al* 1996). The concept of evidence-based therapy has been adopted by the World Confederation for Physical Therapy (WCPT) to further its mission in supporting the profession and its contribution to world health.

Despite worldwide professional acceptance of the principles of evidence-based practice in the physiotherapy profession, the predicament of the profession in practicing

evidence-based therapy is summed up, in an editorial by Bithell (2000), in the following way "... we are uncomfortably aware that we have far too little hard evidence at present". This "hard evidence" that Bithell refers to can either be the amount of evidence available, the quality of the evidence or the relevance of the evidence.

AMOUNT OF EVIDENCE AVAILABLE

The Centre for Evidence Based Therapy has attempted to identify all randomised controlled trials (RCT) and systematic reviews in physiotherapy and collate these on the physiotherapy evidence database (PeDro). In 2001 a total of 2229 RCTs and 297 systematic reviews were recorded in the database (Herbert *et al* 2001). The most recent number available on the website is 5037 (PEDro). Of these, an estimated 200 is on the topic of cardiopulmonary physiotherapy (Herbert *et al* 2001).

THE QUALITY OF THE EVIDENCE

All RCTs in the PeDro database are ranked using a 10-point scale designed by the Centre for Evidence Based Therapy to calculate the quality of the trials. The median score for these studies rose from 3 to 5 over the past few years (Herbert *et al* 2001).

Any professional reading these reports and reviews, however, is constantly faced with the comment "no significant difference". This basically states that the observed outcome could have been due to chance and that there is no certainty that the physiotherapy intervention was indeed responsible for the effect (Sterne & Smith 2001). However, in discussing the concept of significance testing, these authors state: "… the most important need is not to change statistical paradigms but to improve the quality of studies by increasing sample size and precision of measurement." This precision refers to the reliability and validity of the instruments we use to measure the effect of an intervention, however it might be argued that it is time to evaluate the relevance of what we measure.

THE RELEVANCE OF THE EVIDENCE

What is measured is indeed paramount in deciding the worth of an intervention. In reference to physiotherapy, Wijetunge & Baldock (1998:419) stated in an editorial "… not all that is of value can be measured and the philosophy of evidence-based medicine should not be used to devalue the unquantifiable." This observed, unquantifiable value of physiotherapy in the intensive care environment is indeed still widely recognised by the medical profession (Norrenberg & Vincent 2000; Nava & Ambrosino 2000).

The burden of proof is on the physiotherapy profession to find ways to quantify this observed value of physiotherapy interventions in the intensive care setting. This opinion is supported by Nava and Ambrosino. In an editorial (2000:843) they state that, because of "... the almost total lack of self-evaluation among respiratory therapists for objectively assessing the clinical effects of the treatment given to a patient, ... there is no way – in the jungle of evaluation of costs and decisional responsibility – to convince administrative bodies of the value of a particular service."

In order to determine the value of physiotherapy intervention in the ICU the following question arises:

What measurements are physiotherapists currently utilising to provide evidence for the effectiveness of physiotherapy interventions in the adult critical care environment?

A systematic literature review of research articles published after the review article by Stiller (2000) was conducted in an effort to answer this question. Though the method used by Stiller in conducting the literature review is not clearly stated, it is evident from the reference list that she included articles published until 1999. The current literature review thus focuses on articles published from 1999. In an effort to be rigorous in giving a true reflection of the current state of evidence, the search methodology is reported in detail.

Method

Electronic database searches included EBScho Host, CINAHL, Medline (through PubMed) and Web of Science.

The following limits were set in all four databases:

- 1 January 1999 – 31 March 2004
- Human

Keywords used:

- Physiotherap* OR Physical Therap* AND ICU
- (Intensive care units AND (Physiotherap* OR Physical Therap*) NOT (Orthopaedics AND Neurology)
- AU=Ntoumenopoulos G* AND TS=PHYSIOTHER*
- AU=Denehy L* AND TS=Physiother*
- AU=Stiller K* AND TS=physiother*
- AU=Jones AY* AND TS=physiother*
- AU=Dean E* AND TS=Physiother*

Due to the fact that not all physiotherapy journals are included in the above-mentioned databases, and to obtain a good representation of the relevant publications, it was decided to hand search all issues of the following journals.

Core Journals (Maher *et al* 2001):

These journals were hand-searched for the same time frame to identify relevant articles:

- Australian Journal of Physiotherapy
- Physiotherapy Theory and Practice
- Physical therapy
- Physiotherapy Canada
- Physiotherapy

Full text online

The following journals are available to the University of Stellenbosch as full text online and were thus also individually screened for the specified time frame.

- Advances in Physiotherapy
- Physiotherapy Research International
- Journal of Physical Therapy Science

Other

- South African Journal of Physiotherapy

The abstracts of all articles were screened and those that complied with inclusion criteria were obtained from the internet or library.

Inclusion criteria:

- Research articles including randomised controlled trials, case studies and case control studies.
- Observational studies
- Surveys and audits
- Patient population: adult intensive care unit

Exclusion criteria:

As this review is aimed at reporting on outcome measures used in research over the past five years it was decided to exclude:

- Review articles
- Research articles using post cardiac surgery patients as subject matter. Due to fast tracking (patients being extubated within 12 hours following surgery) this patient population is not representative of the adult critical care population. (Patman *et al* 2000).

Results of search:

From the combined searches, 468 articles were retrieved. The following studies met the inclusion criteria and are included in this review.

Surveys	(12)
Case Reports	(7)
Case Control	(1)
Observational Studies	(5)
Randomised Controlled Trial	(10)

Due to the unique study design and lack of strength of evidence, surveys and case reports will be discussed separately.

SURVEYS

It is important to choose the best methodology to answer a specific question (Sackett *et al* 1996). Surveys answer questions concerning current practice. The fact that it is a relatively simple research methodology could be a reason why this research methodology was used so extensively over the preceding five years. In answer to the research question of what physiotherapists are measuring, there seems to be two topics that are continuously explored:

- The techniques physiotherapists use in the intensive care environment
- After-hours service provision

Knowing what the current practice is, however, does not provide evidence of the outcome of the interventions and will not provide the "hard evidence" the profession is seeking to make informed decisions. Refer to Table 3.1 for a summary of surveys:

Table 3.1 Summary of surveys conducted 1 January 1999 – 30 March 2004

AUTHOR	SUBJECT	RESPONSE RATE	COUNTRY	RESULTS
Norrenberg & Vincent (2000)	A profile ICU therapists	22% Physiotherapists	UK, Netherlands, Belgium, Germany, Portugal, Switzerland, Sweden	Variations in the role and profile of therapists exist across Europe.
Jones (2001)	Medical staff perceptions of physiotherapy in ICU	53% Medical Directors	UK, Australia, Canada, SA and Hong Kong	60% of medical directors consider physiotherapists to be replaceable
Lewis (2003)	ICU rehab	80.5% ICU Physiotherapists	UK	Musculoskeletal rehab is provided in 100% of units sampled; only 21% use outcome measures
McCarren *et al* (2003)	Physio's use of vibration	81% Physiotherapists	Australia	Vibration is used by 96% of respondents to assist patients with the clearance of secretions
Hodgson *et al* (1999)	Physio's use of MHI	100% senior ICU Physiotherapists	Australia	91% of respondents used MHI but only 31% monitored airway pressure
Cross (2001)	Physio's use of closed suction systems in adult ICU	52% Physiotherapists	UK	78% response with great variability noted amongst physiotherapists in the specifics of the technique
Chang *et al* (2004)	Physio's use of a tilt table in ICU	87% ICU Physiotherapists	Australia	67.4% of physiotherapists use the table for neurological conditions (63.8%) and (43.1%) for long-term stay
Heck *et al* (2001)	Weekend Physiotherapy service	84% Physiotherapists	Toronto, Canada	83% of respondents offered weekend service
Dixon & Reeve (2003)	Provision of support, training and provision for emergency on call physio service	90% Senior I Physiotherapists	UK	Sufficient guidance and support was offered to all departments. Service provision was in agreement with set standards
McAuley (1999)	Provision of weekend physio service	60%	Canada	High level of agreement to include patients with excessive secretions and those at risk of developing pulmonary complications
Thornton *et al* (1999)	Identify factors affecting motivation in acute care setting over 4 years	63% 1992 69% 1994 77% 1996 Variety Staff	Ottawa, Canada	Items associated with leaving – salary, work type and hours – and staying – salary, work type and staff interaction
Brooks *et al* (2003)	Current practice in management of acute medical conditions	51% Physiotherapy Department	Canada	It was the professional opinion that CRPT was indicated in atelectasis (86%), pneumonia (77%), chest trauma (76%)

CASE REPORTS

Since the development of evidence-based medicine, case reports have fallen into disfavour in the literature and are regarded by some as doing more harm than good (Vandenbroucke 2001). Evidence-based therapy is exclusively concerned with answering the question of what the most effective therapy/intervention in a specific patient population is, and a case study will not answer that question, although it does have value in the progress of medical science (Vandenbroucke 2001). This author also lists the following as the potential roles of case reports:

- Recognition and description of new diseases;
- Detection of beneficial or adverse effects of therapy;
- Study of the mechanism of disease;
- Medical education;
- Recognition of rare manifestations of disease.

Even though case reports are considered the weakest level of evidence, they emerge as the first line of evidence in many cases (Vandenbroucke 2001).

Seven case reports on a variety of topics were identified during the literature search. An interesting addition to the literature of the past few years has been the recognition and development of the rehabilitative role of physiotherapists within the intensive care unit, mainly focusing on the problems patients encounter following prolonged mechanical ventilation. These case studies could be pointing to a new direction for the physiotherapist within the ICU.

The following case reports were published:

- Strict clinical monitoring of patients discharged to the general ward after a prolonged period of mechanical ventilation, as these patients may need re-admission (Latronico *et al* 1999);

- Intensive two-hourly physiotherapy for non-intubated patients in acute respiratory distress could prevent intubation (Wong 2000);

- The measuring of inspiration muscle strength using (MIP) to identify inspiratory muscle dysfunction following prolonged periods of mechanical ventilation. (Bruton *et al* 2002);

- The use of the Modified Borg Scale (MBS) in the ICU as a measure of functional performance (Roos *et al* 2002);

- Early recognition and intensive multidisciplinary rehabilitation of patients suffering from critical illness poly neuropathy (Aichenbaum & Ring 2003);

- The use of hydrotherapy for ventilated patients suffering from Guillian Barre syndrome (GBS) (Taylor 2003); and

- Effectiveness of manual hyperinflation during management of acute atelectasis (Van Aswegen & Eales 2004).

These case reports relied mainly on physiological variables such as oxygenation status, CXR and auscultation findings to measure the effect of the interventions. Studies reported by Roos *et al* (2002) and Bruton *et al* (1999) specifically focused on the development of objective measurements that can be used in the evaluation of ICU patients by physiotherapists namely Modified Borg Scale (MBS) and standard maximal inspiratory pressure (MIP).

Roos *et al* (2002) investigated the use of the Modified Borg Scale (MBS) to evaluate an intubated patient's perceived effort during functional activities. The MBS has been used extensively as a valid and reliable outcome measure in pulmonary rehabilitation programmes and has been accepted into the American Thoracic Society Guidelines for Pulmonary Rehabilitation (1999). This scale is regarded as a patient-centred outcome (Chatburn 2001) and as such could provide physiotherapists with valuable evidence, especially for the rehabilitative aspects of interventions in the critical care patient population.

Two case studies reporting on the relation between standard maximal inspiratory pressure (MIP) and inspiratory muscle weakness have been published (Bruton *et al*

2002). In these studies the MIP and handgrip strength was used as outcome to describe the increasing inspiratory muscle strength in two patients after being mechanically ventilated for longer than 14 days. Testing took place twice weekly as soon as weaning was initiated. Both the MIP and handgrip strength of both patients increased gradually until the patients were successfully weaned. Further studies need to be conducted to determine if MIP is a reliable measure of respiratory muscle strength, and if increased muscle strength is indeed associated with a successful weaning of the patient. This measure could then potentially be used as an effective outcome measure if it can be correlated to the time on the ventilator.

The measurements used in the case control, observational and randomised controlled trials (RCTs) will be discussed together under physiological measurements, special tests, and patient-centred outcomes.

PHYSIOLOGICAL MEASUREMENTS

Physiological measurements do not necessarily relate to patient function (Ridley 2002:126). If these measurements are not related to more patient-centred outcomes, physiological measurements will do little to quantify and qualify the value of a physiotherapy intervention. As stated by Hurley (2000:339), "Often physiotherapy research becomes entangled in the physiological aspects of pathology ... as a consequence the research does not develop to answer questions relevant to clinicians, patients and health services ..."

Nine out of the sixteen remaining studies included in this review rely on physiological measures to report on the outcome of an intervention. The following measures were used:

Pulmonary Function

The effect of physiotherapy intervention on pulmonary function was measured either by the oxygenation status of the lung or by the compliance of the lung. The techniques that have been investigated over the last few years include positioning, manual

hyperinflation (MHI) and a combination of these techniques in patients either presenting with acute lobar atelectases or acute lung injury (ALI).

a) *Pulmonary gas exchange*

Five studies used blood gas analysis as a measurement of the effectiveness of an intervention. Blood gasses give precise measurement of the lung's ability to oxygenate the blood and remove excess carbon dioxide (Wilkens *et al* 1996).

Various measures reporting on the efficiency of pulmonary gas exchange as described by Tobin (1991:148-165) were used to measure the effect of interventions. Patman *et al* (2000) reported an immediate significant improvement in the alveolar–arterial oxygen tension levels following MHI with the patient in supine position. This improvement was sustained for 60 minutes following the intervention. Despite the excluding criteria for this review it was decided to include this study because the researchers investigated the immediate effect of MHI on certain respiratory parameters in intubated patients following uncomplicated coronary artery bypass surgery (CABS).

Contrary to these findings, the FiO2:PaO2 ratio, which also gives an indication of the effectiveness of gas exchange, was unaffected by a combination of MHI and suction in the side lying position of patients suffering from acute lung injury (Barker & Adams 2002). In this study, the researchers investigated the immediate effect that the standard of care as applied in their institution had on patients suffering from acute lung injury (ALI)[1]. Patients were randomly allocated to three groups that all received variations of the standard practice as employed at the hospital.

Group 1: 30 degrees supine head-up position, pre-oxygenated and suctioned

Group 2: Right and left lateral decubitus position 0 degrees head-up, pre-oxygenated and suctioned

[1] Acute lung injury (ALI) has been defined as an umbrella term for hypoxemic respiratory failure, a severe version of which is "Acute Respiratory Distress Syndrome" (ARDS). These patients typically present with bilateral pulmonary infiltrates on chest x-ray, pulmonary capillary wedge pressure <18 mmHg, PaO2:FiO2 <300.

Group 3: Right and left lateral decubitus position 0 degrees head-up, pre-oxygenated 6 MHI breaths and suctioned.

A significant change in PaO_2 values was noted in all three groups. This finding could have been due to loss of recruitment of the injured lung due to loss of positive end expiration pressure (PEEP) following disconnection from the ventilator. The slow decrease in PaO_2 values over the next hour to pre treatment levels could be explained by slow re-recruitment of the lung by continued PEEP.

Differences in the results between these two studies could be related to differences in the pathology of the sample groups. The mechanism for deflation is very different for patients presenting with acute lung injury (ALI) from basal atelectasis following surgery. This underlines the importance of differentiating between underlying pathology and the need for physiotherapists to be selective in their choices of treatment techniques.

The position a patient is placed in also seems to affect oxygenation, as was described by Krause *et al* (2000). These researchers compared the effect of a standard postural drainage position with the head down, to a modified postural drainage position with the head flat, on various oxygenation parameters in patients presenting with acute lobar atelectasis. Due to a small sample size (N=17), the results of this study were not significant although there was an increase in the PaO2/FiO2 ratio from 185 to 259 following the head down position compared to a minimal increase of 225 to 225.5 following the head flat position. A value of more than 200 is indicative of satisfactory gas exchange. The PaO2 increased from 74 to 97 mmHg in the head down position and from 89 to 90 mmHg in head flat position. (Normal PaO2 value 80 – 100 mmHg).

None of these studies were linked to patient-centered outcomes and thus their value for the physiotherapist's continued role within an ICU is limited. These studies do, however, underline the importance of patient-specific interventions as opposed to routine physiotherapy intervention, as the same treatment regime, comprising of positioning, MHI, manual techniques and suctioning, affected the oxygenation status of patients differently, based on the underlying pathology.

b) Lung Compliance

Four studies reported on lung compliance as outcome. They all evaluated the effect of hyperinflation, either manually or by the ventilator, performed in various positions in patients with either ALI or acute lobar atelectasis.

Lung compliance is a physiological measure expressed as the change in volume for a given change in the distending trans thoracic pressure. The total thoracic compliance is calculated as follows: Tidal volume / (Plateau pressure – PEEP). A total compliance of 60 – 100 ml/cmH20 is regarded as normal for mechanically ventilated adults, while compliance of less than 25 ml/cmH2O is not regarded as a positive sign for successful weaning (Tobin 1991). Dynamic pulmonary compliance is calculated using the peak pressure measurement instead of plateau pressure.

Barker and Adams (2002) found no significant difference in dynamic compliance when applying MHI in the lateral decubitus positions in ALI patients, while Berney *et al* (2004) and Patman *et al* (2000) found a significantly increased pulmonary compliance in patients subject to MHI. These contrary results may again be attributed to the underlying pathology of the patients who were included, with Barker and Adams (2002) examining patients with ALI, while Berney *et al* (2004) and Patman *et al* (2000) specifically excluded these patients from their sample.

Interestingly Berney & Denehy (2002) reported similar results from comparing MHI to ventilator hyperinflation (VHI). The fact that the VHI had similar outcomes, i.e. wet weight of sputum cleared and static pulmonary compliance, is an important clinically relevant result, as it actually ends the whole equipment and technique debate that has surrounded MHI for so long (Denehy 1999; Patman *et al* 2001).

The position of the patient, whether it be supine, side lying with the bed at 0 degrees, or 35 degrees tilted, does not seem to affect the compliance of the lung (Berney *et al* 2004; Barker & Adams 2002; Patman *et al* 2000; Berney & Denehey 2002).

Linking increased compliance to successful weaning from the ventilator does seem to make physiologic sense and could potentially influence the time on the ventilator which is regarded as a valid outcome measure from the ICU (Chatburn 2001).

Hemodynamic and metabolic factors

For many years the detrimental effects of physiotherapy techniques on oxygen consumption was accepted as a fact, and various reports of increased VO2 associated with physiotherapy intervention exist (Stiller 2000). Contrary to this, Berney and Denehy (2003) reported that there was no statistically significant difference in the VO2 measured when 20 minutes of undisturbed side lying (head flat) was compared to physiotherapy intervention which comprised of the head down postural drainage position, ventilator hyperinflation (VHI) and suctioning. An increase in VO2 was observed in all patients immediately after changing position but was classified as transient, as the measure returned to baseline within one minute.

The previous studies did not allow the measurements to return to baseline before the next intervention was applied. This previously reported increase in oxygen consumption thus reflected the cumulative effect of position change and therapy. From Berney and Denehy's (2003) study it is clear that changing a patient's position accounts for the major increase in oxygen consumption, but that these values return to baseline within one minute.

In both ALI and atelectases patient groups the effect of MHI, positioning and suctioning on hemodynamic variables (mean arterial pressure, pulse rate and cardiac index) were not found to be clinically significant (Berney & Denehy 2003; Barker & Adams 2002).

SPECIAL TESTS

A variety of special tests and evaluation techniques were used as outcome measures in nine of the studies reviewed. This included CXR (Krause *et al* 2000; Van Aswegen & Eales 2004), auscultation (Van Aswegen & Eales 2004), wet sputum weight (Hodgson *et al* 2000; Berney & Denehy 2002; Berney *et al* 2004).

Resolution of atelectasis on CXR was found within 24 hours:

- following physiotherapy using side lying, percussion and vibrations, MHI and suctioning (Van Aswegen & Eales 2004); and

- when a postural drainage position was used in comparison to a modified position (Krause *et al* 2000).

In clinical practice both CXR and auscultation are evaluation techniques used daily by physiotherapists to report on the management of patients. However, the reliability and validity of these measures have been questioned (Aweida & Kelsey 1990; Halvorsen *et al* 1989). These techniques are suspect and both the inter- and intra rater reliability of CXR and auscultation have been questioned. Not only are the results suspect in not being accurate or reliable, but there is no clear link between abnormal findings on CXR and auscultation and the natural course of a pathology (Stiller & Munday 1992). Relying on these measures alone to provide evidence of effectiveness is suspect.

The following techniques were shown to affect the wet sputum weight in mechanically ventilated patients:

- The head down position will result in greater production of sputum than head flat position (Berney *et al* 2004);

- MHI cleared significantly more sputum than suction alone (Hodgson *et al* 2000); and

- VHI and MHI are equally effective in clearing similar amounts of sputum (Berney & Denehy 2002).

Despite the theory of mucus retention and decreased compliance there is no hard evidence relating mucus retention to pneumonia or atelectasis. In a review article published by Smith and Ellis (2000) the question whether retained mucus was indeed a risk factor for the development of postoperative atelectasis and pneumonia, the authors state that "... the relative contribution of mucus obstruction to the development of atelectasis in the post operative patient may be debated ..." and "… the link between retained mucus and pneumonia has not been established" (Smith & Ellis 2000:74).

PATIENT-CENTRED OUTCOMES

An outcome measure can be described as a measurement used to document the success of an intervention. This success can be described from the service provider's or the patient/family's perspective. The following outcome measures have been identified in the literature: days on mechanical ventilation, ICU length of stay (LOS), mortality rate, quality of death and HRQL (Rubenfeld *et al* 1999). These are the broader outcomes that Stiller (2000:1810) refers to, and this author suggested that it is in this area that research must be focused.

a) *Duration of mechanical ventilation*

Only one study could be found where the length of mechanical ventilation was measured as an outcome for physiotherapy intervention. Ntoumenopoulos *et al* (2002) examined the effect of daily routine intervention that consisted of a gravity assisted drainage position for 20 minutes, vibrations and suctioning, on the development of ventilator associated pneumonia (VAP). Despite the fact that physiotherapy intervention was independently associated with a reduction in the development of VAP, there was no statistical difference in the duration of mechanical ventilation in the two groups. This can be attributed to the small sample (N= 60) as the median days for the intervention group was 3.8 (2-31) and 6.9 (2-20) for the sham group.

This type of study could prove to be important for identifying ICU quality indicators, as the routine physiotherapy applied in this study could be incorporated as a process measure. Please refer to part one of this review for further clarification of this concept.

b) Length of stay in ICU (LOS)

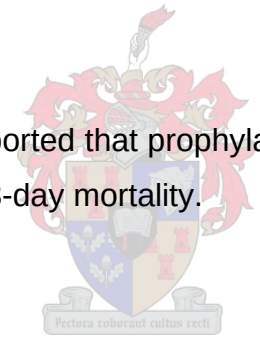
In a case-control study, Berney *et al* (2002) found a significantly decreased LOS for quadriplegic patients who were extubated immediately postoperatively and who received intensive 24-hour physiotherapy as needed. The intervention comprised of IPPB, gravity-assisted positioning and assisted coughing. This group was compared to a control group who received a tracheostomy and daily physiotherapy comprising of gravity-assisted positioning, MHI and suctioning. Despite the possible bias associated with matching, the results of this study does warrant further investigation into the effects of 24-hour service on patient outcome (McAuley 1999).

Mackay and Ellis (2002) found that an increased number of physiotherapy treatments – 8.6 +- 6.24 (6.1 – 10.9) compared with 17.77 +-22.03 (9.5 – 26.0) – did not reduce the length of hospital stay of patients following abdominal surgery. There were, however, fewer postoperation pulmonary complications, and patients were mobilised earlier in the group that received more interventions. These results support those of Berney *et al* (2002) in suggesting that postoperative physiotherapy is most effective immediately after surgery and that the effect diminishes over time. Evaluating ICU length of stay might be a more sensitive measure for physiotherapy intervention than hospital length of stay.

Further work evaluating the effect of physiotherapy on pulmonary complications could result in physiotherapy intervention again being an indicator for quality as either a complication measure or a process measure. Please refer to part one of this review.

c) Mortality

Ntoumenopoulos *et al* (2002) reported that prophylactic physiotherapy in an ICU had no significant influence on ICU or 28-day mortality.



CONCLUSION

In answer to the question of what physiotherapists are measuring, it is apparent that the profession is relying heavily on physiologic variables, special tests, or descriptions of current practice without linking these to patient-centered outcomes. Only reporting on physiological variables and special tests in the adult critical care environment will not convince patients or funders of the value of physiotherapy (Nava & Ambrosino 2000:843). Research must be linked to broader accepted outcomes (Stiller 2000). These outcomes may, however, not be sensitive enough to measure the true effect of physiotherapy intervention in the ICU. Further work is needed to develop and refine measurements that will measure the effect of physiotherapy. Refer to the discussion of process measures in the first part of this review.

It is also important that the effect of physiotherapy staffing levels and qualifications, the provision of 24-hour service, etc. be linked to patient outcomes for physiotherapists to

provide an effective evidence-based service. It is evident from this review that, when designing a research protocol, deciding what to measure is paramount in providing clinicians with evidence for the profession's continued role in the ICU.

Outcomes research provides us with the tools to generate evidence for our continued involvement in the critical care environment. In the third part of this review we will explore which professions and interventions have been linked to favorable patient outcomes from an ICU through outcomes research. The implications of these findings for the physiotherapy profession will be outlined.

REFERENCES

Aichenbaum S & Ring H 2003 Rehabilitation of a patient with critical illness poly neuropathy (CIP) following acute respiratory failure: a case report and review of literature. *Disability and rehabilitation* 25(6):273-276

American Thoracic Society 1999 Pulmonary Rehabilitation. *American Journal of Respiratory and Critical Care Medicine* 159:1666-1682

Aweida D, Kelsey C 1990 Accuracy and reliability of physical therapists in auscultating tape recorded lung sounds. *Physiotherapy Canada* 42(6): 279 – 282

Barker M & Adams S 2002 An evaluation of a single chest physiotherapy treatment on mechanically ventilated patients with acute lung injury. *Physiotherapy Research International* 7(3):157-169

Berney S & Denehy L 2002 A comparison of the effects of manual and ventilator hyperinflationon static lung compliance and sputum production in intubated and ventilated intensive care patients. *Physiotherapy Research International* 7(2):100-108

Berney S, Stockton K, Berlowitz D, Denehy L 2002 Can early extubation and intensive physiotherapy decrease LOS of acute quadriplegic patients in intensive care? A retrospective case control study. *Physiotherapy Research International* 7(1):14-22

Berney S & Denehy L 2003 The effect of physiotherapy treatment on oxygen consumption and haemodynamics in patients who are critically ill. *Australian Journal of Physiotherapy* 49: 99-105

Berney S, Denehy L, Pretto J 2004 Head-down tilt and MHI enhance sputum clearance in patients who are intubated and ventilated. *Australian Journal of Physiotherapy* 50:9-11

Bithell C 2000 Evidence Based Physiotherapy. *Physiotherapy* 86(2):58-60

Brilli RJ, Spevetz A, Branson RD, Campbell GM, Cohen H, Dasta JF, Harvey MA, Kelley MA, Kelly KM, Rudis MI, St Andre AC, Stone JR, Teres D, Weled BJ; American College of Critical Care Medicine Task Force on Models of Critical Care Delivery 2001 Critical care delivery in the ICU: defining clinical roles and best practice model. *Critical Care Medicine* 29(10):2007-2019

Brooks D, Parsons J, Crowe J, Solway S, Kelsey C 2003 Cardiorespiratory Physical Therapy for acute Medical conditions: Canadian survey of clinical practice. *Physiotherapy Canada* 55:216-24

Bruton A, Conway J, Hogate S 2002 Inspiratory muscle dysfunction after prolonged periods of mechanical ventilation. *Physiotherapy* 88(3):131-137

Chang A, Boots R, Hodges P, Paratz J 2004 Standing with assistance of a tilt table in intensive care: A survey of Australian physiotherapy practice. *Australian Journal of Physiotherapy* 50:51-54

Chatburn R 2001 Outcomes Research in Respiratory Care. *Respiratory Care* 46(11):1215-1225

Cross J 2001 A survey of physiotherapists' current practice with closed suction systems in adult patients. *Advances in Physiotherapy* 3:67-75

Denehy L 1999 The use of manual hyperinflation in airway clearance. *European Respiratory Journal* 14:958 -965

Dixon T & Reeve J 2003 Emergency on-call duties. *Physiotherapy* 89(2):104-113

Ferdinande P & Members of Task Force of the European Society of Intensive Care Medicine 1997 Recommendations on minimal requirements for Intensive Care Departments. *Intensive Care Medicine* 23:226-232

Halvorsen J, Kunian A, Gjerdingen B 1989 The interpretation of office radiographs by family physicians. *Journal of Family Practice* 28(4):426-432

Heck C, Newton J, Chan A 2001 Weekend Physiotherapy service provision: A survey of Toronto area hospitals. *Physiotherapy Canada* 53:288-297

Herbert R, Sherington C, Maher C, Moseley A 2001 Evidence-based practice – imperfect but necessary. *Physiotherapy Theory and Practice* 17:201-211

Hodgson C, Carroll S, Denehy L 1999 A survey of manual hyperinflation in Australian hospitals. *Australian Journal of Physiotherapy* 45(3):185-193

Hodgson C, Denehy L, Ntoumenopoulos G, Santamaria J, Carroll S 2000 An investigation of the early effects of manual lung hyperinflation in critically ill patients. *Anaesthesia and Intensive Care* 28(3):255-261

Hurley M 2000 Linking research with practice: The missing link – collaboration. *Physiotherapy* 86:339-341

Jones A 2001 Intensive care physiotherapy - medical staff perceptions. *Hong Kong Physiotherapy Journal* 19:09-16

Krause MW, van Aswegen H, De Wet E, Joubert G 2000 Postural drainage in intubated patients with acute lobar atelectases - a pilot study. *South African Journal of Physiotherapy* 56(3):29-32

Latronico N, Guarneri B, Alongi S, Bussi G, Candiani A 1999 Acute neuromuscular respiratory failure after ICU discharge. *Intensive Care Medicine* 25:1302-1306

Lewis M 2003 ICU rehabilitation within the UK. *Physiotherapy* 89(9):531-538

Mackay M & Ellis E 2002 Physiotherapy outcomes and staffing resources in open abdominal surgery patients. *Physiotherapy Theory and Practice* 18:75-93

Maher C, Moseley A, Sherrington C, Herbert R 2001 Core Journals of evidence based physiotherapy practice. *Physiotherapy Theory and Practice* 17:143-151

McAuley C 1999 Evidence-based Care: Determining the appropriateness of weekend physiotherapy services in an acute care tertiary hospital. *Physiotherapy Canada* 51:126-132

McCarren B, Alison J, Lansbury G 2003 The use of vibration in public hospitals in Australia. *Physiotherapy Theory and Practice* 19(2):87-99

Nava S & Ambrosino N 2000 Rehabilitation in the ICU: The European phoenix. *Intensive Care Medicine* 26:841-844

Norrenberg M & Vincent JL 2000 A profile of European intensive care unit physiotherapists. *Intensive Care Medicine* 26:988-994

Norrenberg M & Vincent JL 2002 Physiotherapy in ICU. Useful or Useless? European Society of Anaesthesiologists http://www.euroanesthesia.org/pages/education/rc_nice/12rc5.html last updated 6 April 2002 *(Accessed 18 March 2003)*

Ntoumenopoulos G, Presneill J, McElholum M, Cade JF 2002 Chest physiotherapy for the prevention of ventilator associated pneumonia. *Intensive Care Medicine* 28:850-856

Patman S, Jenkins S, Stiler K 2000 Manual hyperinflation – effects on respiratory parameters. *Physiotherapy Research International* 5(3):157-171

Patman S, Jenkins S, Smith K 2001 Manual hyperinflation – consistency and modification of the technique by physiotherapists. *Physiotherapy Research International* 6(2):106-117

PEDro (http://www.pedro.fhs.usyd.edu.au/index.html, last updated 24 March 2004) *Accessed 24 July 2004*

Ridley S 2002 Outcomes in critical care. Butterworth & Heinemann. Cornwall ch 1 p1-21

Roos R, Van Aswegen H, Eales C 2002 Perceived effort of functional activities after a period of mechanical ventilation. *South African Journal of Physiotherapy* 58(4):33-36

Rubenfeld G, Angus D, Pinsky M, Curtis R, Connors A, Bernard G and the Members of the Outcomes Research Workshop 1999 Outcomes Research in Critical Care. Results of the American Thoracic Society of Critical Care Assembly Workshop on Outcomes Research. *American Journal of Critical Care Medicine* 160:358-367

Sackett D, Rosenberg W, Muir G, Haynes BA, Scott Richardson W 1996 Evidence-based Medicine: What it is and isn't. *British Medical Journal* 312:71-72

Smith M & Ellis E 2000 Is retained mucus a risk factor for the development of postoperative atelectasis and pneumonia? *Physiotherapy Theory and Practice* 16:69-80

Sterne JA & Smith GD 2001 Sifting the evidence – what's wrong with significance tests? *Physical Therapy* 81(8):1464-1469

Stiller K & Munday R 1992 Chest physiotherapy for the surgical patient. British Journal of surgery 79:745-749

Stiller K 2000 Physiotherapy in ICU. Towards an evidence based practice. *Chest* 118:1801-1813

Taylor S 2003 The ventilated patient undergoing hydrotherapy. *Australian Critical Care* 16(3):111-115

Thornton M, Melis E, Pham B 1999 Development, implementation and results of a survey to identify factors affecting motivation in an acute care physiotherapy setting. *Physiotherapy Canada* 51:251-258

Tobin M 1991Essentials of Critical Care Medicine. Churchill Livingstone. New York ch 2 p139-165

Van Aswegen H & Eales C 2004 The effectiveness of MHI during the physiotherapy management of acute atelectasis: a case report. *SA Journal of Physiotherapy* 60(1):29-32

Vandenbroucke J 2001 In defence of Case Reports and Case Studies. *Annals of Internal Medicine* 134:330-334

Wijetunge A & Baldock GJ 1998 Evidence-based intensive care medicine. *Anaesthesia* 53:419-421

Wilkens RL Sheldon RL, Krider SJ 1996 Clinincal assessment in Respiratory Care 2nd Edition. Mosby. London p73-106

Wong Wai Pong 2000 Physical Therapy for a patient in acute respiratory failure. *Physical Therapy* 80(7):662-670

World Confederation for Physical Therapy http://www.wcpt.org/programmes/index.html *(Accessed 24 July 2004)*

CHAPTER 4 Review Article

OUTCOMES RESEARCH IN THE ICU - FACTORS INFLUENCING PATIENT OUTCOME FROM ICU

SUMMARY

This is the third and final part of a review exploring the value of outcomes research in clarifying the role of the physiotherapist in the critical care environment. The outcome of patients from ICU is determined by the input, the process and also by the characteristics or the case mix of the patients admitted to the unit. In this review we shall identify and discuss the factors that have been associated with a more favourable outcome from the ICU. The studies that are reviewed could indicate to physiotherapists the contribution that this research methodology has made to the current body of evidence concerning the care of patients in an ICU.

INTRODUCTION

As is evident from the first two parts of this review, the effect of physiotherapy interventions, staffing levels, after hours service provision, etc. on patient-centred outcomes has not been systematically documented. The past two decades have seen the emergence of outcomes research as a method of obtaining, implementing and re-evaluating evidence in a constant evolution of "best practice" (Chatburn 2001) within the critical care environment. Although a specific definition for outcomes research is still lacking (Kollef 1998), there seems to be widespread acceptance of the fact that outcomes research is used to formulate clinical guidelines, to assess the quality of medical care and to inform health policy decisions (Kollef 1998; Chatburn 2001).

Observational outcomes research can be used to identify associations between exposure and outcome. This exposure is defined broadly in outcomes research and can include such diverse aspects as medication, structure of the unit, therapeutic interventions, socio-economic status, etc. In observational research, adjusting for case mix is essential for researchers to compare the outcomes of patients from different ICUs (Gunning & Rowan 1999).

The outcome of patients discharged from ICU is determined by the input (the equipment, staff), the process (interventions, timing of care) and also by the characteristics or the case mix of the patients admitted to the unit. For example, units admitting older patients with underlying chronic pathology would be expected to have a higher mortality rate than a unit catering for healthy young patients in a diabetic coma. This expected difference in outcome (mortality) would be because the first unit admitted more severely ill patients and not because the input or process in the unit was poor.

As a research methodology, observational studies must adjust for confounding variables that could influence the results. An observed outcome can be due to a confounding variable that obscures the true causal association when none exists. Since observational research does not use randomisation to control for confounding variables, they are subject to bias. Biases, however, do not always invalidate a study (Pronovost & Angus, 2000). Identifying and minimising the effects of these confounding variables constitutes a large part of the design and analysis of data in outcomes research.

METHODOLOGY

A literature search was conducted to identify variables that have been linked to patient outcome from an ICU, accessing the following databases:

- Medline through Pubmed
- Cinahal
- Web of Science
- Cochrane
- PeDro
- Ebscho Host

The following keywords were used:
Outcomes; ICU; Critical Care; Evidence Based Medicine, Quality indicators.

The references of all retrieved articles were screened and the relevant articles were obtained. The following factors affecting patient outcome were identified and these will be discussed under the headings that follow:

1. Input:	staffing of the unit
	structure of the unit
	use of protocols
2. Process:	time of admission
	the quality of care patients receive before admission
	delayed admission
3. Case mix of patients:	severity of illness
	demographics
	body mass index (BMI)
	comorbidities

1. Input

The specific manner in which a unit is organised and staffed has been linked to the outcome of patients from the unit. The following input variables were identified, namely

the staffing levels, i.e. the numbers involved, the qualifications of staff, and the team members involved, the way a unit has been organised, and the use of protocols. In the literature search no studies that examined a link between physiotherapy staffing levels and patient outcome specifically from ICU could be identified.

1.1 Staffing of the unit

The effect that intensivists, nurses and pharmacologists have on patient outcome has been investigated and is reported as follows:

1.1.1 Intensivists

Pronovost *et al* (2002) documented a detailed report of a rigorously conducted systematic review examining physician staffing patterns and patient outcomes based on literature published from 1979 to 2000. Their analyses of the pooled results indicated that:

a. High intensity ICU physician staffing resulted in a decreased hospital mortality; Relative risk (RR) .71 (95% CI 0.62 – 0.82)
b. High intensity ICU physician staffing resulted in a decreased ICU mortality; Relative risk (RR) .61 (95% CI 0.50 – 0.75)
c. A statistically significant decrease in both hospital and ICU length of stay was associated with high intensity physician staffing levels.

High intensity ICU physician staffing has also been associated with a:

- Decrease in medical care costs (Chalfin *et al* 1995);
- An increased survival lasting up to 12 months after discharge from a unit (Li *et al* 1984); and
- Improved quality of dying (Kollef 1996).

1.1.2 Nursing care

Nursing care has been linked to favourable patient outcomes following critical illness. Adequate patient:nurse ratios have been associated with increased patient outcome especially:

- In the prevention of nosocomial infections (Joiner *et al* 1996)
- Decreased time on mechanical ventilation (Thorens *et al* 1995)

Hours of nursing care have also been linked to patient outcome and found to be inversely proportioned to (Blegen *et al* 1998):

- Medication errors
- Pressure ulcer rates and
- Patient and family complaints.

In an ongoing study by Potter *et al* (2003) to identify the relationship between nurse staffing and patient outcome, baseline data was collected for 12 months from 1 February 2000 until 31 January 2002. These authors will continue to gather similar data during 2004, after the implementation of a new care delivery system by the hospital. The data collected includes patient and family satisfaction, adverse effects, e.g. falls, and prevention of complications. The uniqueness of this study lies in the inclusion of self-reported patient data by means of the visual analogue scale (VAS) to measure distress, willingness to care for self and an index of self care as outcome measures. These measures are to be used as baseline data by the authors.

1.1.3 Pharmacists

Leape *et al* (1999) showed that the inclusion of pharmacists to an ICU:

- Reduce adverse drug events; and
- Reduce cost of care

1.2 Structure of a unit

How intensive care services are delivered may have a greater impact on patient outcome than individual therapies (Randolph & Pronovost 2002). The way a unit is organised has been linked to patient outcome. Units are described as either open or closed. In a closed unit patients are admitted to the unit by the intensivist. This specialised doctor decides on all aspects of care that a patient is to receive in the ICU. He/she consults with relevant specialities like orthopaedics and neurology, when indicated (Carson *et al* 1996).

A closed unit has been associated with

- Shorter ICU and hospital LOS;
- Fewer days of mechanical ventilation;
- Fewer complications (Hanson *et al* 1999; Brilli *et al* 2001).

1.3 Use of protocols

The use of protocols within an ICU has been regarded with some skepticism in the medical community, the concern being that the use of protocols may reduce the quality of care by substituting clinical judgment, thereby breeding complacency or stifling learning (Wall *et al* 2001). Despite these beliefs an increasing number of studies are suggesting that the judicious use of protocols can decrease potentially harmful variations in care, enhance efficiency and improve patient outcome (Wall *et al* 2001).

One such study that has specific relevance for physiotherapy is the RCT done by Kollef *et al* (1997) to compare protocol-directed weaning from mechanical ventilation to physician-directed weaning. The protocol was developed by the physicians and implemented by the respiratory therapists and nurses. The study was completed in four ICUs (n=357). Patients in the protocol group (N=179) spent significantly less time (p=0.29) on the ventilator than the patients in the physician-directed group (n=178). In one of the units the mean Acute Physiology and Chronic Health Evaluation (APACHE II) score was significantly higher in the physician-directed group. No differences were recorded in the other three units. The groups were comparable in age, gender and ethnicity.

O Chan *et al* (2001) described an interdisciplinary process of developing and implementing an extubation protocol in an ICU. This resulted in similar times on the ventilator, compared to literature and historical controls, without any adverse effects to the patients. The exercise was reported as a useful enhancing tool for team building within an unit.

2. Process

The time of admission, the quality of care patients receive before admission and delayed admission have been shown to affect patient outcome on discharge from an ICU and these aspects will be discussed below.

2.1 Time of admission to an ICU

The effect on outcome of the time of day when a patient is admitted to a unit was examined by Morales *et al* (2003). This retrospective cohort study was completed over

five years and included the records of 6 034 patients. A significantly higher mortality rate OR 1.557 (95% CI 1.325 – 1.830) adjusted for severity of illness and admission source was found in patients admitted before 17:00. The hospital LOS was also longer 12.7+-14.8 median eight days vs. 11.0 +-13.5 median seven days in this patient population. The researchers could not explain this finding as they hypothesised that night-time admissions would be associated with higher mortality because of sleep deprivation of staff members. Complications as a result of more invasive procedures and surgeries during the daytime were noted as a possible explanation of the finding. The association between time of day of admission to a unit and patient outcome is not clear from this study.

2.2 The quality of care

The quality of care that patients receive before admission to an ICU was shown to influence patient outcome. McQuillan *et al* (1998) reported on an association between sub-optimal pre ICU admission care and increased mortality, and increased ICU LOS. In this study, the investigators conducted structured interviews with the referring and intensive care clinical teams at two centres. Thereafter they analysed the interviews and completed a questionnaire that focused on the recognition, investigation, monitoring, and management of each patient's airway, breathing, circulation oxygen therapy and monitoring before admission to the unit. These questionnaires were then evaluated by two independent assessors (a nephrologist and an anaesthetist).

The assessors agreed that 54 of the patients (n=100) received suboptimal care. Mortality in the intensive care unit for these patients was 48%. This is almost twice as much as the 20 patients who they agreed had been managed well. Furthermore these assessors were of the opinion that two thirds of these 54 patients' admission to ICU had been delayed.

Admission from other in-hospital areas have also been linked to an increased mortality rate (Bristow *et al* 2000). Patients admitted to an ICU at the beginning of their hospitalisation present with better outcomes in regards to mortality (Hillman *et al* 1999) than those that are transferred later in the course of treatment.

2.3 Delayed admissions to ICU

Parkhe *et al* (2002) reported on the outcome of patients who experienced delayed admission to the ICU. Patients' records were reviewed retrospectively and then grouped into a delayed admission group n=23 (patients admitted after 24 hours of admission to an emergency department) and a direct admission group n=99 (patients admitted within 24 hours of admission to the emergency department). Patients in the delayed group had significantly higher APACHE II and Simplified Acute Physiology Scores (SAPS II) than the direct admission group. Both ICU mortality and thirty-day mortality were also significantly higher in the delayed admissions group.

3 Case mix

Comparing patient outcomes from ICU forms the basis of outcomes research. As discussed in part one of this review, these comparisons can be made in the following three ways:

- Using data from a baseline study before and after change in practice;
- Using published data to compare a different practice;
- Using multi-centre observations.

In all of these examples it is important to determine if the case mix of the patients admitted to the unit is comparable. The following variables have been linked to patient outcome, namely severity of illness, demographics, comorbidities and body mass index (BMI).

3.1 Severity of illness

The patient's underlying disease is regarded as the most important variable in determining outcome from an ICU (Ridley 2002). In order to compare units or compare change in practice in a single unit, it is important to determine how severely ill the patients were on admission. Various scoring systems have been developed to quantify this case mix and then use the score to predict the outcome of a patient. Because of the high mortality rate of up to 30% (Gunning & Rowan 1999) associated with ICU admission, death is regarded as a sensitive, appropriate and meaningful measure of

outcome for ICU intervention and is used as such by the scoring systems. Marino (1998) describes a wide variety of scoring systems, namely the:

- **Glascow Coma Scale**

Used to assess impaired consciousness in patients. It is scored out of 15 with 3 as the worst score.

- **Multiple Organ Dysfunction Score**

This score can be determined daily and gives a clear indication of changes in mortality risks as the score relates the number of major organs failing to mortality.

- **Acute physiologic and chronic health evaluation (APACHE)**

The APACHE was first developed by Knaus in 1981 and then updated to the APACHE II (Knauss *et al* 1985), reducing the original 34 physiological variables to 12 commonly measured variables. APACHE II uses 12 variables + age + previous health to score and an increased score is associated with an increased mortality. The APACHE II scoring system is still the most widely used scoring system, accounting for 64% of 1 339 scientific citations of scoring systems between 1994 and 1999 (Scientific Science Index).

This is so in spite of the APACHE III currently being available. The fact that this scoring system is currently available at considerable cost is making it less attractive to third world countries. As it is still debatable whether it actually represents a significant improvement in scoring, the expenditure is seldom justified (Hariharan *et al* 2002).

Livingston *et al* (2000) compared the performance of five scoring systems within a large Scottish dataset. The scoring systems that were evaluated were: APACHE II and III, the UK modified APACHE II, the simplified acute physiology score (SAPS) II, and the mortality probability model (MPM) II. After prospectively gathering data for two years in 22 units that ranged over Scotland and included 10 393 patients, they concluded that the APACHE II is the most appropriate model for the comparison of mortality rates between units.

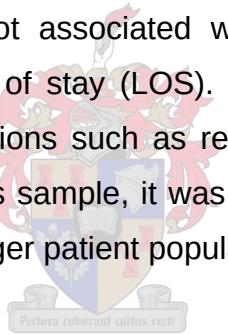
The simplified acute physiological scoring system (SAPS) is a derivation of the original APACHE and was updated in 1993 to SAPS II. The SAPS III project is currently in progress (http://www.saps3.org).

3.2 Demographics

The age and the gender of patients have been examined in relation to the effect this has on patient outcome.

3.2.1 Age

The use of age as a determinant of outcome is still controversial. Age was independently associated with increased mortality in a cohort of 357 patients studied by Kollef (1993). In a study undertaken by Estaban *et al* (2004) to determine the outcome of older patients (> 70) compared to middle age (43 – 70) patients from an ICU it was found that advanced age was not associated with prolonged time on mechanical ventilation, ICU or hospital length of stay (LOS). Increased mortality was associated with the development of complications such as renal failure and shock. As they only included patients > 43 years in this sample, it was not clear whether there would be a difference when compared to younger patient populations.



3.2.2 Gender

The relation between outcome and gender has been the subject of various studies. Kollef *et al* (1997a) investigated the impact of gender on outcome from mechanical ventilation. In this prospective multi-centre study all patients older than 18 requiring mechanical ventilation following ICU admission, were included. This resulted in a sample size of 357 patients. Outcomes measured were mortality, length of mechanical ventilation, and LOS. In the two units, gender was found to be independently associated with mortality. Women requiring mechanical ventilation were at a greater risk of hospital mortality than men, although gender has the smallest predictive power (5%) of mortality. Other factors like severity of illness and organ failure were more important in predicting outcome. In this study, length of mechanical ventilation and LOS was not significantly influenced by gender.

3.3 Body Mass Index (BMI)

In a study undertaken by Garrouste-Orgeas *et al* (2004) over two years in six adult ICUs in different parts of France, 1 698 patients were evaluated to determine the association between Body Mass Index (BMI) and mortality. BMI below 18.5 kg/m2 was independently associated with increased mortality. An increased BMI has been associated with increased time on a ventilator (Bochicchio *et al* 2004).

3.4 Comorbidities

One study examining the outcome of HIV-positive patients admitted to an ICU with a disease unrelated to their status was conducted in Natal, South Africa. Bhagwanjee *et al* (1997) examined the relationship between HIV status and outcome from ICU for patients admitted for diseases unrelated to HIV. The researchers obtained special permission to test all patients admitted to a surgical ICU in the study period. Outcomes measured were LOS in ICU and hospital, mortality in ICU and hospital, incidence of nosocomial sepsis and shock. Informed consent was not obtained. Only 13% of patients N=402 tested positive for HIV. There was no difference in the LOS or mortality between patients who tested positive and those patients testing negative. HIV as a comorbidity does not seem to affect patient outcome from an ICU, if admitted with an unrelated condition. This is in contrast to studies published where the outcome of HIV-positive related ICU admissions were evaluated. De Palo *et al* (1995) examined the mortality rate of patients admitted to an ICU with respiratory failure due to pneumocytis carinii pneumonia (PCP). They conclude poor prognosis for patients receiving mechanical ventilation due to PCP infection.

Other comorbidities that have been reported to increase ventilator days are: history of myocardial infarction (MI), type 1 diabetes mellitus (DM), cancer, hypertension and COPD. (Bochicchio *et al* 2004)

CONCLUSION

It is evident from this review that outcomes research has been informing many aspects of clinical practice in the critical care environment. This review highlighted the input, process and case mix variables that have been associated with improved patient outcome from an ICU. Relating physiotherapy interventions, twenty-four hour provision of physiotherapy services, qualifications and physiotherapy staffing levels, etc. to patient

outcome in the critical care environment has the potential for clarifying the role of the physiotherapist within the ICU.

REFERENCES

Bhagwanjee S, Muckart DJ, Jeena P, Moodley P 1997 Does HIV status influence the outcome of patients admitted to a surgical ICU? *British Medical Journal* 314:1077-1081

Bochicchio GV, Joshi M, Bochicchio K, Tracy K, Scalea T 2004 A time dependent analysis of ICU pneumonia in Trauma patients. *Trauma* 56(2):296-303

Blegen MA, Goode CJ, Reed L 1998 Nursing staffing and patient outcome. *Nursing Research* 47(1):43-50

Brilli RJ, Spevetz A, Branson RD, Campbell GM, Cohen H, Dasta JF, Harvey MA, Kelley MA, Kelly KM, Rudis MI, St Andre AC, Stone JR, Teres D, Weled BJ; American College of Critical Care Medicine Task Force on Models of Critical Care Delivery 2001 Critical care delivery in the ICU: defining clinical roles and best practice model. *Critical Care Medicine* 29(10):2007-2019

Bristow PJ, Hillman KM, Chey T, Daffurn K, Jaques TC, Norman SL, Bishop GF, Simmons EG 2000 Rates of in-hospital arrests, deaths and ICU admissions: the effect of a medical emergency team. *Medical Journal of Australia* 173(5):236-240

Carson SS, Stocking C, Podsadecki T, Christenson J, Pohlman A, MacRae S, Jordan J, Humphrey H, Siegler M, Hall J 1996 Effects of organizational change in the medical ICU of a teaching hospital: a comparison open and closed formats. *Journal of the American Medical Association* 276(4):322-328

Chalfin DB, Cohen IL, Lambrinos J 1995 The economics and cost effectiveness of critical care medicine. *Intensive Care Medicine* 21:952-961

Chatburn R 2001 Outcomes Research in Respiratory Care. *Respiratory Care* 46(11):1215-1225

De Palo V, Millstein BH, Mayo PH, Salzman SH, Rosen MJ 1995 Outcome of intensive care in patients with HIV infection. *Chest* 107(2):506-510

Estaban A, Anzueto A, Frutos-Vivar F, Alia I, Ely EW, Brochrd L, Stewart TE, Apezteguia C, Tobin MJ, Nightingale P, Matamis D, Pimentel J, Abroug F 2004 Outcome of older patients receiving mechanical ventilation. *Intensive Care Medicine* 30(4):639-46

Garrouste-Orgeas M, Troche G, Azoulay E, Caubel A, de Lassence A, Cheval C, Montesino L, Thuong M, Vincent F, Cohen Y, Timsit J 2004 BMI an additional prognostic factor in ICU patients. *Intensive Care Medicine* 30(3):437-443

Gunning K & Rowan K 1999 Outcome data and scoring systems. *British Medical Journal 319: 241-244*

Hanson CW 3rd, Deutschman CS, Anderson HL 3rd, Reilly PM, Behringer EC, Schwab CW, Price J 1999 Effects of an organized critical care service on outcomes and resource utilization: A cohort study. *Critical Care Medicine* 27:270-274

Hariharan S, Moseley S, Kumar A 2002 Outcome evaluation in a surgical intensive care unit in Barbados. *Anesthesia* 57:434-441

Hillman KM 1999 Recognizing and preventing serious in-hospital events. *Medical Journal of Australia* 171:08-09

Joiner GA, SalisburyD, Bollin GE 1996 Utilizing quality insurance as a tool for reducing the risk of nosocomial ventilator associated pneumonia. *American Journal of Medical Quality* 11:100-103

Knaus WA, Draper EA, Wagner DP, Zimmerman JE 1985 APACHE II. A severity of disease classification system. *Critical Care Medicine* 13:818-829

Kollef MH 1993 Do age and gender influence outcome from mechanical ventilation? *Heart Lung* 22:442-449

Kollef MH 1996 Private attending physician status and the withdrawal of life-sustaining interventions in a medical intensive care unit population. *Critical Care Medicine* 24:968-975

Kollef MH, O'Brien JD, Silver P 1997a The impact of gender on outcome from mechanical ventilation. *Chest* 111(2):434-441

Kollef MH, Shapiro S, Silver P, St John R, Prentice D, Sauer S, Ahrens T, Shannon W, Baker-Clinkscale D 1997b A randomized controlled trial of protocol-directed versus physician-directed weaning from mechanical ventilation. *Critical Care Medicine* 25(4):567-574

Kollef MH 1998 Outcomes research as a tool for defining the role of respiratory care practitioners in the Intensive Care Unit Setting. *New Horizons* 6(1):91-98

Leape L, Cullen D, Clapp M, Burdick E, Demonaco H, Erickson J, Bates D 1999 Pharmacist participation on physician rounds and adverse drug events in the ICU. *Journal of the American Medical Association* 282:267-270

Li TC, Phillips MC, Shaw L, Cook EF, Natanson C, Goldman L 1984 On-site physician staffing in a community hospital intensive care unit. *Journal of the American Medical Association* 252:2023-2027

Livingston BM, MacKirdy FN, Howie JC Norrie JD 2000 Assessment and performance of five intensive care scoring models within a large Scottish database. *Critical Care Medicine* 6:1820-1827

Marino P 1998 The ICU Book. Williams & Wilkins. Pennsylvania p 875-879

McQuillan P, Pilkington S, Allan A 1998 Confidential inquiry into quality of care before admission to intensive care. *British Medical Journal* 316:1853-1858

Morales IJ, Peters SG, Afessa B 2003 Hospital mortality rate and LOS in patients admitted at night to the intensive care unit. *Critical Care Medicine* 31(3):858-863

O Chan PK, Fischer S, Stewart TE, Hallett DC, Haynes-Gay P, Lapinsky SE, Mac Donald R, Mehta S 2001Practicing evidence-based medicine: the design and implementation of a multidisciplinary team-driven extubation protocol. *Critical Care* 5:349-354

Parkhe M, Myles PS, Leach DS, Maclean AV 2002 Outcome of emergency department patients with delayed admission to ICU. *Emergency Medicine* 14:50-57

Potter P, Barr N, McSweeney M, Sledge J 2003 Identifying Nurse Staffing and Patient Outcome Relationships: A guide for change in care delivery. *Nursing Economics* 21(4):158-166

Pronovost PJ & Angus DC Using large-scale databases to measure outcomes in critical care. http://www.uninet.edu/cimc2000/mesas/mr2/angus2/databases.htm *(last accessed 17 May 2004)*

Pronovost P, Angus D, Dorman T, Robinson K, Dremsizov T, Young T 2002 Physician staffing patterns and clinical outcomes in critically ill patients. *Journal of the American Medical Association 288(17):2151-2162*

Randolph A & Pronovost P 2002 Reorganizing the delivery of intensive care could improve efficiency and save lives. *Journal of Evaluation in Clinical Practice* 8(1):1-8

Ridley S 2002 Outcomes in critical care. Butterworth & Heinemann. Cornwall

Thorens JB, Kaelin RM, Jolliet P, Chevrolet JC 1995 Influence of quality nursing on the duration of mechanical ventilation in patients with COPD. *Critical Care Medicine* 23(11):1807-1815

Wall R, Dittus R, Wesley E 2001 Protocol-driven care in the ICU: a tool for quality. *Critical Care* 5:283-285

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CHAPTER 5 Methodology

This chapter describes the methodology used in Part One of the baseline study. As this document will be used as a reference in Phase Three of the comprehensive research project, the methodology is documented in its entirety. All the variables mentioned in this chapter will however not be discussed in this thesis as motivated in Chapter 1.

Included in this chapter are the research question and the specific aims of the baseline study. A description of the site of the intensive care unit and the functioning of the multidisciplinary team within this unit are also included in this chapter. This is followed by a description of the sampling process, the instruments and the procedure used to collect the data. Finally the ethical considerations of this project are outlined.

5.1 RESEARCH QUESTION

What is the profile of a surgical ICU in a public sector tertiary hospital in South Africa?

5.2 OBJECTIVES

The objectives of the study that relate to the presentation of this thesis will be indicated by an asterix (*).The objectives of this study were to determine and describe:

5.2.1 The profile of the patients admitted to the ICU from 16 June - 30 September 2003, including:

- Demographics; *
- Severity of illness; *
- Co-morbidities; *
- Time of mechanical ventilation; *
- Length of stay in ICU; *
- Mortality rate; *

5.2.2 The physiotherapy management of patients admitted to the unit.

- Range of physiotherapy techniques used in ICU; *

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* *The objectives in the study that are discussed in Chapters 6 and 7*

- Time spent on direct patient care by the physiotherapists; *
- Positions used in the treatment of patients. *

5.2.3 The following aspects of the nursing management of patients admitted to the unit:

- Nursing involvement in the positioning of patients;
- Nursing involvement in the mobilization of patients.

5.2.4 The following aspects of the daily medical management of patients admitted to the unit:

- Time from hospital admission to unit admission;
- Number of patients re-admitted to ICU in the above mentioned time frame;
- Time to re-admittance to the same ICU;
- Diagnosis of complications that occurred in ICU; *
- Medications prescribed per patient;
- Referrals made while in ICU;
- Surgical interventions done.

5.2.5 The staffing levels of the physicians, nurses and physiotherapists working in the ICU:

- Qualifications of physicians;
- Qualifications of nursing staff;
- Qualifications of physiotherapists;
- Number of physicians and nurses per shift.

5.3 SETTING

This baseline study was completed in A1 West, a ten-bed surgical ICU situated in Tygerberg Hospital (TBH) in the Western Cape. TBH is a 1385 bed tertiary hospital and is utilized as a teaching hospital for students from the Faculty of Health Sciences, University of Stellenbosch and the Faculty of Community and Health Services, University of the Western Cape. TBH serves the Northern Suburbs of the City of Cape Town, the Winelands district (Stellenbosch, Paarl and Malmesbury), and the Overberg

* *The objectives in the study that are discussed in Chapters 6 and 7*

district (Hermanus and Worcester). In addition to the surgical unit there are seven other independently functioning ICU's namely a burn, cardiothoracic, medical, coronary, neurosurgery, neo-natal and pediatric unit.

Unit Structure

The unit is arranged into two five-bed units. The nurses' station is located in the middle of the unit and all beds are visible from the station. There is also one single ward available, which is used when patients present with resistant infections.

All patients requiring intensive support or monitoring following either elective or emergency surgery and trauma, are admitted to the surgical ICU. Patients are admitted to the unit either directly from theatre, or from the resuscitation unit at Tygerberg Hospital (TBH).

Multidisciplinary Team

- The ICU operates as a Level I closed unit with a qualified anesthetist taking final responsibility for patient care (Carson *et al* 1996). Specialists from orthopedics, neurology and surgery are consulted when indicated. A twenty-four hour service is provided, with a registrar available in the unit at all times and consultants from anesthesiology providing after-hours support. This registrar would be from any of the following departments: Orthopedics, Neuro-surgery, Neurology, Anesthesiology, Surgery, and Trauma. A registrar from each of these departments rotate through the unit on a three month cycle as part of their specialization.

- There is a permanent matron allocated to the unit. Each five bed-unit is staffed separately, with at least one senior sister on duty in each of the five-bed units per shift. Other nursing staff include qualified intensive care sisters, nurses and nursing assistants. Due to the current shortage of nursing staff at TBH, nursing staff from agencies are employed as needed.

- The physiotherapy department offers a fulltime service to the unit on a non-referral basis. During the week one physiotherapist is responsible for the unit as part of a clinical rotation that includes other surgical in-patient wards and

outpatients. An after-hours service is provided by all full-time physiotherapists on a rotational basis. Students from the Departments of Physiotherapy of the Universities of Stellenbosch and the Western Cape rotate through the unit on a six week cycle, as part of their clinical training.

- Other staff include a dietician on-call and a medical technician permanently allocated to the unit. The latter is responsible for the maintenance of all equipment in the unit and the daily arterial blood gas analysis of all patients. Patients are referred to occupational therapy as indicated.

Ward Rounds

A variety of ward rounds take place in the unit. These rounds are primarily attended by physicians. Other multidisciplinary team members very rarely attend due to the current understaffing of departments.

Daily

Patients in the unit are managed by the team of physicians under leadership of an anaesthetist. Twice daily ward rounds therefore act as an important communication tool, where all physicians are updated on the status of every patient in the unit. After hours i.e. at weekends and public holidays these rounds still take place between registrars on-call. Consultants do not necessarily attend the after-hours rounds.

Both of the daily rounds are attended by the anaesthetist, the medical officer and all registrars working in the unit. On the morning round the registrar that was on duty during the previous night reports on the status of all patients in the unit. Patients are then allocated to the registrars for the day and the further medical management of each patient is discussed. Special tests and instructions for the rest of the multidisciplinary team are noted on the bed chart. Possible complications are identified and diagnosed by the team involved. This information is noted on the bed chart and in the physician progress report. A similar round with the same purpose as the earlier round is held at the end of the day and the registrar on-call for the night is informed of the status of each patient.

Weekly

There are two rounds that take place on a weekly basis. The purpose of these rounds is different to the daily ward rounds and do not replace any of the daily rounds. Firstly an academic ward round is held every Friday by the Head of the Department of Anesthesiology and Critical Care of the Faculty of Health Sciences at the University of Stellenbosch. Registrars and other senior medical students attend this ward round.

A second weekly round is held with the staff from the Department of Micro Biology every Monday, and is attended by the head of the unit or the medical officer. The purpose of this round is to discuss the antibiotic profile of each patient and the use of antibiotics in the unit.

5.4 STUDY STRUCTURE

Prospective cohort observational study.

5.5 POPULATION

All patients admitted to the surgical ICU at TBH.

5.6 SAMPLING

A cohort of all the patients admitted to the surgical ICU at TBH consecutively from 07:00 on 16 June 2003 until 06:59 on 1 October 2003 were included in the sample. Two methods were used to ensure that all patients were included in the sample:

- Each bed (10) in the unit was visited daily, by the researcher / research assistant and the relevant data extraction sheets *(addenda A1-A4)* were completed.

- After completion of the study period the list of patients that were included in the sample was compared to the unit admission and discharge book.

After 4 attempts one patient folder could not be located by February 2004. One patient had been admitted to the unit twice in the study period. This resulted in 159 patients but 160 admissions included in the sample.

5.7 INSTRUMENTATION

The data extracted in this study were those factors documented in the literature that influence patient outcome from an intensive care unit. Each factor will be referenced as appropriate. The following six data extraction forms were developed by the researcher:

- **Admission data** *(addendum A1)*
- **Daily management of patient data** *(addendum A2)*
- **Daily physiotherapeutic management of the patient** *(addendum A3)*
- **Discharge data** *(addendum A4)*
- **Nursing staffing levels data** *(addendum A5)*
- **Physician staffing levels** *(addendum A6)*

Each of the above mentioned data extraction forms will be discussed as follows:

- **Content** - A brief description of the information included in the form.
- **Pilot Study -** A brief description of the pilot studies conducted on the specific form.

5.7.1 Admission data (*addendum A1)*

The patient admission data was extracted within 24 hours of admission to the unit by the researcher / research assistant from the bedchart *(addendum B1),* physician admission notes *(addendum B2)*, nursing care plan *(addendum B3),* APACHE II score (*addendum B4)* and surgery report *(addendum B5).* In the case of any incomplete notes the researcher consulted with the admitting physician.

Content

The demographics and pre-admission clinical course of a patient could impact on the ICU course of the patient, and thus on the outcome of the patient (Bristow *et al* 2000, Hillman 1999, Garrouste-Orgeas *et al* 2004, Estaban *et al* 2004, Kollef et al 1997, McQuillan *et al* 1998, Morales *et al* 2003).The extracted data was arranged into three categories namely:

General information

- Age
- Gender
- Weight
- Length of the patient
- Address

Patient's condition on admission

- Date of admission to the unit;
- Time of admission to the unit;
- Admission diagnosis;
- Reasons for ICU admission;
- Respiratory support on admission;
- The date of intubation;
- Co-morbidities present on admission; and
- APACHE II: The APACHE is a generic physiological scoring system that was developed in the mid seventies by William Knauss to quantify severity of illness by patient characteristics. In 1985 the original system was revised and the variables to be recorded were reduced to 12 (Knauss *et al* 1985). The latest update of this scoring system APACHE III is now available for purchase (Gunning & Rowan 1999). It is still unclear from the literature whether this version represents a significant improvement in the scoring and warrants the big financial investment (Hariharan *et al* 2002). The ICU at TBH currently uses the APACHE II scoring system for all patients admitted to the unit. This score was incorporated into the sheets as an indication of the case-mix of the unit.

The clinical course before admission to the unit

- The origin of the patient;
- Previous admissions to the ICU within the past 4 months;
- Date of previous admission as appropriate;
- The therapeutic interventions that had been applied after admission to the hospital but before admission to the unit;
- The date, time and length of previous surgery; and

- The presence and management of any infections after admission to the hospital but before admission to the unit.

Pilot Study

During the first week in June 2003 two pilot studies were performed on this data extraction form.

The aims of the pilot studies were to determine

- Time spent on completing the data sheet;
- Accuracy and reliability of the data extraction process;
- Accessibility / completeness of current ICU documentation systems.

The following observations and modifications were made:

- Ten minutes were spent on the completion of the data extraction sheet. This was regarded as acceptable.
- The height and weight of all patients admitted to the unit had not been documented. The medical technician in the unit therefore agreed to document a professional estimate of all patients' weight and height measurements on the bed chart.

5.7.2 Daily management of the patient (*addendum A2)*

The researcher / research assistant daily reviewed the following patient records of the previous 24 hours, from 07:00 the previous day until 06:59 on the day in question:
The bedchart *(addendum B1),* daily progress notes of physician *(addendum B7)* surgery report *(addendum B5),* interdepartmental referral form *(addendum B8),* antibiotic profile *(addendum B9),* prescription card *(addendum B10),* nursing process *(addendum B11)* and nursing care plan *(addendum B3).* In the case of any incomplete notes the researcher consulted with the physician or nursing personnel.

Content

The medical and nursing care a patient receives while in the unit impacts on the outcome of the patient from ICU (Thorens *et al* 1995, Wall *et al* 2001). The data extracted on this form therefore were

- The respiratory support received by the patient;

- Complications that had been diagnosed;
- Infections that had been diagnosed;
- Medication;
- Co–morbidities that had not been identified previously;
- Interdepartmental referrals;
- Relevant aspects of surgery that the patient had received within the past 24 hours;
- Nursing management related to mobilization and pressure care; and
- Physiological variables documented hourly on the bedchart.

Pilot Studies

During the first week in June two pilot studies were performed on this form

The aim of the pilot studies were to determine

- Time spent on completing the data extraction sheet;
- Accuracy of data extraction;
- How accessible / complete the current ICU documentation systems were.

The following observations and modifications were made:

- The hourly physiological variables that are recorded onto the patient's bedchart were omitted from this sheet, as it took 40 minutes per patient to collect data. This information is kept in the unit and is accessible for later inclusion. This reduced the time spent on the data extraction sheet to 12 minutes per patient.

- The ward documentation sheets were not always complete. The unit matron was notified and nursing staff were encouraged to be more rigorous in the completion of their daily record keeping. The researcher also met with all registrars involved in the unit at the time, at which time the aims of the study as well as the proposed methodology was explained. The registrars and medical officer made the commitment to be more rigorous in their daily documentation. The medical officer informed all registrars rotating through the unit in the study period, of the project. The daily attendance of the researcher to the unit acted as a daily reminder of the project to all concerned.

- A large number of data extraction forms were completed daily. A control form was developed to keep a record of all the data sheets for each patient on a daily basis. This was used by the researcher to verify the data extraction forms *(addendum D2).*

5.7.3 Daily physiotherapeutic management of the patient (*addendum A3)*

The record of the treatment was documented by the physiotherapist after each treatment session with the patient. This document was filed in duplicate in the patient's unit folder.

Content

This form served as a record of current practice and was not intended to act as an indicator of the *quality* of treatments. Included in this form were:

- The rank of the treating physiotherapist i.e. the unit, on-call or student physiotherapist;
- Date of treatment;
- Time of treatment;
- Estimated time spent on hands-on treatment;
- Positions of patients used during treatment;
- Functional activities done;
- Amount of assistance the patient required during functional activities;
- Cough ability of the patient; and
- The range of physiotherapy techniques used. These were categorized into breathing exercises, mechanical equipment used, secretion removal techniques, movements used, and manual techniques.

Pilot Study

During the week 19 – 25 May 2003 this form was piloted. In addition a questionnaire on the use of the form was completed by three students, one unit physiotherapist and one on-call therapist.

The aim of the pilot study was to determine:

- Compliance of physiotherapists in documenting treatment in the surgical ICU;
- Logistical handling of data capturing;

The following observations and modifications were made:

- To ensure that the same format of documentation was used by all therapists, it was decided to replace the current physiotherapy documentation system used in the unit with the project data sheets. These sheets were made available as carbon copies which meant there was no extra work involved in the completion of the forms. Minor changes were made to the layout of the form that made it possible to complete the documentation on a single data sheet.

- Because these data sheets were the legal document of the physiotherapy management while the patient was in the unit, it was decided to number the sheets using the hospital code for physiotherapy namely 15-2. This ensured that the information would remain part of the patients' medical record.

- From the questionnaire it became apparent that the interpretation of the techniques varied between therapists. In a bid to "standardize" current practice, a meeting with the TBH physiotherapy department was held. All staff members attended the meeting. The stated aim of this meeting was to reach agreement on the goal and specification of techniques used in this ICU. Small group discussions were held where each group accurately described the techniques currently used. This consensus was documented *(addendum C1).* The physiotherapist responsible for the unit accepted the responsibility to discuss the agreed preference of techniques with all students working in the area as part of their orientation to the clinical area.

5.7.4 Discharge data *(addendum A4)*

Within 24 hours of discharge from the unit, this form was completed by reviewing the discharge summary *(addendum B14)* and nursing process *(addendum B11).* The patient was also followed to the ward where the researcher / research assistant assessed the passive range of motion of limbs, muscle strength of selected muscles and pressure areas of each patient. In the event of death the time and cause of death was documented.

Content

Outcomes research focuses on specific outcome measures (Kollef 1999, Chatburn 2001, Ridley 2002). Data extracted on this sheet were:

- Date of discharge / death;
- Time of discharge / death;
- Passive range of movement of neck and upper and lower limbs;
- Respiratory support received;
- Pressence of pressure sores; and
- Active movement of joints of upper and lower limbs.

Pilot Study

This data extraction sheet was compiled and piloted by fourth year physiotherapy students as part of their final year research project. The pilot study was completed in A1 West by two physicians, two nurses and two physiotherapists respectively March 2003.

The aims of the study were to determine:

- Inter-rater variability of the form and;
- Compliance of the medical team in completing the form.

The following observations and modifications were made:

- The overall inter-rater variability was 79%, with specific items ranging from 71% to 98%. This was regarded acceptable (Aweida & Kelsey 1990).

- Minor changes were made to the original form in regards to the documentation of pressure sores. The wounds were described as dressed rather than classified into the three phases of pressure wounds.

- Increased workload and understaffing of the unit were noted as reasons for the poor compliance in the completion of the data sheet by the rest of the team members. Therefore this form was completed by either the researcher or research assistant instead of one of the team members.

5.7.5 Nursing and physician staffing levels *(addenda A5 and A6)*

Relevant data concerning nursing and physician staff involved in the unit was extracted retrospectively from existing day and night roster books for the entire study period by the researcher at the end of the study period.

Content

There are indications in the literature that staffing levels and qualifications of nursing staff (Potter *et al* 2003, Blegen *et al* 1998) and physicians (Pronovost *et al* 2002) may impact on patient outcomes in the acute care setting. The following data was extracted:

- The number of staff members of the different categories of staff that were in the unit during a specific time frame
- whether nurses were employed on a fulltime - , locum - or student basis.

Pilot Studies

These data sheets were piloted in the first week of April.

The aim of the pilot study was to determine:

- The suitability of the data extraction forms for data extraction from existing documentation systems.

The following changes were made to the form to make it more efficient:

- The format in regards to the categories of staff were adjusted
- The roster cycle was changed

5.8 PROCEDURE

The procedure that was followed during the study period will be discussed under the following headings:

- Project administration
- Process of data extraction
- Verification of data extraction process
- Data capturing and storage

5.8.1 Project administration

Administration formed an essential component of this project and will be discussed in two parts. Firstly due to the vast amount of paper work concerned with this project, special care was taken to ensure the efficient management of all documentation. Secondly, because data extraction was completed daily for the duration of the project and a vast amount of data had to be captured, research assistants were employed.

Management of documentation

- Permission to set up an administration depot in one of the five-bed units of A1 West was obtained from both the head of the unit and the unit matron. This depot consisted of a table with a filing cabinet and a notebook and remained in the unit for the duration of the study. The depot served as a collection point for data sheets and to facilitate communication between the researcher and research assistant.

- On completion, the relevant data extraction sheets were filed in above mentioned cabinet daily.

- Once a week, forms were collated and then stored in the Department of Physiotherapy Faculty of Health Sciences, University of Stellenbosch until the data was captured on a computerized data base.

- To facilitate communication between the researcher and research assistant a notebook was placed at the administration depot. This notebook was checked daily by the researcher and assistant. The researcher was responsible for ensuring a sufficient supply of data extraction and physiotherapy forms.

Appointment of research assistants

Two research assistants were employed for the duration of the project.

- ***Data extraction*****:** Initially four full time physiotherapists from the Department of Physiotherapy, TBH were involved in the study as research assistants to extract the data. After a trial period of 4 days this proved to be ineffective because of time constraints and too much variation in the extracted data. Hereafter a

qualified physiotherapist with four years clinical experience, working as a half day locum in private practice, was appointed as a research assistant for the duration of the project. She had worked in the unit previously, was thus known by staff and she had a good understanding of the systems and ward routine. A job description was accepted by her on her appointment *(addendum D1).*

- ***Data capturing:*** A qualified physiotherapist with 20 years of clinical experience, employed in the Department of Physiotherapy as a research assistant was recruited to assist with the data capturing of the physiotherapy data. After a training period she captured all the physiotherapy management data and a portion of the admission data onto the specified excel spreadsheets on a weekly basis.

- An administration assistant was recruited for assistance in the capturing of the remaining four data extraction forms. She had no clinical qualification. After a trial period it was decided to terminate this process as the data capturing was inaccurate.

5.8.2 Process of data extraction

The following steps were taken to ensure accurate data extraction from the records.

- The accuracy and reliability of the data extraction process were established through pilot studies before the study period *(refer to the discussion of the Instrumentation 5.7).*

- The data extraction for the entire period was completed by either the researcher or the research assistant. During the week the research assistant was responsible for all data extraction and during weekends these duties were shared between the researcher and the research assistant on a rotation basis. In the study period there were two separate weeks that the research assistant was unavailable due to personal reasons. During this time the researcher continued with the daily data extraction.

- To ensure visibility of the project and as a daily reminder of the project to the rest of the team members, the researcher attended one of the ward rounds or visited the unit daily.

- Specified existing unit documentation systems were accessed for data extraction, thus not affecting the workload of any team member *(Addenda B1-B14)*

- Due to the high workload of physicians in the unit, the APACHE II scores were only completed by the discharging physician. The score was based on the documented physiological values of the first 24 hours after admission to the unit. In the case of a patient dying the scores were calculated by the medical officer at a later date. APACHE II scores are filed in the unit. After the study period, these scores were accessed and the data extracted on the admission data form.

5.8.3 Verification of data

As mentioned previously, this chapter will be used as a reference in Phase Three of the comprehensive research project, and thus needs to be an accurate reflection of the entire process used for data extraction. A description of the process that was used to verify patient data, and locate missing data is traditionally included in the chapter on the results of a study. However, because of the structure of this thesis *(refer to 1.6)*, it was decided to include a documentation of the process that was followed to retrieve any missing data. This will be followed by a brief discussion of possible reasons for the missing data.

Reconciliation process

After completion of the project all data extraction sheets were reconciled to ensure that there were:

- Admission and discharge data for every patient that had been admitted to the unit in the study period; and

- Daily monitoring and physiotherapy data for every day that a patient had been in the unit.

- The list of patients that were included in the sample at the end of the study period (n=140) was compared to the unit admission and discharge book to ensure that all patients that had been admitted to the unit in the study period were accounted for. It was found data had not been collected for 21 subjects. The folders of these patients were requested from medical records and A1 unit respectively, and the relevant data extraction sheets were completed, reviewing the same records described in the Instrumentation. The file of only one patient could not be located after four attempts and was thus regarded as lost to follow up.

- The discharge data extraction sheets were reconciled with the admission data extraction sheets to ensure admission and discharge data of all patients in the sample. There was no discharge record of forty patients (n=160). The relevant patient folders were requested and the date and time of discharge / death were documented. However, because the presence of contractures, pressure areas and active movement of specified muscles was also documented by the researcher / research assistant, the discharge data was incomplete for 40 patients. Therefore for the purpose of the statistical analysis the discharge data of 40 patients were lost to follow up.

- To ensure that there was data for every day that a patient had been in the unit, the daily management extraction sheets and the physiotherapy data extraction sheets were reconciled with the number of days the patient spent in the unit and correlating this to the number of data extraction sheets filed for each patient. This process resulted in the following:

- In total the daily management data were missing for 60 individual days. The specific patients' folders were requested from medical records, and A1 unit respectively and the relevant data extraction sheets were completed, reviewing the same records as described in the Instrumentation. All of the daily management data was therefore retrieved.

- In total the physiotherapy data were missing for 56 individual days. After accessing patients folders in medical records eight data capturing sheets were found that had been mistakenly filed in duplicate. Thereafter the folders of all the

patients in the sample (N=159) were re-examined. However no other physiotherapy data capturing sheets were found. On the remaining 48 days, physiotherapy proved to be provided before the patient was admitted to the unit or after discharge from the unit. This data was thus not used in the statistical analysis of the results.

Reasons for missing individual data extraction sheets for single days

The following *possible reasons* for missing data were identified:

- The administrative assistant of the unit was on maternity leave during the study period. This caused an administrative back-log in the unit resulting in the fact that no daily documentation was made of admissions to or discharges from the unit. As a result there was no central document that could be consulted on a daily basis.
- Twenty six of the 161 patients admitted to the unit during the study period spent less than 24 hours in the unit. As a result it was possible for these patients to have been admitted to and discharged from the unit before the researcher / assistant visisted the unit.
- Two patients were transferred to private hospitals before the researcher / research assistant were able to evaluate the patient for the discharge data.
- One patient discharged himself from the hospital after he was discharged from the unit and could thus not be located in another ward by the researcher / research assistant.
- The remaining 16 patients that were missed on discharge can be attributed to a misunderstanding between the researcher and the research assistant.

5.8.4 Process of data capturing and storing

This section describes the process that was used to capture the data and store the data extraction sheets.

- Six Excell spreadsheets were developed in consultation with the statistician, Dr M Kidd for data capturing;

- All the physiotherapy data and a portion of the admission data was captured weekly by a research assistant *(refer to p 84)*.

- Regular spot checks were done by the researcher to verify the accuracy of the process of data capturing.

- The 171 records completed inaccurately by the administrative assistant were corrected by the researcher *(refer to p 84).*

- Data capturing of the remaining admission data and all the daily management, discharge and staffing level data were completed by the researcher. The bulk of the capturing was completed after the study period.

- Spot checks were performed by the researcher a month after all the data had been captured, to verify the accuracy of the process.

- Categorizing of the Excel spreadsheets were completed by the researcher in consultation with the statistician after all data had been captured.

5.9 ETHICAL CONSIDERATIONS

During the execution of this project the following ethical aspects were addressed:

Registration of project:

- Registration with the Faculty of Health Sciences (Research Committee) Project number 2003/055/N *(addendum E1)*

Confidentiality and consent:

- All information obtained remained confidential. The patient's hospital number was used on all data extraction and data capturing sheets as a reference number.

- A proxy consent was obtained from the superintendent of the TBH to review the records for all patients admitted to A1 west during 16 June 2003 – 30 September 2003 *(addendum E2)*

Permission was obtained from the following people:

- Dr JP Muller Senior Clinical Executive Member at TBH - to complete the project in A1 West Intensive Care Unit *(addendum E3).*

- Dr Cate Fourie, head of A1 West, - to attend ward rounds, access the medical personnel schedules for the timeframe of the study, and access the APACHE II scores for each patient.

- Matron Cloete - to set up a filing system in the unit for all data sheets to be filed and also to access the nursing staff schedules for the study period.

- Mr Josephs at the Department of Medical Records - to access the folders of all patients included in the study n = 161 *(addendum E4).*

CHAPTER 6 Research Report

OUTCOME EVALUATION OF A SOUTH AFRICAN SURGICAL ICU – A BASELINE STUDY

ABSTRACT

Objectives: To describe the baseline data of a surgical ICU in South Africa before the implementation of an evidence based physiotherapy practice protocol.

Design: Prospective cohort observational study

Setting: Ten bed closed surgical unit in a university affiliated tertiary hospital.

Patients: Data from 160 consecutive adult ICU admissions from 16 June – 30 September 2003.

Measurements: The patient's clinical data including demographic information, admission diagnosis, surgery classification (elective or emergency) and co-morbidities were recorded on admission to the unit. APACHE II score was calculated based on the physiologic data on admission to the unit. The ICU length of stay or mortality was recorded on discharge from the unit.

Results: Patients were 49 +/- 19.95 years of age. The mean APACHE II score was 12.3 +/ 7.19 and a 12.3% mortality was observed. The standardized mortality ratio was 0.87. Thirty seven percent of patients were admitted to the unit following elective surgery. Patients stayed in the unit for 5.94 +/- 6.55 days. Hypertension was the most frequent co-morbidity found in this cohort (42%), and 21% of patients tested, tested positive for HIV. Co-morbidities had no significant association with ICU LOS or mortality. Neither age nor gender had a significant association with mortality or ICU LOS ($p>0.01$). A significant correlation was established between APACHE II scores and mortality and APACHE II scores and ICU LOS ($p<0.01$).

*Conclusions***:** This baseline study of a surgical ICU in a tertiary environment in the Western Cape presents a picture of a unit providing care comparable to first world environments. Whether the current admission and discharge criteria is making optimal use of the technology available in a level I intensive care unit, is debatable. Other cost effective ways of managing patients that are not as ill could be investigated

INTRODUCTION

The management of patients in an intensive care unit (ICU) is a relatively new discipline in the South African context (Mathivha 2002). Although a number of units were set up by enthusiastic individuals as early as 1968 it was only with the establishment of the Critical Care Society in South Africa in the early 1980's that a more formal approach was undertaken (Russel *et al* 1968, Meiring *et al* 1969, Mieny & Townsend 1970). The development of ICU's in South Africa were based on guidelines set out by the society which are based on units found in first world countries namely USA, Australia and Europe. The structure and grading of South African units are in line with the National Institutes of Health Consensus (NIH) Development Conference (1983).

Units are structured into four levels. Level I Units, so called closed units, are found in university-affiliated tertiary hospitals and run by intensivists. These units usually have highly sophisticated equipment and specifically trained personnel. Level II units are dedicated to a specific patient population, for example, a coronary care unit. Level III units are found in secondary hospitals and have limited invasive monitoring capabilities, while Level IV units are high care units where no invasive support of organs is performed (Mathivha 2002).

The provision of intensive care is an expensive speciality which is increasingly being questioned in the South African context (Mathivha 2002, Potgieter *et al* 1995). In a commentary of critical care in South Africa, Mathivha (2002:24) urges critical care healthworkers to "...put forth strong motivations to the country's health policy-makers..." in an effort to convince them of the importance of such an expensive service within the country's healthcare provision. The ways in which services are provided to critically ill patients and the resultant outcome of these interventions within South African thus needs to be evaluated objectively.

Only five studies could be identified after 1980 that published data on the demographics and outcome of patients admitted to an ICU in Southern Africa (Marik *et al* 1993, Hira *et al* 1985, Badenhorst 1986, Joshua *et al* 1989, Potgieter *et al* 1995). Of these only one study reported on the outcome of patients admitted to an ICU in the Western Cape (Potgieter *et al* 1995).

These early units performed consistently better than predicted (Marik *et al* 1993, Potgieter *et al* 1995). Badenhorst (1986) described the patient statistics of the two multidiciplinary units managed by the critical care department of the University of the Orange Free State. At that time the APACHE II scoring system had not been published. The mortality of patients was 27% but the standardised mortality ratio (SMR)[1] could not be established. Almost 60% of the patients admitted to these units were younger than 40, and 75% of them stayed in the unit for less than ten days.

In 1989 Joshua *et al* described the profile of the only intensive care unit in the Ciskei at that time. A mean APACHE II score of 15, ICU mortality of 13,9% and a SMR of 0.94 was reported. These authors failed to report on the age of their population. The average length of stay (LOS) was 3.6 days. This relatively short stay could have been due to the stated policy of the unit to "...withdraw management if the prognosis continues to be poor" (Joshua *et al* 1989:289).

In the early nineties the cost of ICU was becoming an increasingly important issue and Marik *et al* (1993) evaluated the utilization of intensive care services at Baragwanath Hospital, a tertiary care teaching hospital affiliated to the University of the Witwatersrand. The mean APACHE II score of this unit was 17.1 and 31.5% mortality was observed. The SMR for this cohort was 1.03. The mean age was 37.8 years and patients stayed in the unit an average of 8.7 days. These authors found the quality of care to be on par with units in the USA based on a SMR of 1.03. It was concluded that the ICU was "…highly cost effective" (Marik *et al* 1993:398). The reported daily cost of US$400/day was much lower than the US$2500 reported in the USA at the time.

Potgieter *et al* (1993) also did a cost analysis of the multidisciplinary ICU at Grootte Schuur Hopsital, a tertiary institution affiliated to the University of Cape Town. The cohort presented with a relatively low mean APACHE II score of 9.63 (SD7.35) and a reported 6% mortality. The SMR was not reported. The mean age of this cohort was 40 years, and patients stayed in the unit for a mean of 5.17 days (SD3.29).

[1] SMR is the ratio of observed deaths to predicted deaths based on the APACHE II scoring system

According to the Strategic and Service Delivery Improvement Plan (SSDIP) of the Western Cape Department of Health Draft Paper (2000) the Western Cape population presents with a unique health profile. This includes the following:

- Tuberculosis (TB) is the predominant communicable disease in the Western Cape. This province has the highest TB rates nationally and amongst the highest in the world;
- A rising HIV epidemic which is likely to augment the burden of TB disease as evidence shows that 15-20 % of tuberculosis patients are HIV-infected; and
- More than half of South African males (52%) and 17% of women over the age of 18 years were reported to smoke in 1996. In this province a markedly high proportion of women (45%) smoke compared to the national rate of 17%. These rates are the highest amongst colored women, almost reaching 60%.

The impact of this health profile on patient's outcome from ICU is unclear.

Economic changes effecting the provision of healthcare are global issues, but the adoption of the 2010 Health Care Plan (HCP) by the Provincial government of the Western Cape has far reaching implications for service delivery within the public service and specifically for the provision of intensive care in the tertiary environment. The goal of this HCP is for 90% of patients to be seen at primary, 8% at secondary and only 2% at tertiary level. The implementation of the 2010 HCP will impact on staffing and thus service provision within a tertiary environment.

A baseline study was completed to describe the demographics of patients admitted to the surgical ICU in a tertiary hospital in the Western Cape, and to report on their outcome at discharge from the ICU. This data will act as a comparison before the implementation of new treatment protocols in the ICU.

SETTING

This baseline study was completed in A1 West, a ten-bed surgical intensive care unit situated in Tygerberg Hospital (TBH) in the Western Cape. TBH is a 1385 bed tertiary teaching hospital for students from the Faculty of Health Sciences, University of Stellenbosch and the Faculty of Community and Health Services, University of the Western Cape.

TBH serves the Northern Suburbs of the City of Cape Town, the Winelands district (Stellenbosch, Paarl and Malmesbury), and the Overberg district (Hermanus and Worcester). In addition to the surgical unit there are seven other independently functioning ICU's (burns, cardiothoracic, medical, coronary, neurosurgery, neo-natal and paediatric units). All patients, requiring intensive support or monitoring following both elective and emergency surgery and trauma, are admitted to the surgical ICU. The ICU operates as a Level I Unit with intensivists taking full responsibility for patient care. A twenty four hour service is provided.

The interdisciplinary team involved in patient care consists of an anaesthetist at the head, a medical officer and at least one registrar from each of the following departments namely Orthopedics, Neuro-surgery, Neurology, Anesthesiology, Surgery, and Trauma. These registrars rotate through the unit on a three month cycle, as part of their specialization. There is a permanent matron allocated to the unit and one senior sister in each of the five bed wards. On average the nurse: patient ratio is 1.7 : 1 (*Hanekom 2004 unpublished data*). The physiotherapy department offers a fulltime service to the unit on a non-referral basis. During the week one physiotherapist is responsible for the unit, as part of a clinical rotation that includes other surgical in-patient wards and outpatients. An after-hours service is provided by all full-time physiotherapists on a rotational basis. Students from the Departments of Physiotherapy from the Universities of Stellenbosch and the Western Cape rotate through the unit on a six week cycle, as part of their clinical training. Other staff includes a dietician on call and a medical technician permanently allocated to the unit. The latter is responsible for the maintenance of all equipment in the unit and the daily arterial blood gas analysis of all patients. Patients are referred to occupational therapy as indicated.

METHODOLOGY

A prospective cohort observational study was undertaken. All patients admitted to the surgical ICU from 16 June 2003 until 30 September 2003 were included in the sample. All patients were followed until discharge from the unit. The last patient was discharged on 27 October 2003.

Existing documentation systems for each patient was accessed daily by the researchers. After completion of the study period the list of patients that were included in the sample was compared to the unit admission and discharge book. The file of only one patient could not be located.

The study was approved by the Research Ethics Committee of the University of Stellenbosch. As this was an observational study of a non-therapeutic and non-invasive nature, proxy consent to access patients' folders was obtained from the superintendent of TBH for all patients admitted to the unit during the study period.

PROCEDURE

A trained research assistant and the researcher - both qualified physiotherapists – extracted the relevant data from existing unit documentation systems. The records of each patient were accessed daily for the previous 24 hour period (07:00 – 6:59). To ensure visibility of the project and as a reminder to the rest of the team, the researcher or assistant attended one of the daily ward rounds, or visited the unit.

Two self-designed data extraction forms were used to extract data from existing documentation systems. The following data were extracted:

- **Admission data** included demographic information (age, gender) the date and time of admission to the unit, admission diagnosis, co-morbidities and APACHE II scores. The mechanism of a traumatic injury and the clinical course before admission to the unit including the date, time and length of intubation before admission, as well as the admitting area was documented. The APACHE II scores were calculated by the discharging physician based on the documented physiological values of the first 24 hours after admission to the unit.
- **Discharge data** included the time and date of discharge and the specific ward the patient was discharged to. When applicable the time and reason for death was also documented.

DATA ANALYSIS

Data was analysed in consultation with a statistician using Statistica (version 6). Descriptive data was summarized and the categorical data is presented in either bar - or pie charts, while the continuous data is presented in scatter plots. The central tendency is described in terms of means and the variation of the data as standard deviations (SD).

The Spearman Correlation was used to examine the relationships between the APACHE II score, age and the time spent in the unit. A non parametric test namely the Kruskal Wallis was used to determine the differences between multiple independent groups. The Chi-square goodness of fit test was used to determine if observed frequencies were related to an outcome. Values were accepted as significant at the 5% level ($p<0.05$).

RESULTS

The results of this baseline study will be presented as follows:

1. A description of the demographics of the patients admitted
2. A presentation of the outcomes of patients from the unit

Demographics

One hundred and sixty one admissions were recorded in the study period. One patient was re-admitted, and the data of one patient could not be obtained, therefore the data from 159 patients and 160 admissions were analyzed. The demographic data is presented in Table 6.1.

Table 6.1 Demographics of patients admitted to the unit

Mean Age	49 (SD 19.95)
patients < 45	47% (n=75)
patients 45 - 70	31% (n=50)
patients > 70	22% (n=34)
Male : Female	92 : 67

Admission to the unit

Patients were grouped into an emergency surgery, elective surgery or traumatic injury category. Patients could be placed in both the emergency surgery and the traumatic injury group. A patient admitted following a gunshot wound to the abdomen and in need of an emergency laparotomy would be placed in both groups. In contrast to this scenario a patient would only be placed in the emergency surgery group after an emergency laparotomy for an abdominal aorta aneurysm repair.

The majority of patients (83% n=133) were admitted to the unit following emergency surgery (n=85) or a traumatic injury (n=48), while more than a third of the patients (37% n=59) were admitted following elective surgery.

Two thirds of the traumatic injuries were caused by violence 67% (n=32) while the remaining 33% (n=16) were caused by motor vehicle accidents *(figures 6.1 and 6.2).* The majority of these patients were men. Only six women were admitted to the unit following a traumatic injury. Three women were admitted following a MVA, one woman was admitted following a gunshot wound, while the remaining two women were admitted after a fall.

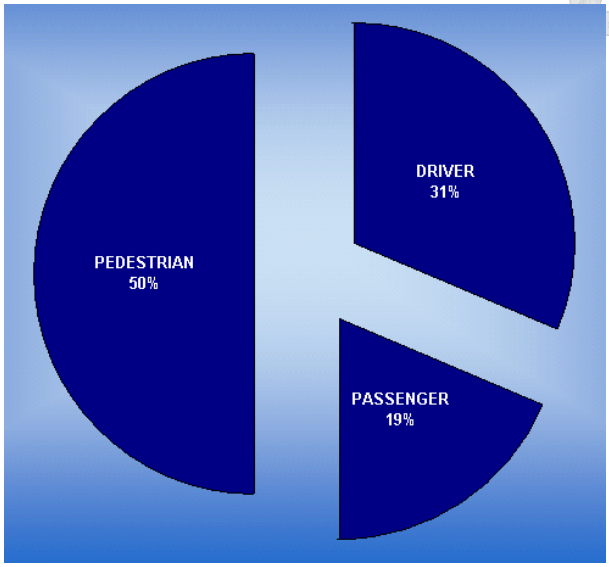


Figure 6.1 Motor vehicle accidents

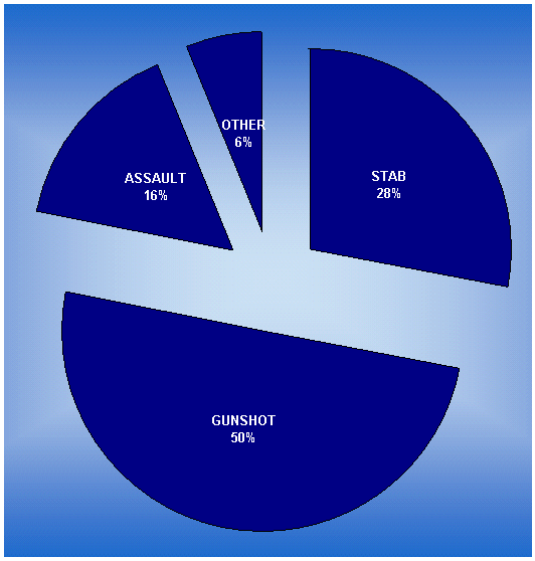


Figure 6.2 Violence

Patients admitted following elective surgery were primarily refered by the department of vascular surgery (n=21) (figure 6.3).

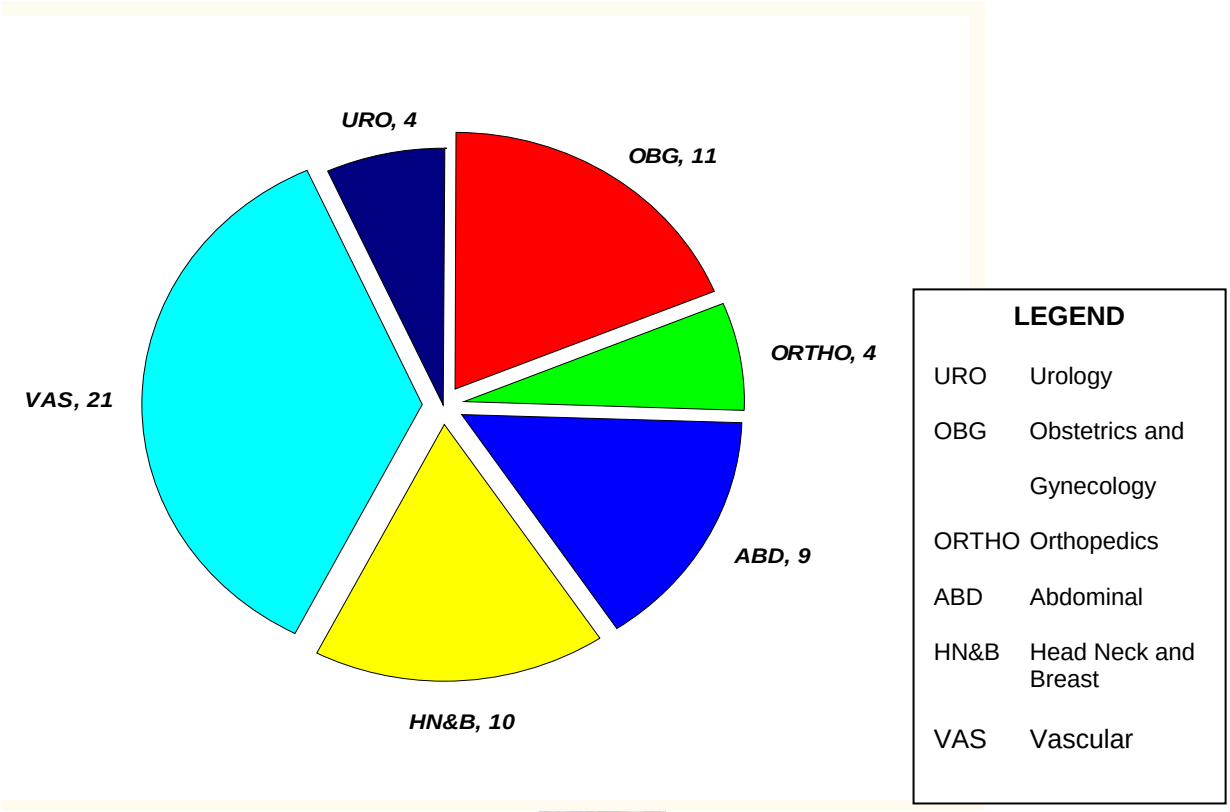


Figure 6.3 Departments referring patients to the unit following elective surgery

Similar proportions of patients were admitted to the unit directly from the theatre (48% n=77), or the emergency room (45% n=72). Only one patient was admitted to the unit directly from another hospital, and only a small proportion (7% n=11) were admitted from other in-patient wards.

Table 6.2 Mean APACHE II scores in various subgroups

GROUP	N	MEAN APACHE II	SD	% DIED
Emergency Surgery	84	13.4	7.95	16%
Trauma	48	11.29	6.81	15%
Elective Surgery	59	10.66	5.93	3%
In-patients	11	10.82	3.45	0 %
Theatre	76	10.62	6.06	5%
Emergency Room	72	14.72	8.09	26%
Outside Hospital	1	2	0	0%
Men	93	12.04	7.10	15%
Women	67	12.67	7.49	7%

Severity of illness

Patients admitted to the unit had a mean APACHE II score of 12.3 (SD 7.19). This score was signifcantly higher ($p<0.01$) when admitted from the emergency room (14.72 SD 8.09). Although not significant ($p=0.09$) , patients admitted after emergency surgery (13.4 SD 7.95) also presented with a higher APACHE II score *(Table 6.2).*

The mean APACHE II score for men (12.04 SD 7.10) were similar to women (12.67 SD 7.49) (*Table 6.2).*

Co-morbidities

Hypertension was the most frequent co-morbidity found in this cohort (42% n = 67). In contrast to this only 15% (n=24) of patients were tested for HIV, of which 21% (n=5) tested positive, 54% (n=13) tested negative and the test results were unavailable for six patients at the end of the study period. Tuberculosis was tested for in 20 patients. Only 8% (n=13) of patients presented with or had a previous history of TB. A fifth of this cohort 20% (n = 32) had a smoking history.

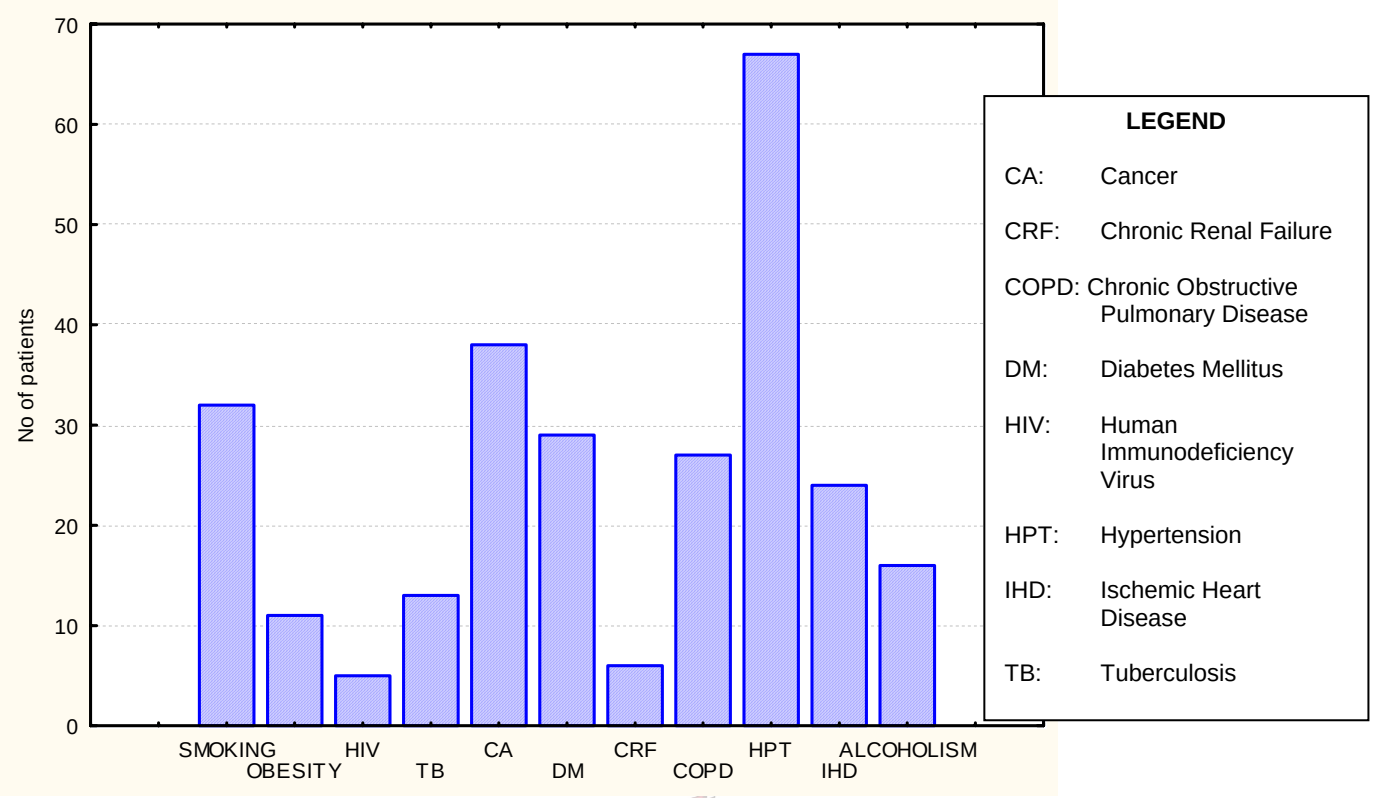


Figure 6.4 Co-morbidities

PATIENT OUTCOMES

The outcomes measured in this study were ICU mortality, and the exact length of stay (LOS) (Marik & Hedman 2000) in the unit. Hospital mortality and the time to death of this population will be reported on in a follow up study.

ICU Mortality

The mean overall ICU mortality for this cohort was 12.3% (n=19). Based on the APACHE II model the predicted mortality was 14.5 %. The standardized mortality ratio (SMR) is the ratio of observed deaths: predicted deaths based on APACHE II. The SMR for this cohort was 0.83. There was a significant association ($p<0.01$) between the APACHE II score and mortality.

Of the 19 patients that died, five patients died within the first 24 hours, while 2 patients died after 14 days.

Table 6.3 Standard mortality ratios in APACHE II categories

APACHE II	n	Observed deaths	Predicted deaths	SMR
0 - 4	18	0%	1%	0
5 - 9	46	2%	3%	0.67
10 - 14	38	5%	6%	0.83
15 - 19	21	5%	11%	0.45
20 - 24	8	56%	29%	2.00
>24	5	50%	37%	1.35

Patients with an APACHE II score of less than 19 performed consistently better than expected, while the more severely ill patients died more often than expected *(Table 6.3).* This was however only significant ($p<0.05$) for the 20 – 24 APACHE II category *(Figure 6.5).*

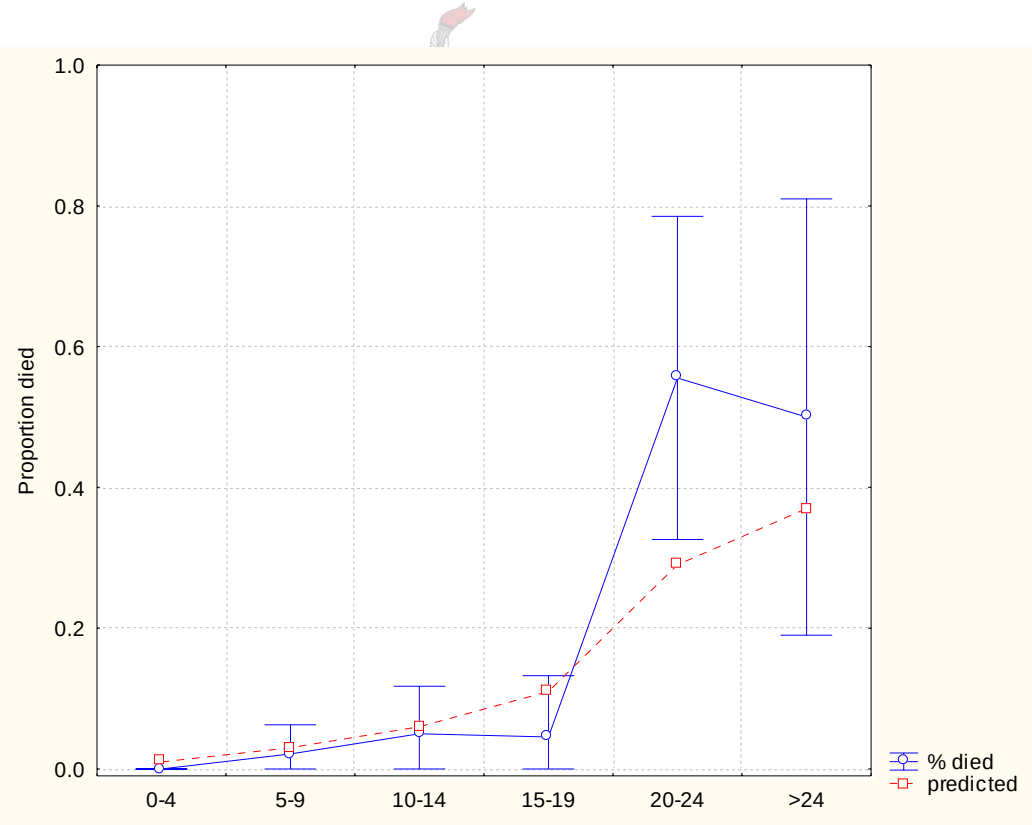


Figure 6.5 Expected to observed mortality

While no significant association was found between the time the patient spent in the unit and mortality *(p=0.83*), on further analysis it was evident that patients were more likely

to die within the first four days of admission to the unit *(Table 6.4).* After this time the mortality was significantly lower, increasing again significantly after staying in the unit for longer than 14 days (p<0.01).

Table 6.4 Time in the unit and mortality

Time in unit	**% Mortality**
< 4 days	14%
>4 < 14 days	2%
> 14 days	40%

In this cohort neither age *(p=0.34)* nor gender *(p=0.1)* was associated with an increased mortality. Using the Chi-square test, no significant association could be established between any of the following variables and mortality *(Table 5).*

Table 6.5 Association of variables and mortality (significant)*

Alcoholism	*p= 0.36*
Smoking	*p= 0.27*
Obesity	*p= 0.73*
Cancer	*p= 0.11*
Diabetes Mellitus	*p= 0.65*
Chronic Renal Failure	*p= 0.16*
Chronic Obstructive Pulmonary Disease	*p= 0.53*
Heart Failure	*p= 0.91*
Hypertension	*p= 0.33*
Ischemic Heart Disease	*p= 0.56*
Peripheral Vascular Disease	p= 0.86
Angina	p= 0.97

Time in the unit

Patients spent a mean of 5.94 (SD 6.55) days in the unit. Of the 17% (n=26) patients that spent less than 24 hours in the unit, 5 patients died. While the mean APACHE II score of these patients was 23.8, the remaining 21 patients had a mean APACHE II score of 6.45. Even though the correlation between the APACHE II score and the time in the unit was not strong (r=0.26), patients with increasing APACHE II scores spent significantly longer (p<0.01) in the unit *(figure 6.6).*

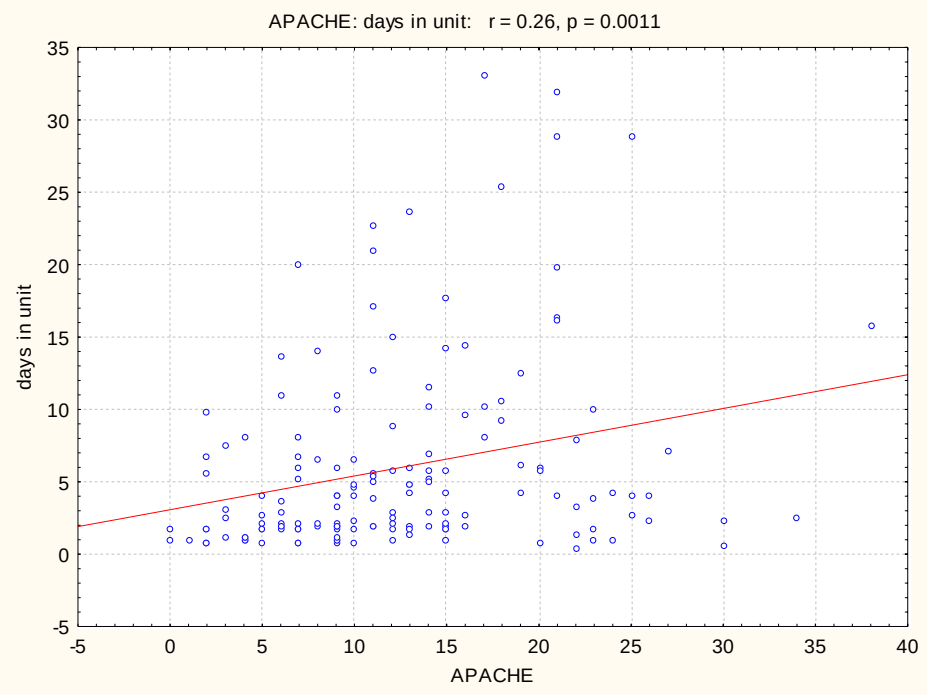


Figure 6.6 Correlation between APACHE II scores and time in the unit

Neither the patients' age *(p=0.29)* nor gender *(p=0.12)* had any significant effect on the time that was spent in the unit *(figure 6.7)*. None of the co-morbidities discussed previously (*see figure 6.4*) had any significantly effect on LOS.

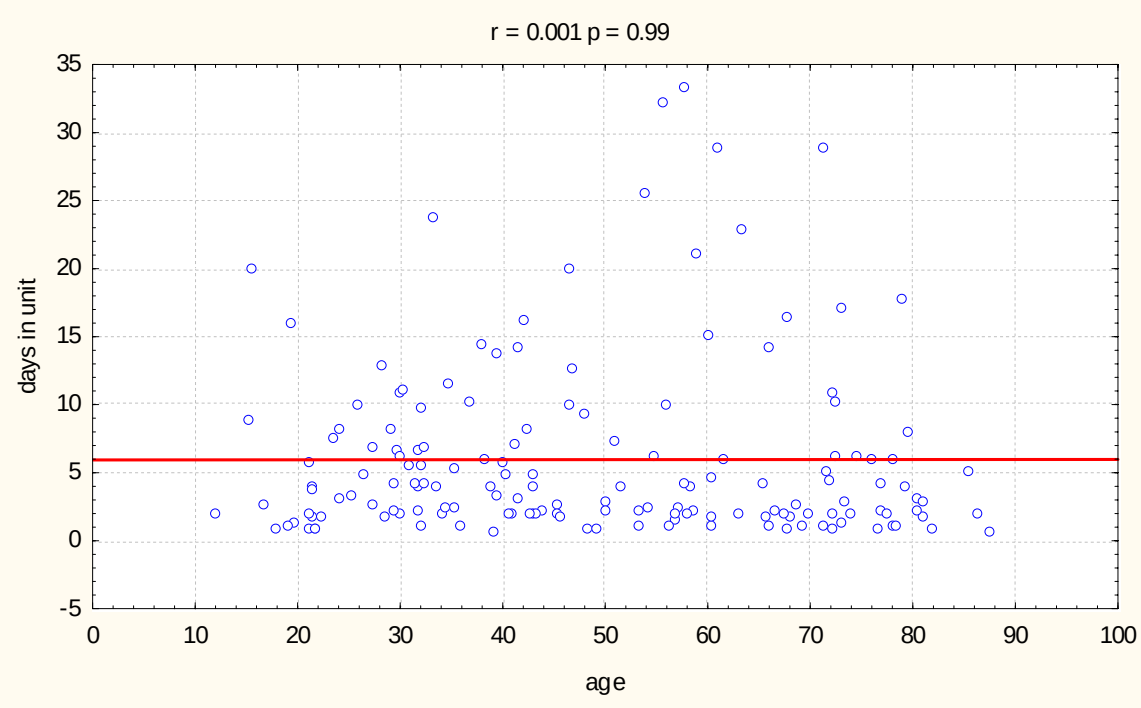


Figure 6.7 Association between age and time in the unit

DISCUSSION

When comparing this cohort of patients with published data it is evident that the patients admitted to this unit were younger than first world populations but older than developing countries, with a similar gender distribution. Patients were admitted to the unit with lower APACHE II scores, compared to both first world and developing countries, but they remained in the unit for longer. The observed mortality was lower than in both first world and developing countries, while the SMR was similar to first world countries but better than in third world countries *(Table 6.6).* A detailed discussion of these variables will follow.

Age

This study confirms the observation that a significantly younger population ($p<0.01$) is admitted to units in developing countries, with a mean age of 49 ± 19.95 found in this population, 44 ± 21 reported in Tunisia (Nouira *et al* 1998) and 52 ± 20 in Brazil (Bastos *et al* 1996). However, the mean age of patients reported in the UK is 57.5 ± 5.32

(Goldhill & Sumner 1998), in the USA 55 ± 18.6 (Knauss *et al* 1985) and 57.8 (SEM ± 0.7) in Canada (Wong *et al* 1995).

Not only was there a difference observed in the mean age of ICU populations, but also in the percentages of patients admitted in the different age groups. In this study only 22% of patients were older than 70. This is similar to the 24.6% reported in Barbados (Hariharan *et al* 2002), but less than the 35% reported in the USA (Knauss *et al* 1985). More convincing statistics of a younger ICU population are the percentages of patients younger than 45 admitted to ICU. Almost half (47%) of this cohort was younger than 45, compared to 27% in the UK (Rowan *et al* 1993) while in the original APACHE II cohort only 16% of patients were younger than 45 (Knauss *et al* 1985). In contrast to this 70% of patients in India and the Baragwanath unit in South Africa were reported to be younger than 45 (Parikh & Karnad 1999, Marik *et al* 1993).

Regional differences in populations within a specific country have resulted in standard deviations of 20 years not uncommon when mean age is reported for a group of units (Goldhill & Sumner 1998, Knauss *et al* 1985). Focusing on units within Southern Africa this unit is admitting patients that are almost 10 years older than previously reported (Marik *et al* 1993 and Potgieter *et al* 1993). Even though the differing time span of data collection ranging over 15 years could have resulted in this observation (Randolph *et al* 1998), there was still an eleven year difference in the mean age of this cohort compared to an audit completed in July 2000 at Baragwanath Hospital in Johannesburg (Mathivha 2002). Regional differences, for example the high incidence of trauma (53%) found in the Baragwanath population compared to 30% in this population could be a possible reason for this.

This trend towards a younger ICU patient population, especially noted in the developing countries could be related to decreasing funds available for intensive care therapy specifically in the public sector and the strict inclusion criteria set up by developing countries (Parik & Karnad 1999, Nouira *et al* 1998). These criteria are necessary so that this very costly service is only provided to those patients that are most likely to benefit from treatment (Mathivha 2002). Whether age should be regarded as one of these criteria is not clear (Stephan *et al* 2001).

The effect of age on patient outcome is unclear from the literature (Hanekom *et al* 2004a, Stephan *et al* 2001). Age has not been associated with prolonged time on the ventilator or increased length of stay in the ICU (Estaban *et al* 2003). Increased mortality was observed in older patients when complications such as acute renal failure or shock was diagnosed (Estaban *et al* 2003, Stephan *et al* 2001). In this cohort no significant association could be found between age and mortality, age and the time spent on the ventilator, or age and the length of stay in the unit.

Gender

There is a worldwide discrepancy reported in gender related admission ratios to intensive care. The 3:2 ratio (men: women) admitted to this unit is comparable to both developing and first world countries (Bastos *et al* 1996, Nouira *et al* 1998, Sirio *et al* 1992). Population demographics have been cited as a possible explanation for this (Sirio *et al* 1992) However, currently both international and national demographic data indicate a more equal ratio of the sexes (United Nations Statistics Division 2002).

The possibility of a referral bias existing in the critical care environment has been mentioned before in that women are usually "sicker" when admitted to a unit (Kollef *et al* 1997). This could not be substantiated in this study with similar APACHE II scores found in the male (12.47) and female (12.42) patients. Kollef *et al* (1997) also suggested that active aggressive medical treatment was discontinued earlier in women than in men because less emergency surgery was being performed in female patients.

Gender has been independently associated with increased hospital mortality in ventilated patients (Kollef *et al* 1997), but the impact of gender on other outcomes is unclear (Hanekom *et al* 2004). In this study no association was found between gender and mortality or time in the unit. Future research should focus on admission rates of female patients and not only on outcome.

Severity of illness

The APACHE II scoring system was developed by Knauss *et al* (1985) based on a cohort of 5030 from multiple centres throughout the United States of America (USA) . Since then it has been shown to be an accurate measure of the severity of illness and outcome prediction in ICU populations (Rowan *et al* 1993, Wong *et al* 1995). This

scoring system has provided researchers with the tools to compare the performance of their units (Hariharan *et al* 2002, Sirio *et al* 1992). APACHE II scores were used in this study to adjust for risk in comparing the outcomes of the same unit over time.

The mean APACHE II score of this cohort is lower than both first world and developing countries *(Table 6.6).* The APACHE II score was calculated based on the worst physiologic variables observed in the patient within the first 24 hours of admission to the unit.

The decision of ICU bed allocation is made daily by intensivists in the public service in an effort to provide this expensive therapy to patients most likely to benefit from it (Mathivha 2002). Examples of exclusion criteria reported in South African units include AIDS, neurologic devestation, end-stage cardiac or renal disease, severe head injury with Glascow Coma score < 8 (Mathivha 2002), incurable malignancies, end stage liver disease, patients with multiple organ failure deemed un-salvageable (Bhagwanjee *et al* 1997).

This unit is admitting relatively high percentages of elective surgery patients (37%) in comparison to other developing countries and almost 10 times more than the 4% reported in the Baragwanath study (Mathivha 2002). Relatively low persentages have been reported in other developing units varying between 23% - 32% (Hariharan *et al* 2002, Bastos *et al* 1996). In the original APACHE II database (Knauss *et al* 1985) 54% of patients admitted to an ICU were admitted after elective surgery. This is comparable to other first world environments varying between 52% - 69% (Sirio *et al* 1992, Berger *et al* 1992). This relative high percentage of elective surgery admissions (37%) could be one reason for the low mean APACHE II score (Kilpatrick *et al* 1994).

A second possible reason for this low APACHE II score could be the fact that only 30% of patients were admitted to this unit following a traumatic injury. This persentage is almost half the 53% reported at Baragwanath (Mathivha 2002) and raises some questions especially in the face of the high violence statistics previously reported in South Africa (Linton 1992). This relatively low statistic is not a true reflection of the persentage of trauma patients admitted to the hospital, as all patients admitted to this hospital are first admitted to the emergency room. Here, emergency care is provided

and patients are kept untill stable. An audit of the emergency room statistics for the same period could provide some answers to the statistics and specifically the outcome of trauma related admissions.

Although less than expected patients were admitted to this unit following a traumatic injury, the composition of the traumatic injuries group is not surprizing. The United Nations found South Africa to present with one of the highest firearm related homicide rates in the world per 100 000 people, second only to Columbia (United Nations International Study on Firearms Regulation 1998). In this cohort 50% of all traumatic injuries were gunshot related. Whereas according to the South African Government's Arrive Alive campaign (2003) 36% of the fatalities in road traffic accidents during January 2003 were pedestrians. In this cohort 50% of patients involved in MVA's were pedestrians.

While it is recognised that a more meaningful evaluation could be performed over a longer time (Randolph *et al* 1998), this three month snapshot of admissions does however lead to the question whether the admission of so many elective surgery patients to a level I ICU is the optimal allocation of recources.

Kilpatrick *et al* (1994) advocated the use of high care units for patients admitted to an ICU following elective surgery, as these patients were generally admitted with low APACHE II scores and a relative short ICU stay. This observation is strengthened by the fact that in this cohort 21 patients with mean APACHE II score of 6.45 were discharged from the unit within 24 hours. It has been established that the greatest cost incurred in ICU occurs within the first 24 hours and is staff related (Potgieter *et al* 1995. Marik *et al* 1993) The first ICU day is almost four times as expensive as other ICU days and 2.5 times as expensive as non-ICU days (Rapoport *et al* 2003). The development of a highcare facility could potentially lead to substantial savings. This facility could be operated in a secondary environment, as proposed by the 2010 HCP.

ICU length of stay

ICU length of stay (LOS) is an accepted outcome measure for ICU intervention (Hanekom *et al* 2004, Marik & Hedman 2000), and is increasingly being used to assess the economic performance of an ICU (Rapoport *et al* 2003). Considering the fact that

the first ICU day is reported to be four times as expensive as other ICU days which in turn are 2.5 times as expensive as non-ICU days (Rapoport *et al* 2003) a shorter ICU stay has potentially huge financial benefits. The daily cost of ICU admission in South Africa was calculated at R1000/ day in 1993 (Potgieter *et al* 1995).

The mean length of stay in this population was 5.94 days. This is a relatively long time compared to 4 days in UK when considering the mean APACHE II score of this unit is 12.3 compared to 19.6 in the UK cohort (Goldhill & Sumner 1998). Eventhough severity of illness has been linked to an increased LOS (Rapoport *et al* 1990), in this cohort the correlation was not strong (r=0.25). The less ill patient population in this unit is staying in ICU 2 days longer than patients in the UK. Two possible reasons for this could be the lack of a step down facility, or the continued medical care of patients not likey to benefit.

Firstly, the fact that this hospital does not have a stepdown facility could force the team to keep patients in the unit longer, as early discharge from ICU has been linked to high re-admission rates or increased hospital mortality (Rapoport *et al* 2003). This is in part substantiated by the fact that only one patient was re-admitted to the unit in the study period. However, this is not a true reflection of the status in this hospital as unstable in-patients are initially admitted to the emergency room, where CPR and other necessary interventions are performed. Once stabilized, patients are then transferred to the ICU. An analysis of the emergency room admissions and hospital mortality will present a more accurate reflection of the standard of care.

Secondly, the relatively long ICU stay in this cohort could be because the very difficult decision to discontinue active treatment of very sick patients not likely to benefit from further intervention, is not made early enough. The survival time of this cohort will only be reported in a follow up study, but almost half of the patients receiving intensive care for longer than 14 days died in the ICU. In a study which compared the outcomes of patients managed in a French and Tunisian ICU, a significantly shorter ICU stay was observed in the Tunisian cohort (6.6 days) after adjusting for severity of illness compared to 8.1 days for the French cohort (Nouira *et al* 1998). These authors stated that the higher demand for ICU beds in Tunisia – a developing country - lead to earlier termination of active treatment (Nouira *et al* 1998). This does lead to the question whether there is not the same demand for ICU beds in this developing unit.

None of the co-morbidities evaluated in this cohort significantly effected the time patients spent in the unit. Conflicting results from former studies have been reported when patients are admitted to an ICU with a disease unrelated to the co-morbidity. In a study to examine the effect of HIV on the outcome of patients admitted to an ICU in Natal South Africa Bhagwanjee *et al* (1997) tested all patients for HIV. Only 13% of those patients tested positive. Allthough HIV positive patients were more prone to septic shock and organ failure in the Natal study these researchers could not find a significant effect on mortality or LOS (Bhagwanjee *et al* 1997). In the study unit it is not practice for all patients to be tested for HIV, and only patients that are concidered for dialysis because of acute renal failure are tested. In this study a fifth (21%) of the cohort tested, were positive for HIV. No associations could be made however due to the small sample (n=5). On the other hand, when patients are admitted to an ICU with a HIV infection or AIDS defining disorder, they present with a significantly increased LOS and mortality (De Palo *et al* 1995).

In another study where the association of co-morbidities on outcome were observed, Bochicchio et al (2004) reported a significant association between obesity, diabetes mellitus (DM) and the LOS, while no association could be established between cancer, renal failure, chronic obstructive pulmonary disease (COPD), alcholism and the LOS. In contrast to this it has been reported that patients admitted to ICU because of respiratory failure as a result of COPD or asthma stay in the unit significantly longer (Nouira *et al* 1998) .

The Western Cape has the highest reported incidence of TB in the World. Although only 13% (n=20) in this cohort were tested, the diagnosis was confirmed in 8% (n=13) of patients. This comorbidity however had no significantly influence on patient outcome, possible due to the small number of patients. The researcher failed to identify any publications evaluating the effect of TB as a co-morbidity on outcome from ICU.

Mortality

The observed mortality in the present study was 12%. This is considerably lower than reported from the USA (20%) (Knauss *et al* 1985), Japan (17%) (Sirio *et al* 1993), Canada (25%) (Wong *et al* 1995) UK (35%)(Goldhill & Sumner 1998), Brazil (29%)

(Bastos *et al* 1996) and South African Baragwanath (31%) (Mathivha 2002). This is mainly due to the differences in APACHE II scores noted previously. In this study a significant association between APACHE II and mortality was established. This association has been confirmed in numerous international studies (Wong *et al* 1995, Sirio *et al* 1992, Beck *et al* 1997, Hariharan *et al* 2002).

In this study mortality was also significantly associated with the LOS ($p<0.01$). Twenty six persent of al deaths occurred within 24 hours of admission to the unit. This is again substantially lower than the 45% reported in the UK (Goldhill & Sumner 1998) and substantially higher than the 4% reported in India (Parikh & Karnard 1999). This discrepency could be due to the stricter inclusion criteria set up in the developing countries for financial reasons (Mathivha 2002).

Standardised mortality ratio

The standardised mortality ratio (observed deaths / predicted deaths) is a widely used measure when comparing the performance of different units (Sirio *et al* 1992, Rowan *et al* 1993, Beck *et al* 1997, Parikh & Karnard 1999, Bastos *et al* 1996, Hariharan *et al* 2002). It is also more reliable than mortality because adjustment is made for severity of illness, age and co-morbidities (Randolph *et al* 1998, Leary *et al* 2002). The SMR of this unit was 0.83. This unit performed better than predicted.

This compares well to the SMR reported from the US (0.65 – 1.27) (Becker & Zimmerman 1996), UK (1.13 – 1.27) (Goldhill & Sumner 1998, Beck *et al* 1997) and Barbadoes 0.97 (Hariharan *et al* 2002). It is also similar to the 1.05 reported by Baragwanath (Mathivha 2002, Marik 1993). However, other developing countries like India and Brazil have reported a high SMR of 1.67 (Parikh & Karnad 1999, Bastos *et al* 1996). This high SMR observed in these developing countries have been attributed to several factors such as the increased time before admission to a unit - the so-called lead time bias - possible less technically sophistication of the units, or the case-mix admitted to the unit (Parikh & Karnad 1999, Bastos *et al* 1996).

Despite the fact that this unit in a developing country is performing similarly to units in first world countries, significantly more patients died in the higher APACHE II categories than predicted. This could imply poor management of "sicker" patients. A more probable

explanation for this could be the small number of patients n=8 admitted to the unit with an APACHE II 20 – 24 category scoring. In such a small population there is not sufficient data to reliable distinguish between high- and low risk patients (Randolph *et al* 1998). However similar discrepencies in these higher APACHE II groups have been reported in other units suggesting a possible underprediction of mortality in more severly ill patients and over prediction in lower APACHE II ranges (Armaganidis 1998).

CONCLUSION AND RECOMMENDATIONS

This baseline study of a surgical ICU in a tertiary environment in the Western Cape presents a picture of a unit providing care comparable to first world environments. Whether the current admission and discharge criteria is making optimal use of the technology available in a level I intensive care unit, is debatable. Other cost effective ways of managing patients that are not as ill could be investigated. These include:

- The implementation of a high care unit (Level IV) (Kilpatrick *et al* 1994) for admission of elective surgery patients that require limited post operative monitoring. This could potentially increase the resources available for sicker patients;

- The implementation of a step-down facility (Rosenberg *et al* 2000) for patients to be discharged to once they are no longer in need of support, but minimal monitoring is still required. This could potentially decrease the ICU LOS without increasing hospital mortality;

- The implementation of a less intensively staffed chronic unit where difficult to wean patients can be admitted. This could also potentially decrease the LOS, making more beds available for "sicker" patients;

- These above mentioned level III and IV units could be succesfully managed at secondary level.

Table 6.6 Comparison of six single centers

		NATIONAL COMPARISON			INTERNATIONAL COMPARISON		
	Hanekom 2004	Mathivha 2002	Potgieter *et al* 1993	Marik *et al* 1993	Hariharan *et al* 2002	Parikh & Karnad 1999	Beck *et al* 1997
LOCATION	**Bellville TBH RSA**	Baragwanath Johannesburg RSA	Cape Town GSH RSA	Baragwanath Johannesburg RSA	Barbados	Bombay India	Hampshire UK
INSTITUTION	**Tertiary Care Centre**	Tertiary Care Centre	Tertiary Centre	Tertiary Centre	Tertiary Care Centre	Tertiary Referal centre	Not stated
BEDS	**10**	18	13	24	6	17	Not stated
UNIT DESCRIPTION	**Surgical**	Mixed medical and surgical	Mixed medical and surgical	Mixed medical and surgical	Surgical	Mixed medical and surgical	Mixed medical and surgical
PATIENT NO	**160**	Not Stated	46	570	309	993	1 144
TIME FRAME	**16 June – 30 Sept '03**	July 2 000	1993	January – Dec1990	July 1999 – June 2001	Jan '95 April '96	April 1993 – March 1996
MEAN AGE	**49 +/- 19.95**	38	40.8 +/- 17.9	37.8 +/- 1.5	51.3 +/- 20.9	36.5 +/- 16	56.7 +/-18.6
% MALE	**58**	65	Not stated	Not stated	53.4	58	60.1
APACHE II	**12.3 +/- 7.19**	20	9.63 +/- 7.35	17.1 +/- .4	Median 9 (IQR 5-16)	14.9 +/- 9.6	15.4 +/- 7.2
LOS	**5.94 +/- 6.55**	Not Stated	5.17 +/- 3.29	8.7 +/- .5	Median 5 (IQR 3-10)	5.5 +/- 7.1	Not stated
MORTALITY	**12**	31.5	6	31.5	15.9	36.2	26.3
PRED MORTAL	**14.5**	30	Not stated	30.4	16.4	21.7	21.3
SMR	**0.83**	1.05	Not stated	1.03	0.97	1.67	1.23

REFERENCES

2010 Healthcare Plan http://www.capegateway.gov.za/text/2004/2/healthcare2010.pdf *(accessed 24 July 2004)*

Armaganidis A 1998 Intensive care in developed and developing countries: are comparisons of ICU performance meaningful? *Intensive Care Medicine* 24:1126-1128

Badenhorst C 1986 Multidisciplinary intensive care in Bloemfontein, 1981 – 1984. *South African Medical Journal* 70(22):674-678

Bastos P, Sun X, Wagner D, Knaus W, Zimmerman J 1996 Application of the APACHE III prognostic system in Brazilian ICU: a prospective multicenter study. *Intensive Care Medicine* 22:564-570

Beck D, Taylor B, Millar B, Smith G 1997 Prediction of outcome from intensive care: A prospective cohort study comparing APACHE II and III prognostic systems in a United Kingdom intensive care unit. *Critical Care Medicine* 25(1):9-15

Becker R & Zimmerman J 1996 ICU scoring systems allow prediction of patient outcomes or comparison of ICU performance. *Critical Care Clinics* 12:503-514

Berger M, Marazzi A, Freeman J, Chiolero R 1992 Evaluation of the consistency of APACHE II scoring in a surgical intensive care unit. *Critical Care Medicine* 20(12):1681-1687

Bhagwanjee S, Muckart DJ, Jeena P, Moodley P 1997 Does HIV status influence the outcome of patients admitted to a surgical ICU? *British Medical Journal* 314:1077-1081

Bochicchio GV, Joshi M, Bochicchio K, Tracy K, Scalea T 2004 A time dependent analysis of ICU pneumonia in Trauma patients. *Trauma* 56(2):296-303

De Palo V, Millstein BH, Mayo PH, Salzman SH, Rosen MJ 1995 Outcome of intensive care in patients with HIV infection. *Chest* 107(2):506-510

Estaban A, Anzueto A, Frutos-Vivar F, Alia I, Ely EW, Brochrd L, Stewart TE, Apezteguia C, Tobin MJ, Nightingale P, Matamis D, Pimentel J, Abroug F 2004 Outcome of older patients receiving mechanical ventilation. *Intensive Care Medicine* 30(4):639-46

Goldhill D & Sumner A 1998 Outcome of intensive care patients in a group of British Intensive care units. *Critical Care Medicine* 26(8):1337-1345

Hanekom S, Coetzee A, Faure M 2004a Outcome research in ICU: Factors influencing patient outcome in ICU *(In Process)*

Hanekom S, Coetzee A, Faure M 2004b Outcomes Research in ICU: an aid in defining the role of physiotherapy *(In Process)*

Hariharan S, Moseley S, Kumar A 2002 Outcome evaluation in a surgical intensive care unit in Barbados. *Anesthesia* 57:434-441

Hira B, Miller M, Bagg M 1985 Outcome after admission to an intensive care unit. *South African Medical Journal* 67:180-181

Joshua N, Jena G, Mletelwa 1989 Multidiciplinary intensive care unit at Cecelia Makiwane Hospital, Mdantsane, Ciskei. *South African Medical Journal* 75:286-289

Kilpatrick A, Ridley S, Plenderleith L 1994 A changing role for intensive therapy: is there a case for high dependancy care? *Anaesthesia* 49:666-670

Knauss WA, Draper EA, Wagner DP, Zimmerman JE 1985 APACHE II. A severity of disease classification system. *Critical Care Medicine* 13:818-829

Kollef MH, O'Brien JD, Silver P 1997 The impact of gender on outcome from mechanical ventilation. *Chest* 111(2):434-441

Leary T, Ridley S, Burchett K, Kong A 2002 Assessing Critical Care Unit Performance: a global measure using graphical analysis. *Anaesthesia* 57:571-755

Linton D 1992 The impact of trauma on ICU facilities in South Africa. *South African Medical Journal* 81:118-119

Marik P, Kraus P, Lipman 1993 Intensive Care Utilization: the Baragwanath Experience. *Anaesthesia Intensive Care* 21:396-399

Marik P & Hedman L 2000 What's in a day? Determinig ICU length of stay. *Critical Care Medicine 28(6):2090-2093*

Mathivha LR 2002 ICU's worldwide: An overview of critical care medicine in South Africa. *Critical Care 6(1):22-23*

Meiring P, Lumsden J, Morrison A, Furnham L 1969 An intensive care unit in a provincial general hospital*. South African Medical Journal* 43:806-809

Mieny C &Townsend R 1970 The surgical intensive care unit of Johannesburg hospital. *South African Medical Journal* 44:675-677

NIH Consensus Development Conference on Critical care medicine 1983 *Critical Care Medicine* 11:466-469

Nouira S, Roupie E, El Atrouss S, Durand-Zaleski I, Brun-Buisson C, Lemaire F, Abroug F 1998 Intensive care use in a developing country: a comparison between a Tunisian and a French unit. *Intensive Care Medicine* 24:1144-1151

Parikh C & Karnard D 1999 Quality, cost and outcome of intensive care in a public hospital in Bombay, India. *Critical Care Medicine 27(9):1754-1759*

Potgieter P, Hammill L, Gough A, Hammond J 1995 Cost of Critical Care in South Africa. *South African Medical Journal 85(5):425-430*

Randolph A, Guyatt G, Carlet J 1998 Understanding articles comparing the outcomes among intensive care units to rate quality of care. *Critical Care Medicine* 26(4):773-781

Rapoport J, Teres D, Lameshow S 1990 Timing of ICU admission in relation to ICU outcome. *Critical Care Medicine* 18:1231-1235

Rapoport J, Teres D, Zhao Y, Lemeshow S 2003 Length of stay data as a guide to hospital economic performance for ICU patients. *Medical Care* 41(3):386-397

Rosenberg A, Zimmerman J, Alzola C, Draper E, Knauss W 2000 ICU length of stay: Recent changes and future challenges. *Critical Care Medicine* 28(10):3465-3473

Rowan K, Kerr J, McPherson K, Short A, Vessey M 1993 Intensive care society's in Britian and Ireland. *British Medical Journal* 307:977-981

Russel J, Stewart A, Kessler A 1968 The design and function of an intensive care unit. *South African Medical Journal* 42:931-933

Sirio C, Tajimi K, Tase C, Knauss W, Wagner D 1992 An initial comparison of intensive care in Japan and the USA. *Critical Care Medicine* 20(9):1207-1215

South African Government's Arrive Alive Campaign 2003
http://www.lenzinfo.org.za/Arrive_alive_campaign_jan_180203.htm *(accessed 4 July 2004)*

Stephan F, Cheffi A, Bonnet F 2001 Nosocomial Infection and outcome of critically ill elderly patients after surgery. *Anesthesiology* 94:407-414

Strategic and Service Delivery Improvement Plan (SSDIP) Provincial Government of the Western Cape Department of Health Draft Paper 2000
http://www.westerncape.gov.za/health_social_services/policy_planning *(accessed 27 March 2003)*

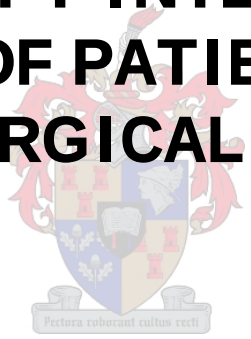
United Nations International Study on Firearm Regulation 1998
http://www.uncjin.org/Statistics/firearms/ *(accessed 23 July 2004)*

United Nations Statistics Division 2002
http://unstats.un.org/unsd/demographic/ww2000/table3b.htm *(accessed 23 July 2004)*

Wong D, Crofts S, Gomez M 1995 Evaluation of predictive abaility of APACHE II system and hospital outcome in Canadian ICU patients. *Critical Care Medicine* 23(7):1177-1183

CHAPTER 7 Research Report

A BASELINE STUDY TO DETERMINE THE CLINICAL COURSE, PHYSIOTHERAPY INTERVENTION AND OUTCOME OF PATIENTS FROM A SURGICAL ICU



ABSTRACT

Objectives: To describe the physiotherapy interventions and clinical outcomes of patients on discharge from a surgical ICU in South Africa.

Design: Prospective cohort observational study.

Setting: Ten-bed closed surgical unit in a university affiliated tertiary hospital.

Patients: Consecutive adult ICU admissions from 16 June – 30 September 2003.

Measurements: The physiotherapy techniques used, positions and functional activities used, the frequency and duration of physiotherapy treatment sessions, the provision of after-hours service, the diagnosis of pulmonary complications and clinical outcomes of patients were recorded.

Results: Nine hundred and twenty seven physiotherapy records were obtained. Students were responsible for 39% (n=366) of treatment sessions, the unit therapist for 34% (n=311) and the on-call therapists for 27% (n=250). Despite routine daily physiotherapy for all patients in the unit, 39% (n=62) developed excessive secretions, 30% (n=48) of patients developed pneumonia and 27% (n=43) of patients were diagnosed with basal atelectasis. Nineteen patients (12%) died in the ICU. Patients spent a mean of 5.94 (SD 6.55) days in the unit. One hundred patients (63%) were ventilated. Almost a third of ventilated patients (31%) were intubated more than once. The patients spent a mean time of 3.8 days (SD 6.30) on the ventilator every time they were re-intubated. The development of pulmonary complications significantly increased the time on the ventilator and the LOS.

Conclusions The picture of the physiotherapy service provided in this unit as reflected in this cohort is of a "traditional" service based neither on the available evidence regarding the prevention or management of pulmonary complications, nor on the incorporation of early rehabilitation into the management of mechanically ventilated adult patients in ICU. This study forms the baseline for evaluation after the implementation of an evidence based physiotherapy protocol in a surgical ICU.

INTRODUCTION

The physiotherapist is still regarded as an integral member of the interdisciplinary team involved in the management of patients in the intensive care unit (ICU). This view is held by both the European Society of Intensive Care Medicine (ESICM), and the American College of Critical Care Medicine (ACCCM). Both bodies recommend that at least one dedicated physiotherapist per 12 bed ICU is desirable (Ferdinande *et al* 1997), and that it is essential that a respiratory therapist[1] be available to the ICU at all times ACCCM (1999). Both these task forces however make it clear that not all their recommendations were based on sound scientific evidence but "…rather express the consensus of opinion leaders involved in intensive care medicine" (Ferdinande *et al* 1997).

This opinion might be challenged by a recent survey conducted by Jones (2001) investigating the perceptions of medical personnel in regard to physiotherapy in ICU. In this study a questionnaire was sent to the directors of ICU's in the UK, Australia, Canada, South Africa and Hong Kong to determine their perceptions of physiotherapy services. The response rate was 53% (n=101). While 79 % of the directors rated the services provided by physiotherapists as either outstanding or very good, nearly 60% of these directors considered that the physiotherapists' work could be performed by other disciplines.

In a review article on evidence-based physiotherapy practice in ICU, Stiller (2000) questioned the scope of physiotherapy in the acute care setting and was "hesitant" to provide guidelines for routine multimodality physiotherapy intervention in ICU stating "…current lack of evidence does not allow a firm directive to be made regarding the benefits, risks, and costs associated with the provision of routine multimodality respiratory physiotherapy to all intubated ICU patients receiving mechanical ventilation" (Stiller 2000:1809). Because of the lack of evidence for the routine physiotherapy management of patients in ICU, this author recommended that units independently

[1] Respiratory therapists are commonly employed in North America. They treat and care for patients with breathing disorders. Their scope of practice is broader than that of a physiotherapist working in the specialist field of cardiopulmonary, but according to the Bureau of Labour Statistics, U.S. Department of Labour, chest physiotherapy techniques are included in the spectrum of techniques used by these therapists

decide on the level of involvement and the primary role of the physiotherapist within the unit.

This lack of evidence is not unique to the physiotherapy profession (Stiller 2000), as evidence for much of the clinical practice routinely employed in the ICU is still lacking (Cook *et al* 1996). This situation has in part contributed to the developing interest in outcome research as a method of obtaining evidence for "best practice" for the medical (Rubenfeld *et al* 1999) and respiratory management of patients (Kollef 1998) in ICU.

Although a specific definition for outcomes research is still lacking (Kollef 1998) there seems to be widespread acceptance of the fact that outcomes research is used to formulate clinical guidelines, to assess the quality of medical care and to inform health policy decisions (Rubenfeld *et al* 1999; Kollef 1998; Chatburn 2001).

In a workshop organized by the American Thoracic Society on Outcomes Research in Critical Care, outcomes research was defined as a "difference in focus" (Rubenfeld *et al* 1999). In contrast to randomized controlled trials (RCT's), outcomes research focuses on the effects of care on endpoints that are important to patients and society, and not at physiologic variables alone (Rubenfeld *et al* 1999). Intensivists, nurses and pharmacists have used outcomes research to determine their role within the ICU (Hanekom *et al* 2004).

Global economic and social policies have an increasing impact on the provision of healthcare services (Benatar 2004). Factors that are impacting on the provision of healthcare include rapid population growth, the emergence of new infectious diseases including HIV/AIDS, ecological degradation associated with modern consumption patterns, massive shifts of people around the world and numerous local and regional wars (Benatar *et al* 2003). The impact global economic policies have on the provision of healthcare internationally, are causing service providers, policy makers and clinicians to make difficult decisions about various aspects of the services that are provided (Povar *et al* 2004).

Following the successful political transition of the South African society, the country is now faced with the challenges of social transition and more specifically healthcare

reform (Benatar 1997). The Government's drive to reform healthcare is based on a framework of a district based approach to primary care. However, providing a free primary healthcare service for all is resulting in resources being withdrawn mainly from academic medical centres (Benatar 1997). In the Western Cape the public health sector has seen a 24.4% downsizing of hospital beds and a 27.9% downsizing of personnel (Benatar 2004). According to the Draft Paper on the Strategic and Service Delivery Improvement Plan of the Western Cape Health Department (2000) there has been a 19% downsizing of beds in Tygerberg Hospital (TBH) and a 28.8% cut in personnel over the past 4 years. Currently there are 15 fulltime posts and one 5/8 physiotherapy post available in TBH which is a 1385 bed tertiary hospital. This hospital has 8 specialized independently functioning ICU's namely burns, cardiothoracic, medical, coronary, neurosurgery, neo-natal, paediatric as well as a surgical unit. The adoption of the 2010 Health Care Plan (HCP) by the Provincial Government of the Western Cape will have even more far reaching implications for service delivery within the public service, as the proposed changes will necessarily lead to a restructuring and relocation of personnel. This in turn will have implications for the staffing of the ICU. The vision of this Plan is for 90% of all patient contact to be at district level, 8% at secondary level and only 2% at tertiary level. It is accepted that a Level 1 ICU is to function at tertiary level (Mathivha 2002).

Before the implementation of an evidence-based physiotherapy protocol in a surgical ICU a baseline study was completed to determine:

- the physiotherapy techniques used in ICU;
- the time spent on direct patient care by the unit physiotherapist, the students and the on-call physiotherapist;
- the positions used in the treatment of patients;
- the respiratory complications that occurred in ICU; and
- selected outcomes of patients i.e. ICU mortality, length of stay in ICU and time of mechanical ventilation.

SETTING

This baseline study was completed in A1 West, a ten-bed surgical ICU situated in Tygerberg Hospital (TBH) in the Western Cape. This is a 1385 bed tertiary teaching

hospital for students of the Faculty of Health Sciences, University of Stellenbosch and the Faculty of Community and Health Services, University of the Western Cape.

TBH serves the Northern Suburbs of the City of Cape Town, the Winelands district (Stellenbosch, Paarl and Malmesbury), and the Overberg district (Hermanus and Worcester). In addition to the surgical unit there are seven other independently functioning ICU's. All patients requiring intensive support or monitoring following either elective or emergency surgery and trauma, are admitted to the surgical ICU, which operates as a Level I Unit with intensivists taking final responsibility for patient care. A twenty four hour service is provided, with a registrar available in the unit at all times.

The interdisciplinary team involved in patient care consists of an anaesthetist at the head, a medical officer and at least one registrar from each of the following departments namely Orthopaedics, Neuro-surgery, Neurology, Anaesthesiology, Surgery, and Trauma. These registrars rotate through the unit on a three month cycle as part of their specialization. A permanent matron is allocated to the unit and one senior sister to both the five bed wards. On average the nurse: patient ratio is 1.7: 1 (Hanekom 2004 *unpublished data*). The physiotherapy department offers a fulltime service to the unit on a non-referral basis. During the week one physiotherapist is responsible for the unit as part of a clinical rotation that includes other surgical in-patient wards and outpatients. An after-hours service is provided by all full-time physiotherapists on a rotational basis. Students from the Departments of Physiotherapy of the Universities of Stellenbosch and the Western Cape rotate through the unit on a six week cycle as part of their clinical training. Other staff includes a dietician on call and a fulltime medical technician who is responsible for the maintenance of all equipment in the unit and the daily arterial blood gas analysis of all patients. Patients are referred to occupational therapy as indicated.

METHODOLOGY

A prospective cohort observational study was undertaken. All patients admitted to the surgical ICU from 16 June 2003 until 30 September 2003 were included in the sample. All patients were followed until discharge from the unit. The last patient was discharged on 27 October 2003.

The study was approved by the Research Ethics Committee of the University of Stellenbosch. As this was an observational study of a non-therapeutic and non-invasive nature, proxy consent to access patients' folders was obtained from the superintendent of TBH for all patients admitted to the unit during the study period.

INSTRUMENTATION

Three self designed data extraction sheets were developed.

Daily progress data included the patient's ventilatory status, the time of intubation or extubation, the reason for this and any respiratory complications diagnosed by the interdisciplinary team. The opinion of the medical team involved in the daily clinical management of the patient was accepted.

Physiotherapy data capturing sheet served as a record of current practice. Included in this form were information on the rank of the treating physiotherapist i.e. the unit, on-call or student physiotherapist; the date and time of treatment, the estimated time spent on hands-on treatment, the positions of patients used during treatment; the functional activities done, the amount of assistance the patient required during functional activities, the cough ability of the patient and the range of physiotherapy techniques used. These were categorized into breathing exercises, mechanical equipment used, secretion removal techniques, movements used, and manual techniques.

After a pilot study was completed on the use of these forms it became apparent that the interpretation of the techniques could vary between therapists. Small group discussions were held in the department, and consensus in regards to the specification of the techniques was reached and documented.

Discharge data included the date and time of discharge / death.

PROCEDURE

A research assistant – qualified physiotherapist with 4 years of clinical experience - was appointed for the duration of the project. Specified existing unit documentation forms were used for data extraction. To ensure visibility of the project and as a daily reminder of the project to the rest of the team members, the researcher attended one of the daily ward rounds, or visited the unit during the day. Data was collected as follows:

Daily progress data

The records of each patient were accessed daily for the previous 24 hour period (07:00 – 6:59), by either the researcher or research assistant and the relevant data extracted.

Physiotherapy data

For the duration of the project all physiotherapy documentation systems used in the unit were replaced by a self designed physiotherapy data capturing sheet. These sheets were made available as carbon copies so that there was no extra work for the physiotherapists to complete the forms. These forms were completed by the physiotherapist after each treatment session and kept in the patient folder. By the end of the day the duplicate forms were removed from the patient folder by the researcher and filed.

Discharge data

The time and date of discharge or death was documented.

Reconciliation of data

After completion of the project, all data sheets were compared to admission and discharge data to ensure that there was data for every day a patient was in the unit. In total the daily management data was missing for sixty individual days. The specific patients' folders were requested from medical records, and A1 unit respectively and the relevant data extraction sheets were completed, reviewing the specified records. All of the daily management data were retrieved.

In total the physiotherapy data were not available for 56 individual days. After accessing patients folders in medical records eight data capturing sheets were found that had been mistakenly filed in duplicate. There after the folders of all the patients in the sample (N=159) were examined. However no other data capturing sheets were found. On the remaining 48 days, physiotherapy was provided before the patient was admitted to the unit or after discharge from the unit. This data was thus not used in the statistical analysis of the results.

DATA ANALYSIS

Data was analysed in consultation with a statistician using Statistica (version 6). Descriptive data was summarized and the categorical data is presented in either bar - or pie charts. The central tendency is described in terms of means and the variation of the data as standard deviations (SD).

A non parametric Kruskal Wallis test was used to determine the differences between multiple independent groups. The Chi-square goodness of fit test was used to determine if observed frequencies of techniques used in patients where a complication was diagnosed was different from techniques used if the complication was not diagnosed. A covariate analysis was done to determine if there was a significant difference in the outcome of patients when comparing groups of therapists. No patients were seen by only one therapist for the duration of their stay in the unit, so for the purposes of analysis a patient was considered to be seen by a student if 60% of treatment sessions were completed by the student. Although values were accepted as significant at the 5% level ($p<0.05$), it was decided to report p-values as actual numbers with a smaller p-value indicating stronger evidence to accept or reject a hypothesis.

RESULTS

One hundred and sixty one admissions were recorded in the study period. One patient was re-admitted, and the data of one patient could not be obtained, therefore the data from 159 patients and 160 admissions were analysed. Nine hundred and twenty seven physiotherapy records were obtained. Students were responsible for 39% (n=366) of treatment sessions, the unit therapist for 34% (n=311) and the on-call therapists for 27% (n=250).

The majority of patients 90% (n=144) were treated once a day, 9% (n=14) twice and only 1% (n=2) were treated 3 times a day by the physiotherapists. During 91 sessions patients were evaluated by the therapist it was documented that the patient was not treated as they were either considered too unstable for physiotherapy intervention (n=36), or that the patient would not benefit (n=34) *(Figure 7.1).*

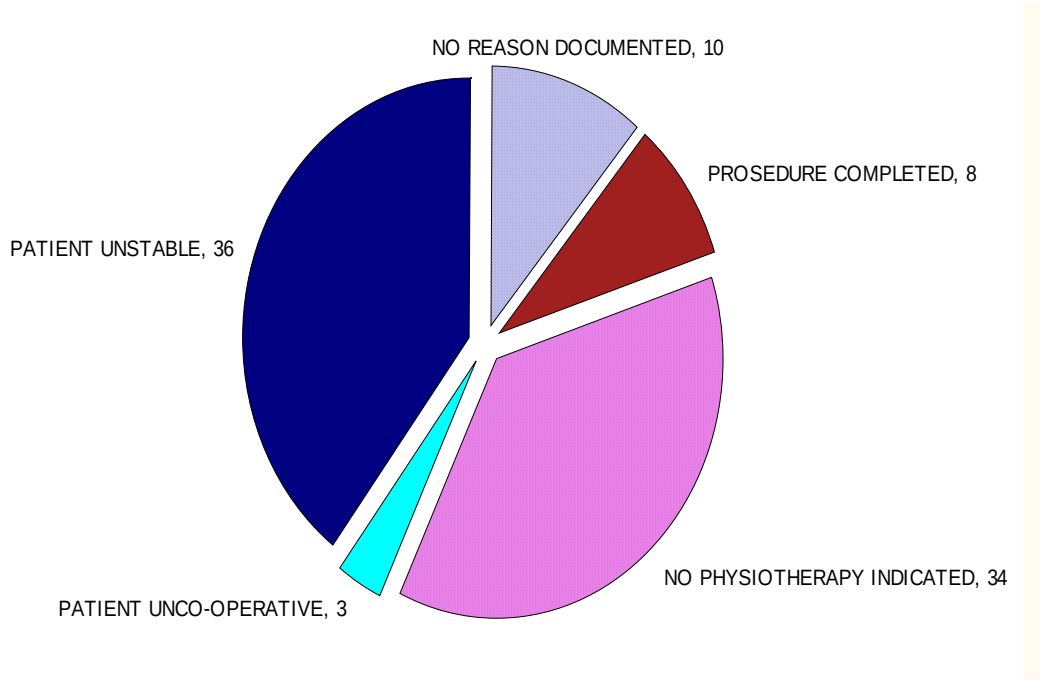


Figure 7.1 Documented reasons for no physiotherapy intervention

In each of these treatment sessions (N=927), physiotherapists spent a mean of 17.73 (SE 0.86) minutes per patient. Student physiotherapists spent significantly ($p<0.01$) longer with patients than either the unit therapist or the on-call therapist *(Figure 7.2).*

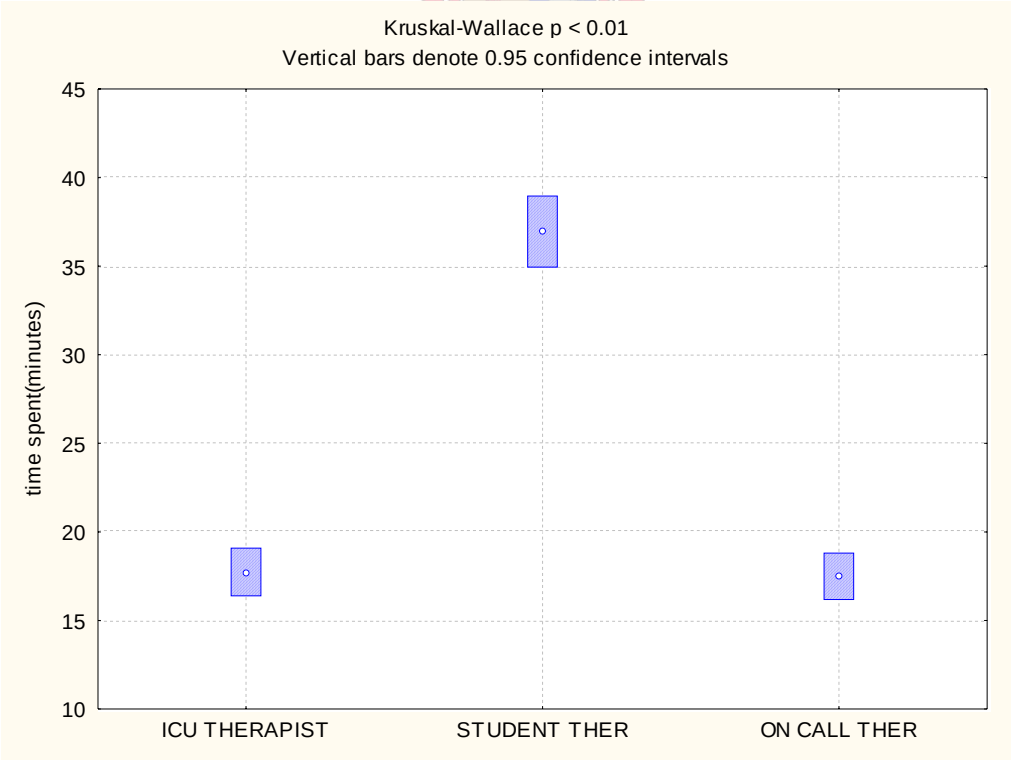


Figure 7.2 Therapist treatment duration

Patients were treated seven days a week and the largest proportion of patients were treated between 8:30 and 11:30 in the morning. Even though the department offers a 24 hour service, there was no record of any patient being seen after hours between 16:00 and 07:00 *(Figure 7.3).*

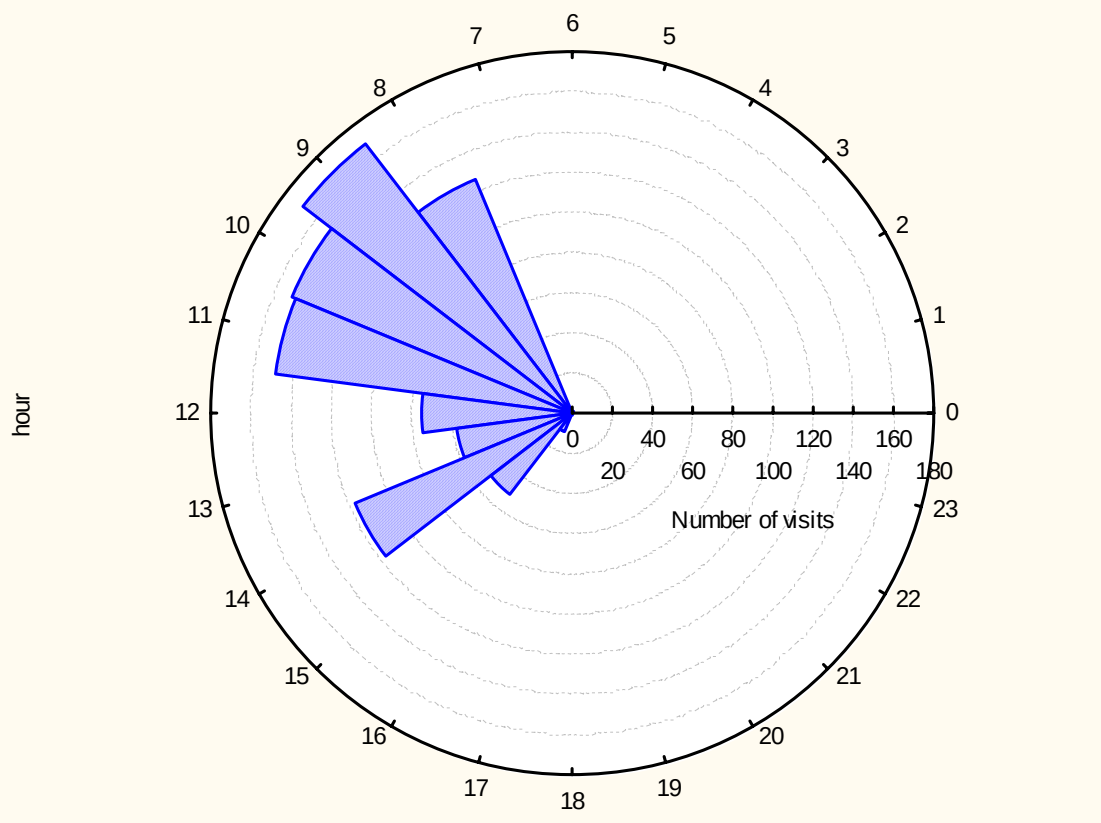


Figure 7.3 Daily times of treatment sessions

Physiotherapists used a variety of treatment techniques. The unit physiotherapists relied primarily on a "standard" cardiopulmonary physiotherapy regime consisting of the vibromat, manual shakings, percussion and suctioning. In contrast to this the students' techniques were more varied and included more active assisted movements (AAM's), position change and mobilization of patients. Students appeared to prefer manual vibrations to the vibromat (*Figure 7.4).*

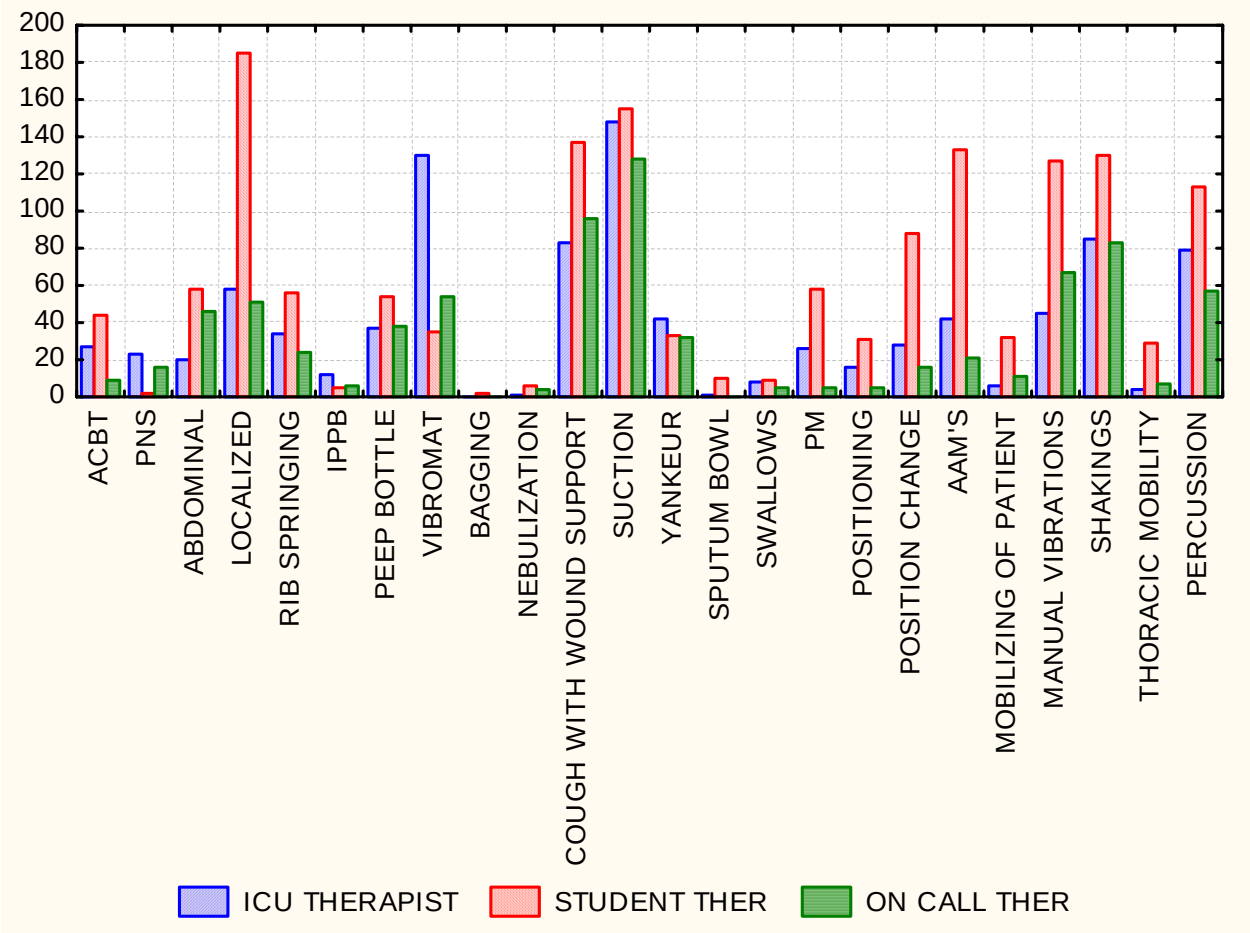


Figure 7.4 Frequency of techniques used by therapists

The techniques used to treat patients after a complication had been diagnosed, differed significantly from the techniques chosen in the absence of the complication. Table 7.1 indicates how often the technique (%) was used. The specific complications include pneumonia, excessive secretions or basal atelectasis. Values were considered significant if the specific technique had been used more or less often than in patients where the diagnosis had not been made.

Patients presenting with acute atelectasis were treated significantly more often with a regime consisting of abdominal breathing, IPPB, PEEP bottle and thoracic mobility exercises. It can be expected that patients diagnosed with pneumonia and excessive secretions were treated quite similarly but significantly different than those with basal atelectasis. The treatment regime consisted of PNS techniques, position change and shakings. Rib springing, use of vibromat, suctioning, movement of a patient, percussion and manual vibrations were used less discriminately between the three pathologies but significantly more than in other patients.

Table 7.1 Frequency of techniques used in patients who developed respiratory complications (%)

	PNEUMONIA			EXCESSIVE SECRETIONS			BASAL ATELECTASES		
BREATHING EXERCISES	**YES**	**NO**	***P value***	**YES**	**NO**	***P value***	**YES**	**NO**	***P value***
ACBT	38	62	=0.24	37	63	=0.14	37	63	=0.30
PNS	**33**	**67**	**<0.01**	**30**	**70**	**<0.01**	26	74	=0.03
Abdominal	49	51	=0.12	48	52	=0.09	**56**	**44**	**<0.01**
Localized	78	22	=0.02	**77**	**23**	**<0.01**	**84**	**16**	**<0.01**
Rib Springing	**60**	**40**	**<0.01**	**51**	**49**	**<0.01**	**53**	**47**	**<0.01**
MECHANICAL									
IPPB	11	89	=0.83	16	84	=0.04	19	81	=0.04
PEEP Bottle	51	49	=0.20	51	49	=0.12	58	42	=0.02
Vibromat	**76**	**24**	**<0.01**	**74**	**26**	**<0.01**	**65**	**35**	**<0.01**
Bagging	2	98	=0.5	3	97	=0.05	2	98	=0.5
Nebulization	11	89	=0.04	**11**	**89**	**<0.01**	12	88	=0.03
SECRETION REMOVAL									
Cough with W/S	76	24	=.25	77	23	=0.07	74	26	=0.36
Suction	**87**	**13**	**<0.01**	**82**	**18**	**<0.01**	**74**	**26**	**<0.01**
Yankeur	44	56	=0.04	**51**	**49**	**<0.01**	44	56	=0.05
Sputum Bowl	4	96	=0.97	7	93	=0.33	9	91	=0.09
Swallows	16	84	=0.12	16	84	=0.02	16	84	=0.09
MOVEMENT									
PM	**49**	**51**	**<0.01**	**38**	**62**	**<0.01**	**35**	**65**	**<0.01**
Positioning	**49**	**51**	**<0.01**	**44**	**56**	**<0.01**	**47**	**53**	**<0.01**
Position change	**60**	**40**	**<0.01**	**56**	**44**	**<0.01**	51	49	=0.02
Active Assisted Movements	**64**	**36**	**<0.01**	**64**	**26**	**<0.01**	**67**	**33**	**<0.01**
Mobilizing of patient	**36**	**64**	**<0.01**	**33**	**67**	**<0.01**	**42**	**58**	**<0.01**
MANUAL TECHNIQUES									
Manual Vibrations	**82**	**18**	**<0.01**	**75**	**25**	**<0.01**	**63**	**37**	**<0.01**
Shakings	**91**	**9**	**<0.01**	**82**	**18**	**<0.01**	63	37	=0.03
Thoracic Mobility	**27**	**73**	**<0.01**	21	79	=0.04	**35**	**65**	**<0.01**
Percussion	**89**	**11**	**<0.01**	**79**	**21**	**<0.01**	**65**	**35**	**<0.01**

Techniques used significantly more after a complication was diagnosed

Techniques used significantly less after a complication was diagnosed

In this unit patients are routinely nursed in the 30 degree head up supine position (Hanekom 2004 *unpublished data*). This routine nursing position, or supine with the bed horizontal, were the two positions used most often in the treatment of patients by all therapists. Students again showed more variation in their choices and used side lying and sitting – either long sitting, high sitting or sitting in a chair with at least forty treatment sessions per position *(Figure 7.5).*

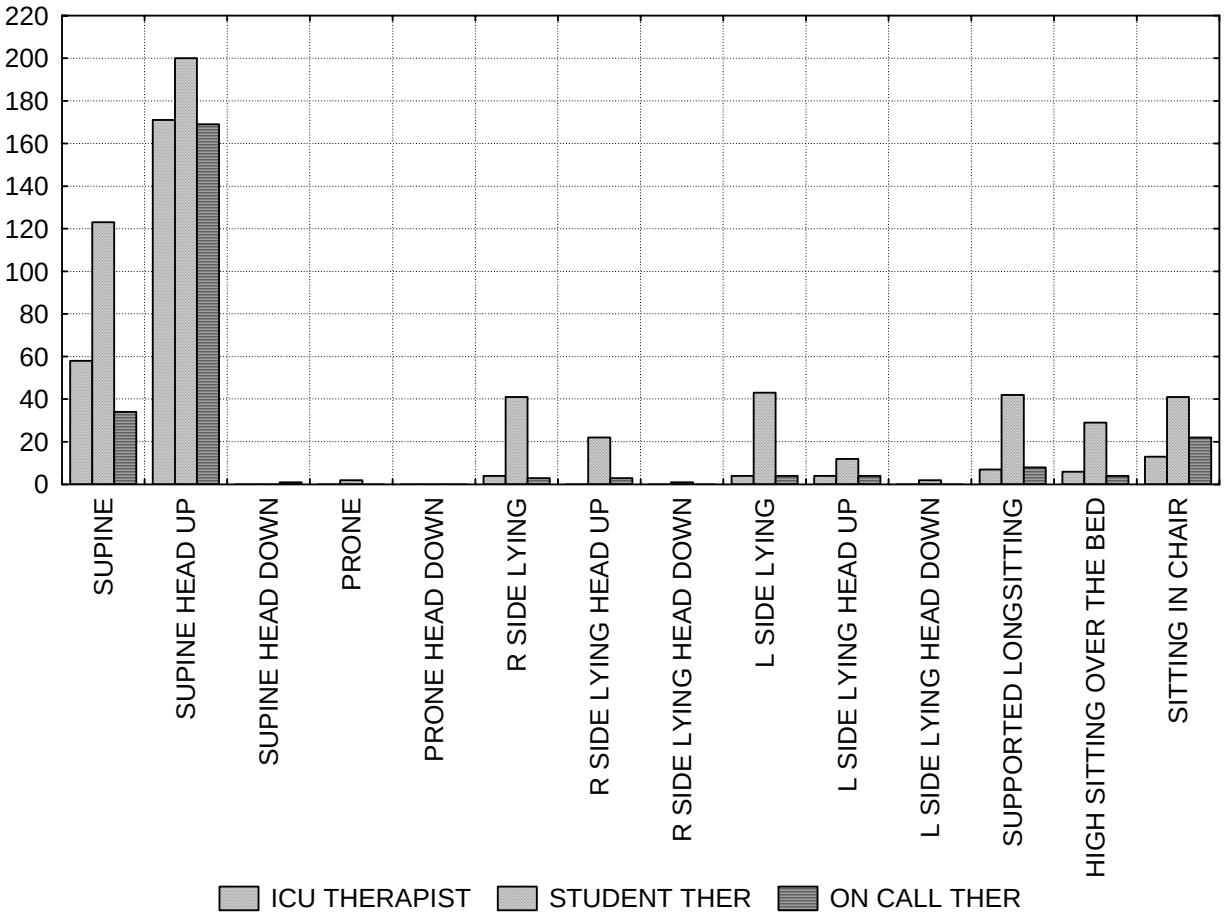


Figure 7.5 Frequency of positions used

Functional activities were only used in 15% (n=142) of treatment sessions, with students being more likely to incorporate functional activities into the daily management of patients. Moving the patient up in bed was used most often. Unit therapists never recorded walking with the patient as part of their management, and both students and on-call therapists recorded this in a very small number (n=5) of sessions *(Figure 7.6).*

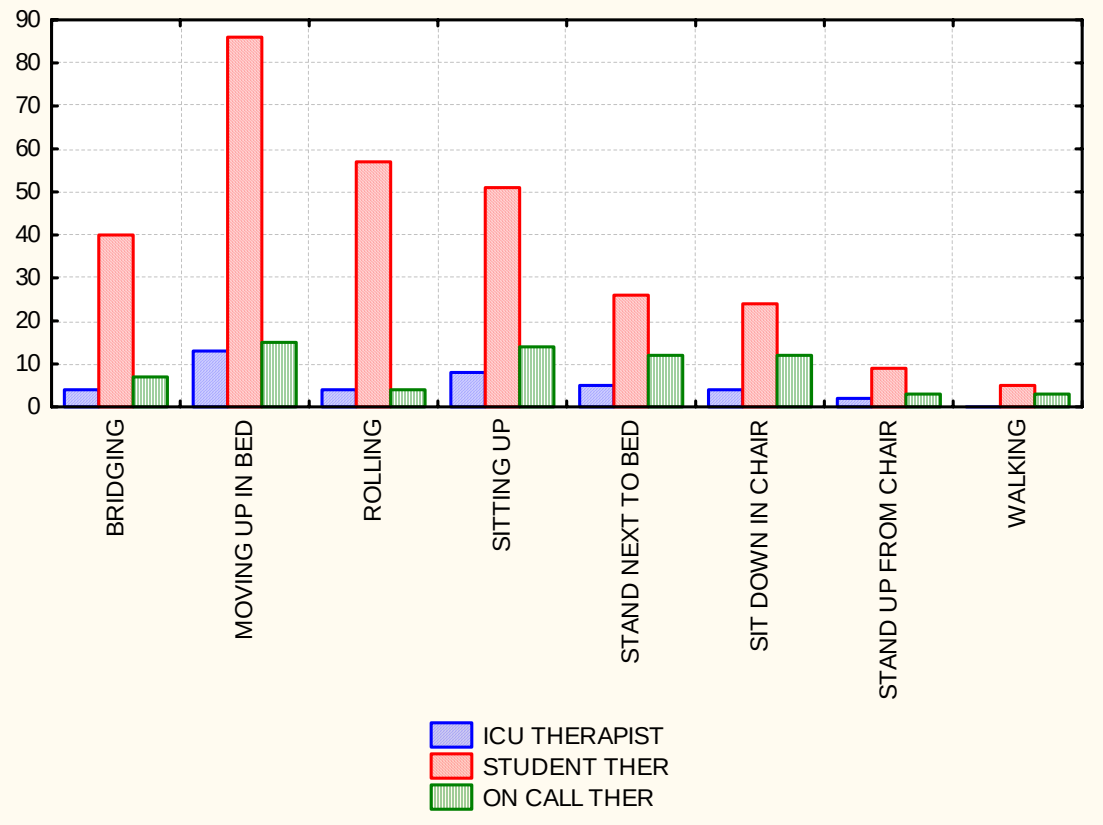


Figure 7.6 Frequency of functional activities used

Complications developed

Patients developed a variety of lung complications during their stay in the unit, and were not limited to the development of only one complication. Despite routine daily physiotherapy for all patients in the unit, 39% (n=62) developed excessive secretions, 30% (n=48) of patients developed pneumonia, 27% (n=43) were diagnosed with basal atelectasis, 17% (n=27) had a lung collapse and 16% (n=25) of patients suffered from severe bronchospasm (*Figure 7.7).*

Pneumonia was diagnosed in 48 patients (30%), of whom 46 were ventilated. Only two non-ventilated patients were diagnosed with pneumonia. The first was a patient admitted to the unit for monitoring following elective femoral bypass surgery who developed pneumonia on day 1, and was discharged on day 2. The second patient had a history of rheumatic heart disease and was admitted to the unit for monitoring following an elective caesarian-section. She developed pneumonia on day 6 and was discharged on day 8. The development of these complications significantly increased the time the patients spent on the ventilator and the time in the unit ($p<0.01$).

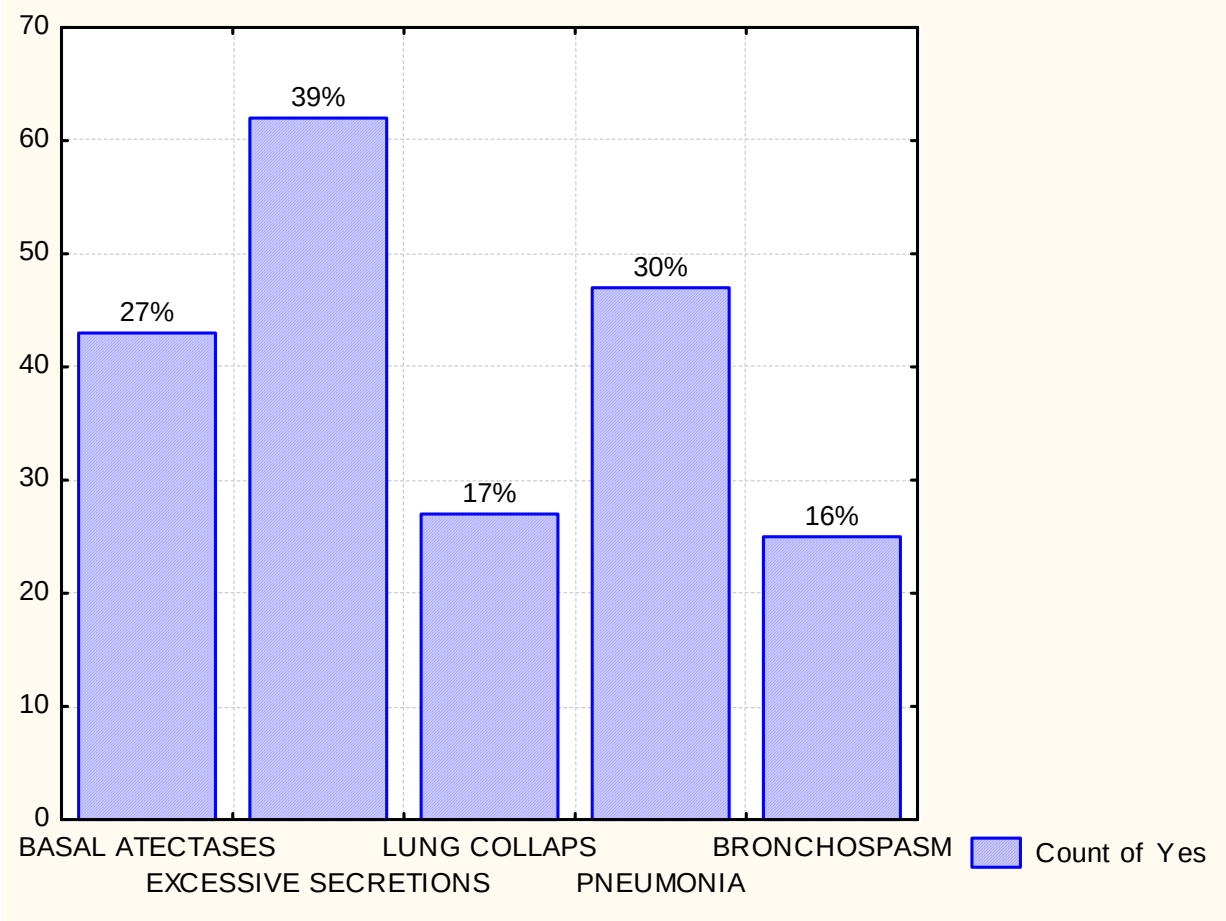


Figure 7.7 Pulmonary complications diagnosed

Patient Outcomes

Nineteen patients (12%) died in the ICU. Patients spent a mean of 5.94 (SD 6.55) days in the unit, with the APACHE II score and the development of complications having a significant impact ($p<0.01$) on the length of stay (LOS). Initially it was determined that patients treated by students spent a significantly shorter time ($p<0.01$) in the unit *(Figure 7.8).*

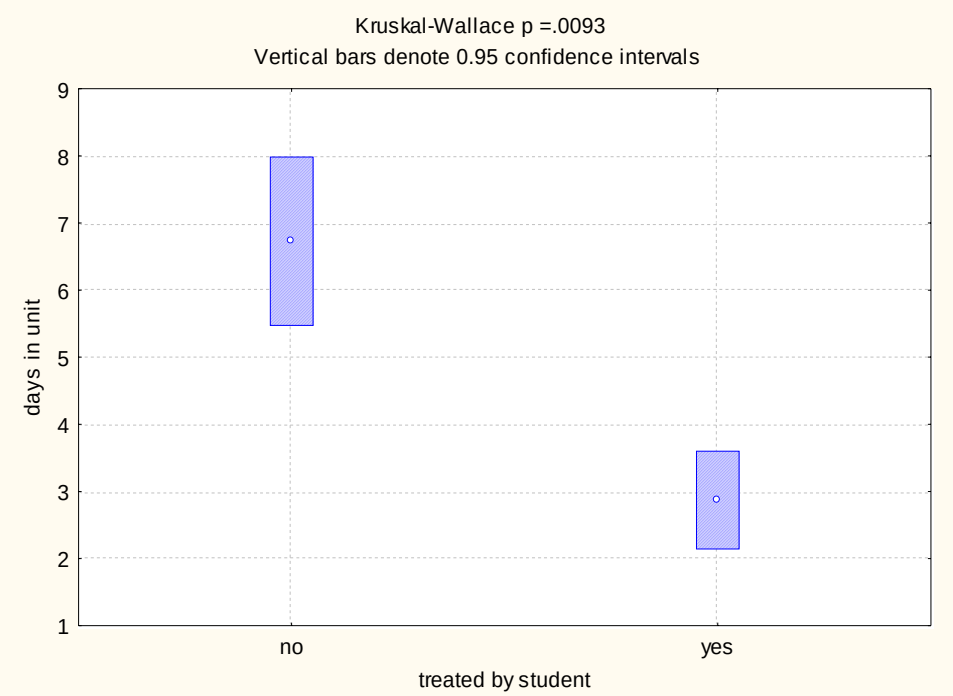


Figure 7.8 Intervention by student therapists and LOS

However, after establishing the significant impact APACHE II score has on LOS an analysis of covariance was done with APACHE II as covariate, showing no significant difference in LOS between the two groups *(Figure 7.9).*

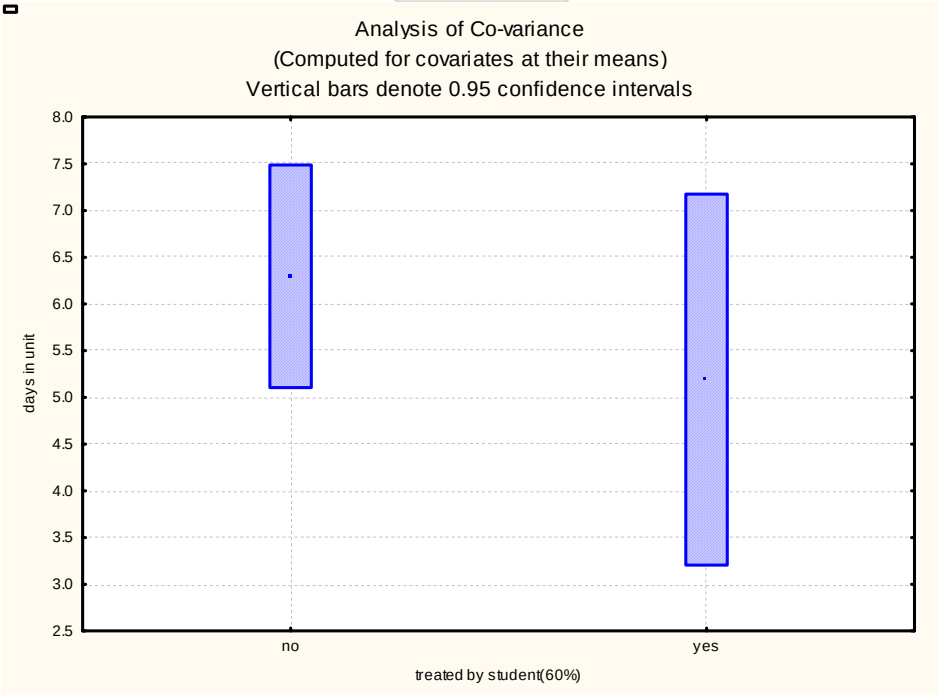


Figure 7.9 Intervention by student therapist and LOS with APACHE II as covariate

One hundred patients (63%) were ventilated during their stay in the unit. Ninety persent (n=90) of these patients were intubated and ventilated on admission to the unit, and the remaining 10 patients were intubated within 2 days of admision to the unit. Intubated patients spent a mean time of 6.52 days (SD 8.76) on the ventilator. The ventilator time was calculated from the time of intubation until extubation. In the case of re-intubations the separate times were calculated and then added for an exact presentation of the time a patient was ventilated. The development of complications significantly increased this time. Especially the development of pneumonia ($p<0.01$) and excessive secretions ($p<0.01$) had a highly significant effect on ventilator time.

Almost a third of ventilated patients (31%) were intubated more than once with a total of 57 re-intubations *(Figure 7.10).* The patients spent a mean time of 3.8 days (SD 6.30) on the ventilator every time they were re-intubated.

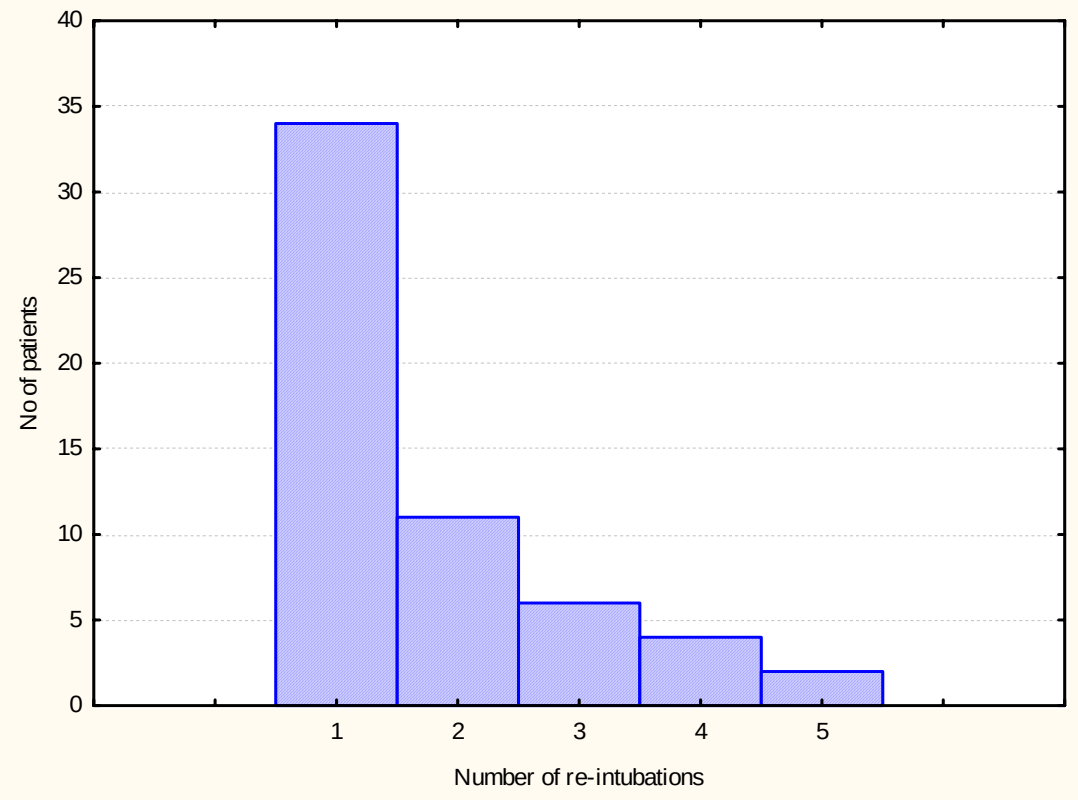


Figure 7.10 Number of times a patient was re-intubated

The development of excessive secretions was most often documented as the reason for re-intubation *(Figure 7.11).*

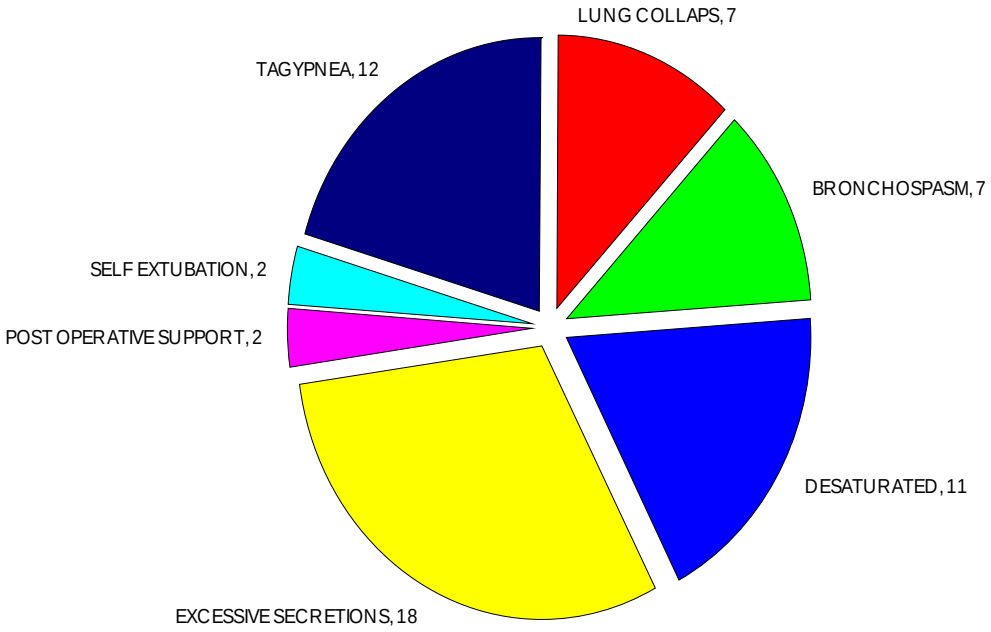


Figure 7.11 Reasons for failed extubations

DISCUSSION

This observational study prospectively investigated the physiotherapy techniques used in the surgical ICU, the time spent on patient care and also described the development of specific pulmonary complications. The patients outcome from ICU i.e. mortality, time on the ventilator and length of stay in the unit were also examined. Previous studies have primarily relied on surveys to determine the range of treatment techniques used and time spent on patient care in ICU (Jones *et al* 1992, Norrenberg & Vincent 2000).

Physiotherapists have claimed to play a role both in the prevention of pulmonary complications (Ntoumenopolous et al 2002) and in minimizing pulmonary secretion retention (Ciesla 1996). However, in this study it was noted that despite the routine daily physiotherapy treatment of all patients in the unit, pulmonary secretion retention was diagnosed in 39% of patients, pneumonia in 30% and basal atelectasis in 27% of patients *(Figure 7)*.

Excessive secretions

The development of excessive secretions in intubated patients has been described previously (Ntoumenopolous *et al* 2002, Ciesla 1996). In this cohort excessive secretions was the most common pulmonary complication (39%) diagnosed, it significantly increased the time patients spent on the ventilator and was also the reason most often documented for failed extubations. The fact that 30% of this cohort needed to be re-intubated, some as many as five times, could indicate that it might be worthwhile to explore the more active involvement of the physiotherapist in the weaning and extubation of patients in future studies (Bruton *et al* 1999).

The success of a protocol directed weaning practice has been well documented (Kollef *et al* 1997b, Smirnios *et al* 2002, O Chan *et al* 2001). These studies have mainly been completed in the USA thus using respiratory therapists to manage the protocols. Although 25% of units surveyed in Europe reported that the physiotherapists were involved in the extubation of patients, 22% in the supervision of weaning and 12% in the adjustment of mechanical ventilation (Norrenberg & Vincent 2000) to the author's knowledge no studies have evaluated the effect of a physiotherapist on the successful weaning of patients.

In the discussion of their study results Norrenberg & Vincent (2000:992) equated the physiotherapist to the respiratory therapist stating "…several studies have been conducted on the role of the *physiotherapist* in weaning patients from mechanical ventilation". Although the scope of practice of these two professionals overlap, according to the US labour law there are inherent differences in the training and scope of practice. It is unclear whether physiotherapists would indeed have the same effect.

The results from this study suggest that the number of failed extubations might prove to be a sensitive outcome measure for physiotherapy intervention in the management of intubated and ventilated patients. In this cohort a third of the patients needed to be re-intubted, some up to 5 times, and each re-intubation increased the time spent on the ventilator by nearly four days. The reasons documented for failed extubations in the majority of cases namely excessive secretions, tagypnea and desaturation could indicate the potential value of this outcome measure for physiotherapy intervention.

Pneumonia

While the diagnosis of ventilator associated pneumonia (VAP) is controversial (Torres & Ewig 2004, de Roso & Craven 2003, Grossman & Fein 2000, Kollef 2004) there seems to be widespread acceptance of the pathogenetic sequence of VAP, namely the bacteriological colonization of the orophayngeal tract and the aspiration of these contaminated secretions into the lower airway (Kollef 2004, de Roso & Craven 2003). In this cohort 29% of patients developed VAP, which is similar to the published prevalence of VAP ranging between 9% and 68% (Bowton 1999). The presence of VAP in this cohort significantly increased both the time patients spent on the ventilator and the unit LOS.

Whether the routine physiotherapy management of patients can prevent the development of VAP is controversial (Young & Ridley 1999, Kollef 2004). However, in a randomized controlled trial involving 60 adult intubated patients it was determined that twice daily chest physiotherapy comprising gravity assisted drainage position for 20 minutes with the affected lung uppermost, chest wall vibrations and airway suctioning via the endotracheal tube was independantly associated with a significant reduction in the occurrence of VAP (Ntoumenopolous *et al 2002)*.

This combination of treatment techniques described by Ntoumenopolous *et al* (2002) was however not observed in this study. Gravity assisted positions were never recorded and side lying with the bed in horizontal were only recorded in a very limited number of sessions. The current practice in this unit consisted primarily of a combination of supine positioning (30 degrees head up), mechanical vibration and suctioning once a day. Based on the available evidence this practice would not result in the prevention of VAP.

Atelectasis

Twenty seven percent of patients in this cohort developed basal atelectasis. Even though no association has been established between physiotherapy intervention and the prevention of atelectasis (Stiller & Munday 1992), physiotherapy intervention has been shown to be an effective modality in the treatment of atelectasis (Stiller *et al* 1990, Stiller *et al* 1996, Stiller 2000). The physiotherapeutic management used by Stiller *et al* (1996) to effectively treat atelectasis included a gravity assisted drainage position, manual hyperinflation (MHI) or deep breathing exercises, and suctioning or coughing

performed hourly for six hours. The addition of vibrations did not significantly affect the resolution of the atelectasis.

Neither the frequency of intervention nor the specifics of the techniques described by Stiller *et al* (1996) was observed in this cohort. In this study manual hyperinflation (MHI) was only recorded in two treatment sessions, however the therapists indicated their unease in the use of MHI at the start of the project, mainly due to the lack of effective equipment in the department. The unit has a self assembled two litre anaesthetic bag without a PEEP valve or a manometer that is used for hyperinflation. Even though MHI is a routinely used physiotherapy technique with 91% of therapists in 32 Australian teaching hospitals reporting to use it regularly (Hodgson *et al* 1999), it has been involved in some controversy over the years. This controversy has primarily focussed on the application of the technique and the equipment used (Dennehy 1999, Hilla *et al* 2002, Patman *et al* 2000, Patman *et al* 2001). However, in a recent study similar amounts of wet sputum were produced when comparing manual hyperinflation to ventilator hyperinflation (Berney & Denehy 2002). This finding could have far reaching implications for the standardization of the technique in future studies.

Even though these previously mentioned studies did not evaluate the effect of resolution on broader outcomes like the time spent on the ventilator or ICU LOS, the significant effect that atelectasis had on the time patients spent on the ventilator in this cohort, is an indication of the possible importance of this outcome measure in future studies.

Treatment frequency and duration

Despite the high incidence of pulmonary complications reported in this cohort, 90% (n=144) of patients were still only treated once a day and 64% (n=595) of the treatment sessions were done by 11:30. Although this unit in TBH offers a 24 hour service, no record was made of any after hour treatment session.

One reason for this could be that there was no indication for physiotherapy after hours; however the high percentage of patients suffering from excessive secretions does not make this a likely assumption. Alternatively it could be that because of the understaffing of the physiotherapy department and the limited time the physiotherapist spends in the

unit, the therapist is not considered to be an active member of the interdisciplinary team in the unit. This might make it less likely for other team members to call after-hours.

Jones *et al* (1992:45) advocated for 24 hour provision of physiotherapy service stating "...it is difficult to justify physiotherapy as being an obligatory and indispensable form of treatment and yet provide no after-hour service". Fifty percent of Australian units offer 24 hour service (Jones *et al* 1992) while the percentage of units providing this service in the UK dropped from 96% in 1992 (Jones *et al* 1992) to 79% in 2000 (Norrenberg & Vincent 2000). Germany, Portugal and Sweden have reported no night time availability of physiotherapists (Norrenberg & Vincent 2000). In spite of this physiotherapy department offering a 24 hour service, in this study no documentation was made of treatment provided between 15:30 and 07:30.

In a case report Wong (2000) described the process of team discussion that lead to the provision of two hourly physiotherapy interventions over a 24 hour period that prevented the intubation of a patient in acute respiratory distress. The importance of functioning as an active member of the interdisciplinary team within an intensive care environment can not be over emphasized. It has also been documented that early extubation and on-call overnight physiotherapy provided to quadriplegic patients resulted in a reduction in unit LOS (Berney *et al* 2002). The study designs used in these two studies limit the strength of this evidence and the effect of providing a 24 hour service on patient outcomes needs to be established in future studies.

Students spent almost twice as long with patients than the therapists. This is not an unexpected finding as students appear to need more time due to the development of clinical skills and should also have more time to spend with patients because of a lighter workload. Fifteen minutes has been the duration of treatment reported by the majority (50%) of physiotherapists in surveys conducted in Hong Kong, UK, and Australia (Jones *et al* 1992). Randomized controlled trials evaluating interventions in ICU usually report a twenty minute period of positioning before the application of techniques such as MHI, vibration or suctioning (Berney & Denehy 2003, van Aswegen & Eales 2004, Krauss *et al* 2000, Ntoumopolous *et al* 2002).

In contrast to this however, therapists at Johannesburg Hospital reported spending 30.2 (SD 2.54) minutes with ventilated patients that presented with complications, 33.26 (SD 7.47) minutes with ventilated patients that did not present with complications and 23.31 (SD 9.74) minutes with non-ventilated patients diagnosed with complications (Steenkamp *et al* 2003). Therapists in this cohort spent significantly less time with the patients despite the fact that the patients treated by the therapists had significantly higher APACHE II scores than those treated by the students.

Despite the significantly longer treatment time of students, this did not translate to an independent difference in the observed outcomes measured in this study. This however can not relate to the assumption that treatment duration has no effect on patient outcome. To this author's knowledge this has not been investigated.

The effect of physiotherapy on pulmonary function has been demonstrated to be short-lived and to compensate for this it has been recommended that physiotherapy interventions must be applied at more frequent intervals (Stiller 2000). For example in their management of acute lobar atelectasis Stiller *et al* (1996) recommended six hourly physiotherapy interventions, while a twice daily intervention was used by Ntoumenopolous *et al* (2002) to demonstrate an independent association between physiotherapy intervention and a reduction in the development of VAP.

For many years the increased metabolic demand associated with multimodality physiotherapy was used to motivate for this relatively short treatment duration (Stiller 2000, Paratz 1992). However, in a recent study by Berney and Denehey (2003) this clinical reasoning was challenged. In this study the authors evaluated the effect of multimodality physiotherapy intervention to a period of undisturbed side lying. The researchers allowed values to return to baseline after positioning and were therefore able to show that the greatest metabolic demand during a physiotherapy session was made by the positional change and was not significantly influenced by further physiotherapy modalities. Acutely ill patients are therefore not compromised more by physiotherapy intervention than for example a routine procedure such as the washing of a patient.

The current understaffing of the physiotherapy department could offer a possible explanation for both the frequency and duration of treatment sessions observed in this cohort, as only 15 fulltime physiotherapists are employed in this 1385 bed tertiary hospital. The work is equally distributed between therapists resulting in a combination of responsibilities, where the therapist responsible for the surgical ICU is also responsible for a number of surgical wards and outpatients. This is in contrast to 75% of units surveyed in the UK who have reported at least one physiotherapist working exclusively in ICU (Norrenberg & Vincent 2000).

Choice of techniques

Even though all patients were seen routinely by the therapists, the choice of treatment techniques differed. Treatment techniques used were significantly different after a complication had been diagnosed *(Table 7.1).* Whether these were valid choices must be evaluated in the light of current available evidence. The aim of this study was to determine a baseline of current practice and outcomes related to interventions. It is however also important to evaluate the practice as reflected in this study to current available evidence for specific techniques used in the ICU.

Manual techniques such as percussions, vibrations and shakings were used rather indiscriminately by all therapists in the treatment of most patients in this cohort. This is similar to the results of a survey conducted on the use of vibration in 95 randomly selected hospitals throughout Australia. The response rate of the questionaire was 81% (n=95). 96% of respondents reported the use of vibration to assist in clearing excessive secretions *(*McCarren *et al* 2003*)*. However, the evidence regarding the effect of these techniques in mechanically ventilated patients are lacking (McCarren *et al* 2003, Stiller 2000). Eales *et al* (1995) evaluated the effect of a single treatment session comprising of chest wall vibrations, MHI, pre-oxygenation and suctioning in 37 mechanically ventilated patients following cardiac surgery. They reported no significant effect on lung compliance or arterial blood gas values when adding chest wall vibrations and MHI to a regime of pre-oxygenation and suctioning. Stiller *et al* (1996) also reported that the addition of vibrations to a regime of positioning, MHI and suction failed to significantly alter the resolution of atelectasis on a chest radiograph.

This is in contrast to the study by Ntoumenopolous *et al* (2002) where an independent reduction in the occurrence of VAP was demonstrated with the routine provision of physiotherapy in 60 mechanically ventilated adult patients. This intervention comprised of four sets of chest wall vibrations in gravity assisted position, and suctioning. However, because Ntoumenopolous *et al* (2002) did not distinguish between the techniques used, It is not clear from the study which of the three techniques used were responsible for the result.

Mechanical vibration was the only technique used more often by the unit therapists than either the students or the on-call therapists. In a review article Thomas *et al* (1995) warned against the use of these devices as no clinical or scientific evidence was available to support its use. The ease of use has been stated as a possible reason for their popularity (Thomas *et al* 1995).

The importance of effective positioning in ICU is a theme that can be identified in most recent studies performed in ICU (Ntoumenopolous *et al* 2002, Berney & Denehey 2002, Berney & Denehey 2003, Krause *et al* 2000, Berney *et al* 2004). It has been described in the management of atelectasis (Stiller *et al* 1996) and in the prevention of VAP (Ntoumenopolous *et al* 2002). In a recent study by Berney *et al* (2004) it was determined that twenty minutes in a head down tilt position significantly increased the expiratory flow and wet sputum production, when compared to head flat position. The results of the current study indicate that this evidence is not being incorporated into daily practice, as positioning was seldom used in treatment sessions and the preferred position in 57% (n=535) treatment session was the 30 degrees head up supine position.

The importance of early rehabilitation in the critical environment is increasingly being recognized (Nava & Ambrosino 2000; Lewis 2003) and this evolving role is in part based on the Physiologic Hierarchy of Treatment of Impaired Oxygen Transport designed by Dean and Frownfelter (1996). This model is based on sound physiological evidence (Dean 1994) and the premise is that the optimal physiological functioning of the human body occurs when the body is upright and moving. According to this model manual techniques and suctioning are of the lowest order, thus offering the least physiological basis for management, while the upright positioning and mobilizing of patients is the first choice to optimize oxygen transport in the body.

In a survey conducted to explore the provision of rehabilitation services in ICU, senior physiotherapists of thirty six teaching hospitals were contacted (Lewis 2003). The response rate was 80.5%. One hundred percent (n=29) of the respondents indicated that they offered some form of rehabilitation which included passive movements (97%), tilt table (86%), hoisting into a chair (90%), standing frame (59%), musculo-skeletal assessment and an exercise regime (100%). This is in contrast to only 6% of treatment sessions in this cohort where patients were mobilized, 11% which included passive movements and 24% which included active assisted movements. These activities are usually time consuming which could offer an explanation for it not being incorporated into treatment sessions in this unit. The effect these early rehabilitative measures will have on patient outcome needs to be established. The identification and development of sensitive outcome measures such as the exercise test described by Roos *et al* (2002) also needs further investigation.

Possible limitations

One can argue that a limitation of this study is the way in which pulmonary complications were diagnosed. There were no diagnostic criteria set up to identify specific lung complications as described in the studies by Stiller (1996) and Ntoumenopoulos et al (2002). The conclusion can then be made that the incidence of pulmonary complications as reported in this study are suspect. However, this is a closed unit with the intensivists taking final responsibility for patient care. Despite the fact that registrars rotate through the unit, patients are cared for by the whole team. The feedback system within the unit is adequate with ward rounds taking place twice daily. Complications and the management thereof are decided at these rounds. The danger of over diagnosis and management of pulmonary complications have been reported (Joiner et al 1996, de Roso & Craven 2003). The once weekly microbiology ward round, where the antibiotic profile of each patient is discussed can be regarded as a measure to ensure that patients are not inadequately medicated. In this unit patients are managed based on the team diagnosis and as such the authors regarded it as a valid measure of pulmonary complications in this study population.

The importance of multi regression techniques in observational studies as previously highlighted by other authors (Kollef *et al* 1997a) is also obvious in this study. An attempt

was made to compare the physiotherapy interventions of students and therapists in relation to patient outcomes. Initially a significant difference ($p<0.01$) was observed in the outcome of patients treated by students compared to therapists, however after using multivariate statistical analysis techniques it was clear that the significant differences observed in the outcomes of patients were due to differences in the patients and not due to differences in the interventions. The patients that were treated by the therapists were more severely ill than those treated by the students. In observational research there is no randomization of groups that could ensure that the groups are equal, but there are statistical methods to determine if a variable is independently associated with an outcome. Knowledge of variables that have been associated with outcome are therefore essential to make valid assumptions (Rubenfeld *et al* 1999).

CONCLUSION

The picture of the physiotherapy service provided in this unit as reflected in this cohort is of a traditional service based neither on the available evidence regarding the prevention or management of pulmonary complications, nor on the incorporation of early rehabilitation in the management of mechanically ventilated adult patients in ICU. The resistance of clinicians to the implementation of evidence into practice has been widely reported (McCarren *et al* 2003, Cross *et al* 2001, Hurley 2000, Bithell 2000).

The economic realities of providing a service in the public domain in the year 2004 must encourage physiotherapists to determine the most appropriate manner of service provision. There is limited evidence for the effective evaluation of patients, the provision of a very specific pathology based service, and the early rehabilitation of patients in ICU (Stiller *et al* 1996, Ntoumenopolous *et al* 2002, Berney *et al* 2004, Nava 1998). These three aspects could be regarded as three pillars of an evidence based physiotherapy service in the ICU. This service might best be offered by a dedicated ICU therapist, who can monitor patients closely, operate as an integral member of the interdisciplinary team and be more prescriptive in the management of patients especially in regards to the positioning, mobilizing, weaning and extubation of patients. Whether this is an economically viable option in a public service hospital must be explored. Providing a non-optimal service is not beneficial to patients, other members of the interdisciplinary team in the unit, or to the therapists.

Based on the current available evidence Stiller (2000:1809) recommended that the decision to provide routine multimodality physiotherapy to all patients in an ICU "…can only be made by consultation between physiotherapists and other ICU staff in individual units." To provide the profession with evidence for the continued or alternative role of the physiotherapist within an ICU, it is necessary to document the service that is provided as well as the outcome of the patients. This study forms the baseline for evaluation after the implementation of an evidence based physiotherapy protocol in a surgical ICU.

REFERENCES

2010 Healthcare Plan http://www.capegateway.gov.za/text/2004/2/healthcare2010.pdf *(accessed 24 July 2004)*

American College of Critical Care Medicine of the Society of Critical Care Medicine 1999 Critical Care services and personnel: recommendations based on a system of categorization into two levels of care. *Critical Care Medicine* 27:422-426

Benatar S 1997 Health Care reform in the new South Africa. *New England Journal of Medicine* 336(12):891-895

Benatar SR, Daar AS, Singer PA 2003 Global health ethics: the rationale for mutual caring. *International Affairs* 79(1):107-138

Benatar S 2004 Health Care reform and the crisis of HIV and AIDS in South Africa. *New England Journal of Medicine* 351(1):81-92

Berney S & Denehy L 2002 A comparison of the effects of manual and ventilator hyperinflationon static lung compliance and sputum production in intubated and ventilated intensive care patients. *Physiotherapy Research International* 7(2):100-108

Berney S, Stockton K, Berlowitz D, Denehy L 2002 Can early extubation and intensive physiotherapy decrease LOS of acute quadriplegic patients in intensive care? A retrospective case control study. *Physiotherapy Research International* 7(1):14-22

Berney S & Denehy L 2003 The effect of physiotherapy treatment on oxygen consumption and haemodynamics in patients who are critically ill. *Australian Journal of Physiotherapy* 49: 99-105

Berney S, Denehy L, Pretto J 2004 Head-down tilt and MHI enhance sputum clearance in patients who are intubated and ventilated. *Australian Journal of Physiotherapy* 50:9-11

Bithell C 2000 Evidence Based Physiotherapy. *Physiotherapy* 86(2):58-60

Bowton DL 1999 Nosocomial pneumonia in the ICU – year 2000 and beyond. *Chest* 115 (Supplement 3):28S-33S

Bruton A, Conway J, Holgate S 1999 Weaning adults from mechanical ventilation. *Physiotherapy* 85(12):652-661

Chatburn R 2001 Outcomes Research in Respiratory Care. *Respiratory Care* 46(11):1215-1225

Ciesla N 1996 Chest Physical Therapy for patients in the Intensive Care Unit *Physical Therapy* 76(6):609-625

Cook D, Sibbald W, Vincent J, Cerra F 1996 Evidence based critical care medicine: what is it and what can it do for us? Evidence Based Medicine in Critical Care Group. *Critical Care Medicine* 24:334-337

Cross J 2001 A survey of physiotherapists' current practice with closed suction systems in adult patients. *Advances in Physiotherapy* 3:67-75

Dean E 1994 Oxygen transport: a physiologically based conceptual framework for the practice of cardiopulmonary physiotherapy. *Physiotherapy* 80:347-355

Dean E & Frownfelter D 1996 Principles and Practice of Cardiopulmonary Physical Therapy 3rd edn. Mosby. Missouri ch 1 p 1-23

De Roso F & Craven D 2003 Ventilator associated pneumonia: Current management strategies*. Infectious Medicine* 20(5):248-259

Denehy L 1999 The use of manual hyperinflation in airway clearance. *European Respiratory Journal* 14:958 -965

Eales CJ, Barker M, Cubberley NJ 1995 Evaluation of a single chest physiotherapy treatment to post-operative, mechanically ventilated cardiac surgery patients. *Physiotherapy Theory and Practice* 11:23-28

Ferdinande P & Members of Task Force of the European Society of Intensive Care Medicine 1997 Recommendations on minimal requirements for Intensive Care Departments. *Intensive Care Medicine* 23:226-232

Grossman R & Fein A 2000 Evidence-based assessment of diagnostic tests for VAP. *Chest* 117:177S-181S

Hanekom S, Coetzee A, Faure M 2004 Outcome research in ICU: Factors influencing patient outcome in ICU *(In Process)*

Hilla J, Ellis E, Holmes W 2002 Feedback withdrawal and changing compliance during manual hyperinflation. Physiotherapy Research International 7(2):53-64

Hodgson C, Carroll S, Denehy L 1999 A survey of manual hyperinflation in Australian hospitals. *Australian Journal of Physiotherapy* 45(3):185-193

Hurley M 2000 Linking research with practice: The missing link – collaboration. *Physiotherapy* 86:339-341

Jones A, Hutchinson R, Oh T 1992 Chest physiotherapy practice in intensive care units in Australia, the UK and Hong Kong. *Physiotherapy Theory and Practice* 8:39-47

Jones A 2001 Intensive care physiotherapy - medical staff perceptions. *Hong Kong Physiotherapy Journal* 19:09-16

Joiner GA, SalisburyD, Bollin GE 1996 Utilizing quality insurance as a tool for reducing the risk of nosocomial ventilator associated pneumonia. *American Journal of Medical Quality* 11:100-103

Kollef MH, O'Brien JD, Silver P 1997a The impact of gender on outcome from mechanical ventilation. *Chest* 111(2):434-441

Kollef MH, Shapiro S, Silver P, St John R, Prentice D, Sauer S, Ahrens T, Shannon W, Baker-Clinkscale D 1997b A randomized controlled trial of protocol-directed versus physician-directed weaning from mechanical ventilation. *Critical Care Medicine* 25(4):567-574

Kollef MH 1998 Outcomes research as a tool for defining the role of respiratory care practitioners in the Intensive Care Unit Setting. *New Horizons* 6(1):91-98

Kollef M 2004 The prevention of ventilator associated pneumonia. *Critical Care Medicine* 32(6):1396-1405

Krause MW, van Aswegen H, De Wet E, Joubert G 2000 Postural drainage in intubated patients with acute lobar atelectases - a pilot study. *South African Journal of Physiotherapy* 56(3):29-32

Lewis M 2003 ICU rehabilitation within the UK. *Physiotherapy* 89(9):531-538

Mathivha LR 2002 ICU's worldwide: An overview of critical care medicine in South Africa. *Critical Care 6(1):22-23*

McCarren B, Alison J, Lansbury G 2003 The use of vibration in public hospitals in Australia. *Physiotherapy Theory and Practice* 19(2):87-99

Nava S 1998 Rehabilitation of patients admitted to a respiratory intensive care unit. *Archives of Physical and Medical Rehabilitation* 79:849-854

Nava S & Ambrosino N 2000 Rehabilitation in the ICU: The European phoenix. *Intensive Care Medicine* 26:841-844

Norrenberg M & Vincent JL 2000 A profile of European intensive care unit physiotherapists. *Intensive Care Medicine* 26:988-994

Ntoumenopoulos G, Presneill J, McElholum M, Cade JF 2002 Chest physiotherapy for the prevention of ventilator associated pneumonia. *Intensive Care Medicine* 28:850-856

O Chan PK, Fischer S, Stewart TE, Hallett DC, Haynes-Gay P, Lapinsky SE, Mac Donald R, Mehta S 2001Practicing evidence-based medicine: the design and implementation of a multidisciplinary team-driven extubation protocol. *Critical Care* 5:349-354

Paratz J 1992 Haemodynamic stability of the ventilated ICU patient. A review. *Australian Journal of Physiotherapy* 38:167-172

Patman S, Jenkins S, Stiler K 2000 Manual hyperinflation – effects on respiratory parameters. *Physiotherapy Research International* 5(3):157-171

Patman S, Jenkins S, Smith K 2001 Manual hyperinflation – consistency and modification of the technique by physiotherapists. *Physiotherapy Research International* 6(2):106-117

Povar G, Blumen H, Daniel J, Daub S, Evans L, Holm R, Levkovich N, McCarter AO, Sabin J, Snyder L, Sulmasy D, Vaughan P, Wellikson LD, Campbell A 2004 Ethics in practice: managed care and the changing health care environment: medicine as a

profession managed care ethics working group statement. *Annals of Internal Medicine* 141(2):131-136

Roos R, Van Aswegen H, Eales C 2002 Perceived effort of functional activities after a period of mechanical ventilation. *South African Journal of Physiotherapy* 58(4):33-36

Rubenfeld G, Angus D, Pinsky M, Curtis R, Connors A, Bernard G and the Members of the Outcomes Research Workshop 1999 Outcomes Research in Critical Care. Results of the American Thoracic Society of Critical Care Assembly Workshop on Outcomes Research. *American Journal of Critical Care Medicine* 160:358-367

Smirnios N, Connolly A, Wilson M, Curley F 2002 Effects of a multifaceted, multidisciplinary, hospital-wide quality improvement program on weaning from mechanical ventilation. *Critical Care Medicine* 30(6):1224-1230

Steenkamp H, Warren G, Kruger P Boghosi G and Semple F 2003 Statistical Results of an Analysis of the Physiotherapy Department in the Johannesburg Hospital. South African Journal of Physiotherapy 59(2):3-11

Stiller K, Geake T, Taylor J, Grant R, Hall B 1990 Acute lobar atelectasis. A comparison of two chest physiotherapy regimens. *Chest* 98(6):1336-40

Stiller K & Munday R 1992 Chest physiotherapy for the surgical patient. *British Journal of Surgery* 79:745-749

Stiller K, Jenkins S, Grant R, Geake, Taylor, Hall 1996 Acute lobar atelectasis: a comparison of five physiotherapy regimens. *Physiotherapy Theory and Practice* 12(4):197-209

Stiller K 2000 Physiotherapy in ICU. Towards an evidence based practice. *Chest* 118:1801-1813

Strategic and Service Delivery Improvement Plan (SSDIP) Provincial Government of the Western Cape Department of Health Draft Paper 2000

http://www.westerncape.gov.za/health_social_services/policy_planning *(accessed 27 March 2003)*

Thomas J, DeHueck A, Kleiner M, Newton J 1995 To vibrate or not to vibrate: Usefulness of the mechanical vibrator for clearing bronchial secretions. *Physiotherapy Canada* 47(2):120-125

Torres A & Ewig S 2004 Diagnosing VAP. *New England Journal of Medicine* 350(5):433-435

Van Aswegen H & Eales C 2004 The effectiveness of MHI during the physiotherapy management of acute atelectasis: a case report. *SA Journal of Physiotherapy* 60(1):29-32

Wong Wai Pong 2000 Physical Therapy for a patient in acute respiratory failure. *Physical Therapy* 80(7):662-670

Young P & Ridley S 1999 Ventilator associated pneumonia. Diagnosis, pathogenesis and prevention. *Aneasthesia* 54:1183-1197

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

The findings of this prospective cohort observational study supports the growing concern noted in the literature about the value of routine multimodality physiotherapy intervention to all patients admitted to an ICU (Stiller 2000, Ntoumenopolous *et al* 2002). Despite routine daily physiotherapy management of all patients in the surgical ICU at TBH, 39% (n=62) of patients developed excessive secretions, 30% (n=48) developed pneumonia, 27% (n=43) were diagnosed with basal atelectasis and 17% (n=27) developed a lung collapse. These complications significantly increased the time the patients spent on the ventilator. Furthermore 33% (n=57) of patients needed to be re-intubated more than once with excessive secretions documented most often as the reason for re-intubation. Each re-intubation increased the time spent on the ventilator by nearly four days.

On closer inspection, however, it is clear that the physiotherapy interventions used in this cohort were not based on the available evidence. Neither the frequency of treatment, the positions used nor the techniques applied were evidence-based. In the light of this information would it then be unexpected to find less than optimal patient outcomes?

With the impact global economic policies have on the provision of healthcare internationally, service providers, policy makers and clinicians have to make difficult decisions about the services that are provided (Povar *et al* 2004). Managers of physiotherapy departments urgently need information on optimizing staffing resources allocated to a specific area.

Outcomes research provides the tools to make this information available. In this baseline measure of outcomes a snapshot of the clinical service in the surgical ICU was provided. In recent years surveys have been used to inform

the profession of current practice (Jones *et al* 1992, Norrenberg & Vincent 2000). However, due to the study design of these surveys the investigated practices could not be linked to patient outcome.

Improvement in clinical practice does not rely solely on evidence for the effectiveness of specific techniques, but also on the evaluation of the physiotherapy service that is provided to a diverse group of patients. Lack of evidence for the effectiveness of specific techniques can no longer be used as reason for unchanged, routine practice of physiotherapy. Over the past three years the total number of randomized controlled trials and systematic reviews recorded in the physiotherapy evidence database has doubled from 2526 records in 2001 to a total of 5037 by 2004 (PEDro 2004) The profession now needs to move one step forward and evaluate the effect of packages of care in the ICU.

8.1 Challenges of observational outcomes research

It is evident from this study that observational research presents the researcher with unique challenges. The following observations were made in this study:

- The importance of multi regression techniques in observational studies as previously highlighted by other authors (Kollef *et al* 1997) was also obvious in this study. An attempt was made to compare the physiotherapy interventions of students and therapists in relation to patient outcomes. Initially a significant difference was observed in the outcome of patients treated by students compared to therapists, but after using multivariate statistical analysis techniques it was clear that the significant differences observed in the outcomes of patients were due to differences in the patients and not due to differences in the interventions. As previously reported, the patients that were treated by the therapists were more severely ill than those treated by the students. In observational research there is no randomization of groups that could ensure that the groups are equal, but there are statistical methods to determine if a variable is independently associated with an

outcome. Knowledge of variables that have been associated with outcome are therefore essential, to make valid assumptions (Rubenfeld *et al* 1999).

- The burden of data collection can be very high in observational research especially if the research question is not specific enough. In this study the research question was very broad resulting in a high burden in terms of financial and human resources. However, being a baseline outcome study to be used as forerunner for further research, the description of the clinical service needed to be clear and extensive.

- It is recommended that future observational studies limit the information to be collected by formulating a very specific research question.

- The use of duplicate physiotherapy data forms in this study simplified the extraction process. It is recommended that existing physician and nursing documentation systems be modified in consultation with team members to facilitate efficient extraction of data in future projects.

- The development of a specific physiotherapy documentation format for use in ICU could be an important tool for multi-centre comparisons.

- Due to the vast amount of paperwork involved in an observational research project the administrative procedure must be clear and well documented from the outset.

- The development of a user friendly computer database could limit the burden of paperwork.

- The development of clinically relevant outcome measures sensitive enough to evaluate the effect of physiotherapy intervention in ICU needs urgent attention (Roos *et al* 2002, Mackay & Ellis 2002)

- The results of this study indicate that it could be valuable to investigate the number of failed extubations for use as a possible outcome measure.

- The use of the rate of respiratory complications as a possible outcome measure is controversial. Both the criteria used by Mackay & Ellis (2002) and Ntoumenopolous *et al* (2002) failed to be sensitive enough to measure change. In this study no diagnostic criteria were formulated to identify specific lung complications. The conclusion could be made that the incidence of pulmonary complications as reported in this study are suspect. However, this is a closed unit with the intensivists taking full responsibility for patient care. Despite the fact that registrars rotate through the unit, patients are cared for by the whole team. The feedback system within the unit is adequate with ward rounds taking place twice daily. Complications and the management thereof are decided at these rounds. The danger of over diagnosis and management of pulmonary complications have been reported (Rowe *et al* 2000, de Rosa and Craven 2003). The once weekly microbiology ward round, where the antibiotic profile of each patient is discussed can be regarded as a measure to ensure that patients are not inadequately medicated. In this unit patient's management is based on the team diagnosis and as such the researcher regarded it as a valid measure of pulmonary complications in this study population.

In conclusion the results from this study confirm the valuable contribution that outcomes research can make to inform practice. This baseline study has laid the foundation for evaluation of future practice changes within the unit, and could in part help in the formulation of clinical guidelines. If similar studies were to be completed in other centers, the baseline outcome data from this study could be used to compare packages of care. Multi-centre comparison of units could provide objective data to guide staffing levels, plan future services and determine research priorities.

8.2 A reflection on Phase Two of the comprehensive research project

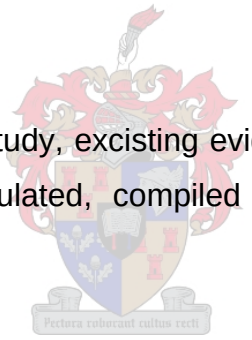
In conclusion to this Masters Thesis it is important to map out the next phase of the research project. The second phase will need to be completed in steps and address the following:

- Development of an evidence-based physiotherapy practice protocol for ICU management;
- Staged implementation of the protocol;and
- Measurement of the effect.

For the successful implementation of this protocol it is important for members from the interdisciplinary team involved in the unit, as well as the physiotherapy department, to be involved in the development of this protocol.

8.2.1 Step 1: Development of an evidence-based physiotherapy practice protocol

Based on the results of this study, excisting evidence and current experience guidelines need to be formulated, compiled and or collated as well as evaluated for the:



- Appropriate screening of patients for physiotherapy intervention;

- Routine positioning and structured mobilization of patients;

- Evidence-based management of patients diagnosed with pneumonia, lobar atelectases and excessive secretions;

- Succesful weaning and extubation of patients from the ventilator by members of the interdisciplinary team;

- Establishment of ventilator settings for effective hyperinflation of the lungs or alternatively the development of equipment; and

- Development of outcome measures that are sensitive both at the level of appropriate screening and protocol implementation.

8.2.2 Step 2: The implementation and evaluation of the protocol:

The implementation of the protocol will also need to be completed in stages.

- The first stage will be to implement and evaluate the protocol under “ideal” circumstances i.e. a fulltime therapist working exclusively in the unit. This therapist would then manage the patients in the unit by prescribing positioning or early mobilizations, and be able to provide the specific techniques and frequency of treatment documented in the literature (Stiller *et al* 1996, Ntoumenopolous *et al* 2002);

- The current financial realities within the public service might make this a difficult appointment to make;

- It is anticipated that research funding to finance this will be needed;

- dependant on the results of the effectiveness of the protocol, the second stage of the protocol implementation would need to incorporate the unit and the physiotherapy department; and

- this stage is also likely to include action research.

Finally, despite the limitations of an outcomes research methodology described earlier, this study has shown that this methodology can be beneficial in providing objective data for clarifying the role of the physiotherapist in an ICU.

References

2010 Healthcare Plan http://www.capegateway.gov.za/text/2004/2/healthcare2010.pdf *(accessed 24 July 2004)*

Adam S & Forrest S 1999 ABC of supportive care. *British Medical Journal* 319:175-178

Aichenbaum S & Ring H 2003 Rehabilitation of a patient with critical illness poly neuropathy (CIP) following acute respiratory failure: a case report and review of literature. *Disability and rehabilitation* 25(6):273-276

American College of Critical Care Medicine of the Society of Critical Care Medicine 1999 Critical Care services and personnel: recommendations based on a system of categorization into two levels of care. *Critical Care Medicine* 27:422-426

American Thoracic Society 1999 Pulmonary Rehabilitation. *American Journal of Respiratory and Critical Care Medicine* 159:1666-1682

Angus DC & Carlet J 2003 Surviving intensive care: a report from the 2002 Brussels Roundtable. *Intensive Care Medicine* 29(3):368-377

Armaganidis A 1998 Intensive care in developed and developing countries: are comparisons of ICU performance meaningful? *Intensive Care Medicine* 24:1126-1128

Aweida D & Kelsey C 1990 Accuracy and reliability of physical therapists in auscultating tape recorded lung sounds. *Physiotherapy Canada* 42(6): 279-282

Badenhorst C 1986 Multidisciplinary intensive care in Bloemfontein, 1981 – 1984. *South African Medical Journal* 70(22):674-678

Barker M & Adams S 2002 An evaluation of a single chest physiotherapy treatment on mechanically ventilated patients with acute lung injury. *Physiotherapy Research International* 7(3):157-169

Bastos P, Sun X, Wagner D, Knaus W, Zimmerman J 1996 Application of the APACHE III prognostic system in Brazilian ICU: a prospective multicenter study. *Intensive Care Medicine* 22:564-570

Beck D, Taylor B, Millar B, Smith G 1997 Prediction of outcome from intensive care: A prospective cohort study comparing APACHE II and III prognostic systems in a United Kingdom intensive care unit. *Critical Care Medicine* 25(1):9-15

Becker R & Zimmerman J 1996 ICU scoring systems allow prediction of patient outcomes or comparison of ICU performance. *Critical Care Clinics* 12:503-514

Benatar S 1997 Health Care reform in the new South Africa. *New England Journal of Medicine* 336(12):891-895

Benatar SR, Daar AS, Singer PA 2003 Global health ethics: the rationale for mutual caring. *International Affairs* 79(1):107-138

Benatar S 2004 Health Care reform and the crisis of HIV and AIDS in South Africa. *New England Journal of Medicine* 351(1):81-92

Berger M, Marazzi A, Freeman J, Chiolero R 1992 Evaluation of the consistency of APACHE II scoring in a surgical intensive care unit. *Critical Care Medicine* 20(12):1681-1687

Berenholtz SM, Dorman T, Ngo K, Pronovost P 2002 Qualitative review of intensive care unit quality indicators. *Journal of Critical Care* 17(1):1-12

Berney S & Denehy L 2002 A comparison of the effects of manual and ventilator hyperinflationon static lung compliance and sputum production in intubated and ventilated intensive care patients. *Physiotherapy Research International* 7(2):100-108

Berney S, Stockton K, Berlowitz D, Denehy L 2002 Can early extubation and intensive physiotherapy decrease LOS of acute quadriplegic patients in intensive care? A retrospective case control study. *Physiotherapy Research International* 7(1):14-22

Berney S & Denehy L 2003 The effect of physiotherapy treatment on oxygen consumption and haemodynamics in patients who are critically ill. *Australian Journal of Physiotherapy* 49: 99-105

Berney S, Denehy L, Pretto J 2004 Head-down tilt and MHI enhance sputum clearance in patients who are intubated and ventilated. *Australian Journal of Physiotherapy* 50:9-11

Bhagwanjee S, Muckart DJ, Jeena P, Moodley P 1997 Does HIV status influence the outcome of patients admitted to a surgical ICU? *British Medical Journal* 314:1077-1081

Bithell C 2000 Evidence Based Physiotherapy. *Physiotherapy* 86(2):58-60

Blegen MA, Goode CJ, Reed L 1998 Nursing staffing and patient outcome. *Nursing Research* 47(1):43-50

Bowton DL 1999 Nosocomial pneumonia in the ICU – year 2000 and beyond. *Chest* 115 (Supplement 3):28S-33S

Bochicchio GV, Joshi M, Bochicchio K, Tracy K, Scalea T 2004 A time dependent analysis of ICU pneumonia in Trauma patients. *Trauma* 56(2):296-303

Brooks D, Parsons J, Crowe J, Solway S, Kelsey C 2003 Cardiorespiratory Physical Therapy for acute Medical conditions: Canadian survey of clinical practice. *Physiotherapy Canada* 55:216-24

Bruton A, Conway J, Holgate S 1999 Weaning adults from mechanical ventilation. *Physiotherapy* 85(12):652-661

Bruton A, Conway J, Hogate S 2002 Inspiratory muscle dysfunction after prolonged periods of mechanical ventilation. *Physiotherapy* 88(3):131-137

Brilli RJ, Spevetz A, Branson RD, Campbell GM, Cohen H, Dasta JF, Harvey MA, Kelley MA, Kelly KM, Rudis MI, St Andre AC, Stone JR, Teres D, Weled BJ; American College of Critical Care Medicine Task Force on Models of Critical Care Delivery 2001 Critical care delivery in the ICU: defining clinical roles and best practice model. *Critical Care Medicine* 29(10):2007-2019

Bristow PJ, Hillman KM, Chey T, Daffurn K, Jaques TC, Norman SL, Bishop GF, Simmons EG 2000 Rates of in-hospital arrests, deaths and ICU admissions: the effect of a medical emergency team. *Medical Journal of Australia* 173(5):236-240

Brown JJ & Sullivan G 1989 Effect on ICU mortality of a full-time critical care specialist. *Chest* 96:127-129

Budget speech 2004/05 http://www.wcpp.gov.za/enews/enews_view.asp?id=32 *(Visited 22July 2004)*

Carson SS, Stocking C, Podsadecki T, Christenson J, Pohlman A, MacRae S, Jordan J, Humphrey H, Siegler M, Hall J 1996 Effects of organizational change in the medical ICU of a teaching hospital: a comparison open and closed formats. *Journal of the American Medical Association* 276(4):322-328

Chaboyer W, Foster M, Creamer J 2002 Health Status of ICU survivors: a pilot study. *Australian Critical Care* 15(1):21-26

Chalfin DB, Cohen IL, Lambrinos J 1995 The economics and cost effectiveness of critical care medicine. *Intensive Care Medicine* 21:952-961

Chang A, Boots R, Hodges P, Paratz J 2004 Standing with assistance of a tilt table in intensive care: A survey of Australian physiotherapy practice. *Australian Journal of Physiotherapy* 50:51-54

Chatburn R 2001 Outcomes Research in Respiratory Care. *Respiratory Care* 46(11):1215-1225

Ciesla N 1996 Chest Physical Therapy for patients in the Intensive Care Unit *Physical Therapy* 76(6):609-625

Clancy CM & Eisenberg JM 1998 Outcomes research: measuring the end results of healthcare. *Science* 282:245-246

Combes A, Costa M, Trouillet J, Baudot J, Mokhtari M, Gibert C, Chastre J 2003 Morbidity, mortality and HRQL of patients requiring >= 14 days of mechanical ventilation. *Critical Care Medicine* 31(5):1373-1381

Cook D, Sibbald W, Vincent J, Cerra F 1996 Evidence based critical care medicine: what is it and what can it do for us? Evidence Based Medicine in Critical Care Group. *Critical Care Medicine* 24:334-337

Cross J 2001 A survey of physiotherapists' current practice with closed suction systems in adult patients. *Advances in Physiotherapy* 3:67-75

Dean E 1994 Oxygen transport: a physiologically based conceptual framework for the practice of cardiopulmonary physiotherapy. *Physiotherapy* 80:347-355

Dean E & Frownfelter D 1996 Principles and Practice of Cardiopulmonary Physical Therapy 3rd edn. Mosby. Missouri ch 1 p 1-23

De Roso F & Craven D 2003 Ventilator associated pneumonia: Current management strategies. *Infectious Medicine* 20(5):248-259

Degoricija V, Sefer S, Kujundzic-Tiljak M, Gjurasin M 2002 Intensive Care units in Croatia: 2001 Survey. *Croatian Medical Journal* 43(6):713-721

De Palo V, Millstein BH, Mayo PH, Salzman SH, Rosen MJ 1995 Outcome of intensive care in patients with HIV infection. *Chest* 107(2):506-510

Dixon T & Reeve J 2003 Emergency on-call duties. *Physiotherapy* 89(2):104-113

Denehy L 1999 The use of manual hyperinflation in airway clearance. *European Respiratory Journal* 14:958 -965

De Jonghe B, Sharshar T, Lefaucher J, Durand-Zaleski I, Boussarsar M, Cerf C, Renaud E 2002 Paresis acquired in the ICU; A prospective multicentre study. *Journal of the American Medical Association* 288(22):2859-2867

Drakulovic MB, Torres A, Bauer T 1999 Supine body position as a risk factor for nosocomial pneumonia in mechanical ventilated patients. *Lancet* 354:1851-58

Eagle KA, Mulley AG, Skates SJ 1990 LOS in ICU; effects of practice guidelines and feedback. *Journal of American Medical Association* 264:992-997

Eales CJ, Barker M, Cubberley NJ 1995 Evaluation of a single chest physiotherapy treatment to post-operative, mechanically ventilated cardiac surgery patients. *Physiotherapy Theory and Practice* 11:23-28

Estaban A, Anzueto A, Frutos-Vivar F, Alia I, Ely EW, Brochrd L, Stewart TE, Apezteguia C, Tobin MJ, Nightingale P, Matamis D, Pimentel J, Abroug F 2004 Outcome of older patients receiving mechanical ventilation. *Intensive Care Medicine* 30(4):639-46

Ferdinande P & Members of Task Force of the European Society of Intensive Care Medicine 1997 Recommendations on minimal requirements for Intensive Care Departments. *Intensive Care Medicine* 23:226-232

Florence Nightingale website at the University of Minnesota http://www.mrs.umn.edu/~sungurea/introstat/history/w98/Nightengale.html *(Accessed 11 May 2004)*

Gardner A & Sibthorpe B 2002 Will he get back to normal? Survival and functional status after intensive care therapy. *Intensive and Critical Care Nursing* 18:138-145

Garrouste-Orgeas M, Troche G, Azoulay E, Caubel A, de Lassence A, Cheval C, Montesino L, Thuong M, Vincent F, Cohen Y, Timsit J 2004 BMI an additional prognostic factor in ICU patients. *Intensive Care Medicine* 30(3):437-443

Glass D 1999 Clinical outcomes research: the international perspective. *Current Opinion in Anaesthesiology* 12(2):217-220

Goldhill D & Sumner A 1998 Outcome of intensive care patients in a group of British Intensive care units. *Critical Care Medicine* 26(8):1337-1345

Grossman R & Fein A 2000 Evidence-based assessment of diagnostic tests for VAP. *Chest* 117:177S-181S

Gunning K & Rowan K 1999 Outcome data and scoring systems. *British Medical Journal 319: 241-244*

Halvorsen J, Kunian A, Gjerdingen B 1989 The interpretation of office radiographs by family physicians. *Journal of Family Practice* 28(4):426-432

Hanekom S, Coetzee A, Faure M 2004 Outcome research in ICU: Factors influencing patient outcome in ICU *(In Process)*

Hanekom S, Coetzee A, Faure M 2004 Outcomes Research in ICU: an aid in defining the role of physiotherapy *(In Process)*

Hanson CW 3rd, Deutschman CS, Anderson HL 3rd, Reilly PM, Behringer EC, Schwab CW, Price J 1999 Effects of an organized critical care service on outcomes and resource utilization: A cohort study. *Critical Care Medicine* 27:270-274

Hariharan S, Moseley S, Kumar A 2002 Outcome evaluation in a surgical intensive care unit in Barbados. *Anesthesia* 57:434-441

Heck C, Newton J, Chan A 2001 Weekend Physiotherapy service provision: A survey of Toronto area hospitals. *Physiotherapy Canada* 53:288-297

Herbert R, Sherington C, Maher C, Moseley A 2001 Evidence-based practice – imperfect but necessary. *Physiotherapy Theory and Practice* 17:201-211

Heyland DK, Konopad E, Noseworthy TW, Johnston R, Gafni A 1998 Is it "worthwhile" to continue treating patients with prolonged stay (>14 days) in the ICU? An economic evaluation. *Chest* 114(1):192-198

Higgins T, McGee W, Steingrub J, Rappaport J 2003 Early indicators of prolonged ICU stay: Impact of illness severity, physician staffing, and pre-intensive care unit length of stay. *Critical Care Medicine 31(1):45-51*

Hilla J, Ellis E, Holmes W 2002 Feedback withdrawal and changing compliance during manual hyperinflation. *Physiotherapy Research International* 7(2):53-64

Hillman KM 1999 Recognizing and preventing serious in-hospital events. *Medical Journal of Australia* 171:08-09

Hira B, Miller M, Bagg M 1985 Outcome after admission to an intensive care unit. *South African Medical Journal* 67:180-181

Hodgson C, Carroll S, Denehy L 1999 A survey of manual hyperinflation in Australian hospitals. *Australian Journal of Physiotherapy* 45(3):185-193

Hodgson C, Denehy L, Ntoumenopoulos G, Santamaria J, Carroll S 2000 An investigation of the early effects of manual lung hyperinflation in critically ill patients. *Anaesthesia and Intensive Care* 28(3):255-261

Hough A 1996 Physiotherapy in Respiratory Care 2nd Edition. Chapman & Hall. London p 170

Hurley M 2000 Linking research with practice: The missing link – collaboration. *Physiotherapy* 86:339-341

Jones A, Hutchinson R, Oh T 1992 Chest physiotherapy practice in intensive care units in Australia, the UK and Hong Kong. *Physiotherapy Theory and Practice* 8:39-47

Jones A 2001 Intensive care physiotherapy - medical staff perceptions. *Hong Kong Physiotherapy Journal* 19:09-16

Joiner GA, Salisbury D, Bollin GE 1996 Utilizing quality insurance as a tool for reducing the risk of nosocomial ventilator associated pneumonia. *American Journal of Medical Quality* 11:100-103

Joshua N, Jena G, Mletelwa 1989 Multidiciplinary intensive care unit at Cecelia Makiwane Hospital, Mdantsane, Ciskei. *South African Medical Journal* 75:286-289

Jacobs P & Noseworthy T 1990 National estimates of Intensive Care utilization and costs: Canada and the United States. *Critical Care Medicine* 18:1282-1286

Kirk R 2000 *General surgical operations* 4th ed. Churchill Livingstone. London p51

Kilpatrick A, Ridley S, Plenderleith L 1994 A changing role for intensive therapy: is there a case for high dependancy care? *Anaesthesia* 49:666-670

Knauss WA, Draper EA, Wagner DP, Zimmerman JE 1985 APACHE II. A severity of disease classification system. *Critical Care Medicine* 13:818-829

Kollef MH 1993 Do age and gender influence outcome from mechanical ventilation? *Heart Lung* 22:442-449

Kollef MH 1996 Private attending physician status and the withdrawal of life-sustaining interventions in a medical intensive care unit population. *Critical Care Medicine* 24:968-975

Kollef MH, O'Brien JD, Silver P 1997 The impact of gender on outcome from mechanical ventilation. *Chest* 111(2):434-441

Kollef MH, Shapiro S, Silver P, St John R, Prentice D, Sauer S, Ahrens T, Shannon W, Baker-Clinkscale D 1997 A randomized controlled trial of protocol-directed versus physician-directed weaning from mechanical ventilation. *Critical Care Medicine* 25(4):567-574

Kollef MH 1998 Outcomes research as a tool for defining the role of respiratory care practitioners in the Intensive Care Unit Setting. *New Horizons* 6(1):91-98

Kollef MH 1999 Improving outcomes in the ICU setting. *Chest* 115:1490-1492

Kollef M 2004 The prevention of ventilator associated pneumonia. *Critical Care Medicine* 32(6):1396-1405

Kotagel UR, Robbins JM, Kini MK, Schoetker PJ, Atherton HD, Kirshbaum MS 2002 Impact of a bronchiolitis program. *Chest* 121(6):1789-1797

Krause MW, van Aswegen H, De Wet E, Joubert G 2000 Postural drainage in intubated patients with acute lobar atelectases - a pilot study. *South African Journal of Physiotherapy* 56(3):29-32

Latronico N, Guarneri B, Alongi S, Bussi G, Candiani A 1999 Acute neuromuscular respiratory failure after ICU discharge. *Intensive Care Medicine* 25:1302-1306

Leape L, Cullen D, Clapp M, Burdick E, Demonaco H, Erickson J, Bates D 1999 Pharmacist participation on physician rounds and adverse drug events in the ICU. *Journal of the American Medical Association* 282:267-270

Leary T, Ridley S, Burchett K, Kong A 2002 Assessing Critical Care Unit Performance: a global measure using graphical analysis. *Anaesthesia* 57:571-755

Lewis M 2003 ICU rehabilitation within the UK. *Physiotherapy* 89(9):531-538

Lim E, Callaghan C, Motalleb-Zadeh R, Wallard M, Misra N, Ali A, Halstead JC, Tsui S 2002 A prospective study on clinical outcome following pleurotomy during cardiac surgery. *The Thoracic and Cardiovascular Surgeon* 50(5):287-291

Linton D 1992 The impact of trauma on ICU facilities in South Africa. *South African Medical Journal* 81:118-119

Lipsett P, Swaboda S, Dickerson J, Ylitalo M, Gordon T, Breslow M, Campbell K, Dorman T, Pronovost P, Rosenfeld B 2000 Survival and functional outcome after prolonged Intensive Care Unit stay. *Annals of Surgery* 231(2):262-268

Li TC, Phillips MC, Shaw L, Cook EF, Natanson C, Goldman L 1984 On-site physician staffing in a community hospital intensive care unit. *Journal of the American Medical Association* 252:2023-2027

Livingston BM, MacKirdy FN, Howie JC Norrie JD 2000 Assessment and performance of five intensive care scoring models within a large Scottish database. *Critical Care Medicine* 6:1820-1827

Mackay M & Ellis E 2002 Physiotherapy outcomes and staffing resources in open abdominal surgery patients. *Physiotherapy Theory and Practice* 18:75-93

Maher C, Moseley A, Sherrington C, Herbert R 2001 Core Journals of evidence based physiotherapy practice. *Physiotherapy Theory and Practice* 17:143-151

Managed Care Ethics Working Group 2004 Ethics in practice: managed care and the changing health care environment: medicine as a profession managed care ethics working group statement *Annals of Internal Medicine* 141(2):131-136

Marik P, Kraus P, Lipman 1993 Intensive Care Utilization: the Baragwanath Experience. *Anaesthesia Intensive Care* 21:396-399

Marik P & Hedman L 2000 What's in a day? Determinig ICU length of stay. *Critical Care Medicine 28(6):2090-2093*

Marino P 1998 The ICU Book. Williams & Wilkins. Pennsylvania appendix 3 p 875-879

Mathivha LR 2002 ICU's worldwide: An overview of critical care medicine in South Africa. *Critical Care 6(1):22-23*

McAuley C 1999 Evidence-based Care: Determining the appropriateness of weekend physiotherapy services in an acute care tertiary hospital. *Physiotherapy Canada* 51:126-132

McCarren B, Alison J, Lansbury G 2003 The use of vibration in public hospitals in Australia. *Physiotherapy Theory and Practice* 19(2):87-99

McQuillan P, Pilkington S, Allan A 1998 Confidential inquiry into quality of care before admission to intensive care. *British Medical Journal* 316:1853-1858

Meiring P, Lumsden J, Morrison A, Furnham L 1969 An intensive care unit in a provincial general hospital*. South African Medical Journal* 43:806-809

Mieny C, Townsend R 1970 The surgical intensive care unit of Johannesburg hospital. *South African Medical Journal* 44:675-677

Morales IJ, Peters SG, Afessa B 2003 Hospital mortality rate and LOS in patients admitted at night to the intensive care unit. *Critical Care Medicine* 31(3):858-863

Moreno R, Morais P 1997 Outcome prediction in intensive care: results of a prospective, multicentre Portuguese study. *Intensive Care Medicine* 23:177-186

Nava S 1998 Rehabilitation of patients admitted to a respiratory intensive care unit. *Archives of Physical and Medical Rehabilitation* 79:849-854

Nava S & Ambrosino N 2000 Rehabilitation in the ICU: The European phoenix. *Intensive Care Medicine* 26:841-844

NIH Consensus Development Conference on Critical care medicine 1983 *Critical Care Medicine* 11:466-469

Norrenberg M & Vincent JL 2002 Physiotherapy in ICU. Useful or Useless? European Society of Anaesthesiologists http://www.euroanesthesia.org/pages/education/rc_nice/12rc5.html last updated 6 April 2002 *(Accessed 18 March 2003)*

Norrenberg M & Vincent JL 2000 A profile of European intensive care unit physiotherapists. *Intensive Care Medicine* 26:988-994

Nouira S, Roupie E, El Atrouss S, Durand-Zaleski I, Brun-Buisson C, Lemaire F, Abroug F 1998 Intensive care use in a developing country: a comparison between a Tunisian and a French unit. *Intensive Care Medicine* 24:1144-1151

Ntoumenopoulos G, Gild A, Cooper DJ 1998 The effect of manual lung hyperinflation and postural drainage on pulmonary complications in mechanically ventilated trauma patients *Anaesthesia and Intensive Care* 26:492-496

Ntoumenopoulos G, Presneill J, McElholum M, Cade JF 2002 Chest physiotherapy for the prevention of ventilator associated pneumonia. *Intensive Care Medicine* 28:850-856

O Chan PK, Fischer S, Stewart TE, Hallett DC, Haynes-Gay P, Lapinsky SE, Mac Donald R, Mehta S 2001Practicing evidence-based medicine: the design and implementation of a multidisciplinary team-driven extubation protocol. *Critical Care* 5:349-354

Paratz J 1992 Haemodynamic stability of the ventilated ICU patient. A review. *Australian Journal of Physiotherapy* 38:167-172

Parkhe M, Myles PS, Leach DS, Maclean AV 2002 Outcome of emergency department patients with delayed admission to ICU. *Emergency Medicine* 14:50-57

Parikh C and Karnard D 1999 Quality, cost and outcome of intensive care in a public hospital in Bombay, India. *Critical Care Medicine 27(9):1754-1759*

Patman S, Jenkins S, Stiler K 2000 Manual hyperinflation – effects on respiratory parameters. *Physiotherapy Research International* 5(3):157-171

Patman S, Jenkins S, Smith K 2001 Manual hyperinflation – consistency and modification of the technique by physiotherapists. *Physiotherapy Research International* 6(2):106-117

PEDro (http://www.pedro.fhs.usyd.edu.au/index.html last updated 24 March 2004).

Potgieter P, Hammill L, Gough A, Hammond J 1995 Cost of Critical Care in South Africa. *South African Medical Journal 85(5):425-430*

Potter P, Barr N, McSweeney M, Sledge J 2003 Identifying Nurse Staffing and Patient Outcome Relationships: A guide for change in care delivery. *Nursing Economics* 21(4):158-166

Povar G, Blumen H, Daniel J, Daub S, Evans L, Holm R, Levkovich N, McCarter AO, Sabin J, Snyder L, Sulmasy D, Vaughan P, Wellikson LD, Campbell A 2004 Ethics in practice: managed care and the changing health care environment: medicine as a profession managed care ethics working group statement. *Annals of Internal Medicine* 141(2):131-136

Pugin J, Auckenthaler R, Mili N, Janssens JP, Lew PD, Sutter PM 1991 Diagnosis of ventilator associated pneumonia by bacteriologic analysis of bronchoscopic and nonbronchoscopic “blind” bronchoalveolar lavage fluid. *American Review of Respiratory Disease* 143:1121-1129

Pronovost PJ & Angus DC Using large-scale databases to measure outcomes in critical care. http://www.uninet.edu/cimc2000/mesas/mr2/angus2/databases.htm *(accessed 17 May 2004)*

Pronovost PJ, Miller MR, Dorman T, Berenholtz SM, Rubin H 2001 Developing and implementing measures of quality of care in the intensive care unit. *Current Opinion in Critical Care* 7(4):297-303

Pronovost P, Angus D, Dorman T, Robinson K, Dremsizov T, Young T 2002 Physician staffing patterns and clinical outcomes in critically ill patients. *Journal of the American Medical Association 288(17):2151-2162*

Pronovost PJ, Berenholtz SM, Ngo K, McDowell M, Holzmueller C, Haraden C, Resar R, Rainey T, Nolan T, Dorman T 2003 Developing and pilot testing quality indicators in the ICU. *Journal of Critical Care* 18(3):145-155

Randolph A, Guyatt G, Carlet J 1998 Understanding articles comparing the outcomes among intensive care units to rate quality of care. *Critical Care Medicine* 26(4):773-781

Randolph A & Pronovost P 2002 Reorganizing the delivery of intensive care could improve efficiency and save lives. *Journal of Evaluation in Clinical Practice* 8(1):1-8

Rapoport J, Teres D, Lameshow S 1990 Timing of ICU admission in relation to ICU outcome. *Critical Care Medicine* 18:1231-1235

Rapoport J, Teres D, Zhao Y, Lemeshow S 2003 Length of stay data as a guide to hospital economic performance for ICU patients. *Medical Care* 41(3):386-397

Ridley S 2002 Outcomes in critical care. Butterworth & Heinemann. Cornwall ch 1 p 1-21

Roos R, Van Aswegen H, Eales C 2002 Perceived effort of functional activities after a period of mechanical ventilation. *South African Journal of Physiotherapy* 58(4):33-36

Rosenberg A, Zimmerman J, Alzola C, Draper E, Knauss W 2000 ICU length of stay: Recent changes and future challenges. *Critical Care Medicine* 28(10):3465-3473

Rowan K, Kerr J, McPherson K, Short A, Vessey M 1993 Intensive care society's in Britian and Ireland. *British Medical Journal* 307:977-981

Rubenfeld G, Angus D, Pinsky M, Curtis R, Connors A, Bernard G and the Members of the Outcomes Research Workshop 1999 Outcomes Research in Critical Care. Results of the American Thoracic Society of Critical Care Assembly Workshop on Outcomes Research. *American Journal of Critical Care Medicine* 160:358-367

Russel J, Stewart A, Kessler A 1968 The design and function of an intensive care unit. *South African Medical Journal* 42:931-933

Sackett D, Rosenberg W, Muir G, Haynes BA, Scott Richardson W 1996 Evidence-based Medicine: What it is and isn't. *British Medical Journal* 312:71-72

Sackett D & Wennberg JE 1997 Choosing the best research design for each question. *British Medical Journal* 315:1636-1637

Sachdeva R, Guntupalli K 1999 International comparisons of outcomes in intensive care units. *Critical Care Medicine* 27(9):2032-2033

Schurink C, van Niewenhoven C, Jacobs J, Rozenberg-Arska M 2004 CPIS for ventilator associated pneumonia: accuracy and inter-observer variability. *Intensive Care Medicine* 30:217-224

Sirio C, Tajimi K, Tase C, Knauss W, Wagner D 1992 An initial comparison of intensive care in Japan and the USA. *Critical Care Medicine* 20(9):1207-1215

Smirnios N, Connolly A, Wilson M, Curley F 2002 Effects of a multifaceted, multidisciplinary, hospital-wide quality improvement program on weaning from mechanical ventilation. *Critical Care Medicine* 30(6):1224-1230

Smith M & Ellis E 2000 Is retained mucus a risk factor for the development of postoperative atelectasis and pneumonia? *Physiotherapy Theory and Practice* 16:69-80

South African Government's Arrive Alive Campaign 2003 http://www.lenzinfo.org.za/Arrive_alive_campaign_jan_180203.htm *(Accessed 4 July 2004)*

Steenkamp H, Warren G, Kruger P Boghosi G and Semple F 2003 Statistical Results of an Analysis of the Physiotherapy Department in the Johannesburg Hospital. South African Journal of Physiotherapy 59(2):3-11

Stephan F, Cheffi A, Bonnet F 2001 Nosocomial Infection and outcome of critically ill elderly patients after surgery. *Anesthesiology* 94:407-414

Sterne JA & Smith GD 2001 Sifting the evidence – what's wrong with significance tests? *Physical Therapy* 81(8):1464-1469

Stiller K, Geake T, Taylor J, Grant R, Hall B 1990 Acute lobar atelectasis. A comparison of two chest physiotherapy regimens. *Chest* 98(6):1336-40

Stiller K & Munday R 1992 Chest physiotherapy for the surgical patient. British Journal of surgery 79:745-749

Stiller K, Jenkins S, Grant R, Geake, Taylor, Hall 1996 Acute lobar atelectasis: a comparison of five physiotherapy regimens. *Physiotherapy Theory and Practice* 12(4):197-209

Stiller K 2000 Physiotherapy in ICU. Towards an evidence based practice. *Chest* 118:1801-1813

Strategic and Service Delivery Improvement Plan (SSDIP) Provincial Government of the Western Cape Department of Health Draft Paper 2000 http://www.westerncape.gov.za/health_social_services/policy_planning *(accessed March 27 2003)*

Taylor S 2003 The ventilated patient undergoing hydrotherapy. *Australian Critical Care* 16(3):111-115

Thomas J, DeHueck A, Kleiner M, Newton J 1995 To vibrate or not to vibrate: Usefulness of the mechanical vibrator for clearing bronchial secretions. *Physiotherpay Canada* 47(2):120-125

Thorens JB, Kaelin RM, Jolliet P, Chevrolet JC 1995 Influence of quality nursing on the duration of mechanical ventilation in patients with COPD. *Critical Care Medicine* 23(11):1807-1815.

Thornton M, Melis E, Pham B 1999 Development, implementation and results of a survey to identify factors affecting motivation in an acute care physiotherapy setting. *Physiotherapy Canada* 51:251-258

Tobin M 1991Essentials of Critical Care Medicine. Churchill Livingstone. New York

Torres A, Ewig S 2004 Diagnosing VAP. *New England Journal of Medicine* 350(5):433-435

United Nations International Study on Firearm Regulation 1998 http://www.uncjin.org/Statistics/firearms/

United Nations Statistics Division 2002 http://unstats.un.org/unsd/demographic/ww2000/table3b.htm *(accessed 23 July 2004)*

Van Aswegen H & Eales C 2004 The effectiveness of MHI during the physiotherapy management of acute atelectasis: a case report. *SA Journal of Physiotherapy* 60(1):29-32

Vandenbroucke J 2001 In defence of Case Reports and Case Studies. *Annals of Internal Medicine* 134:330-334

Wall R, Dittus R, Wesley E 2001 Protocol-driven care in the ICU: a tool for quality. *Critical Care* 5:283-285

Welch CH, Thompson K, Long-Krug, S 1999 Evaluation of patient perceived health status using the Medical Outcomes Survey Short Form 36 in an intensive care unit population. *Critical Care Medicine* 27(8):1466-1471

Whitnet J, Harden B, Keilty S 2002 Assisted cough. *Physiotherapy* 88:201-207

Wijetunge A & Baldock GJ 1998 Evidence-based intensive care medicine. *Anaesthesia* 53:419-421

Wilkens RL Sheldon RL, Krider SJ 1996 Clinincal assessment in Respiratory Care 2nd Edition. Mosby. London p73-106

Wong Wai Pong 2000 Physical Therapy for a patient in acute respiratory failure. *Physical Therapy* 80(7):662-670

Wong D, Crofts S, Gomez M 1995 Evaluation of predictive abaility of APACHE II system and hospital outcome in Canadian ICU patients. *Critical Care Medicine* 23(7):1177-1183

World Confederation for Physical Therapy http://www.wcpt.org/programmes/index.html *(Accessed 24 July 2004)*

Young P & Ridley S 1999 Ventilator associated pneumonia. Diagnosis, pathogenesis and prevention. *Aneasthesia* 54:1183-1197

ADDENDA A

SELF DESIGNED DATA EXTRACTION SHEETS

A1 Admission data

A2 Daily management of patient data

A3 Daily physiotherapeutic management of patient

A4 Discharge data

A5 Nursing staffing Levels

A6 Physician staffing levels

ADDENDA B

EXCISTING UNIT DOCUMENTS

B1 Bedchart

B2 Physician admission notes

B3 Nursing care plan

B4 APACHE II score

B5 Surgery report

B6 Nursing admission notes

B7 Daily progress notes of physicians

B8 Interdepartmental referral form

B9 Antibiotic Profile

B10 Prescription card

B11 Nursing process

B12 Pressure sores

B13 Physician instructions

B14 Discharge summary

ADDENDA C

PHYSIOTHERAPY TECHNIQUES

C1 Physiotherapy techniques

C2 Attendance register

ADDENDA D

VERIFICATION OF DATA

D1 Job description of research assistant

D2 Control forms

ADDENDA E

ETHICAL CONSIDERATIONS

E1 Registration with the Faculty of Health Sciences

E2 Proxy consent document

E3 Permission from Tygerberg Hospital

E4 Permission from medical records

A1	**B1**	**B6**	**B11**	**C1**	**E2**
A2	**B2**	**B7**	**B12**	**C2**	**E3**
A3	**B3**	**B8**	**B13**	**D1**	**E4**
A4	**B4**	**B9**	**B14**	**D2**	**A5**
A6	**B5**	**B10**	**B15**	**E1**	**A5**

A1	**B1**	**B6**	**B11**	**C1**	**E2**
A2	**B2**	**B7**	**B12**	**C2**	**E3**
A3	**B3**	**B8**	**B13**	**D1**	**E4**
A4	**B4**	**B9**	**B14**	**D2**	**A5**
A6	**B5**	**B10**	**B15**	**E1**	**A5**

A1	**B1**	**B6**	**B11**	**C1**	**E2**
A2	**B2**	**B7**	**B12**	**C2**	**E3**
A3	**B3**	**B8**	**B13**	**D1**	**E4**
A4	**B4**	**B9**	**B14**	**D2**	**A5**
A6	**B5**	**B10**	**B15**	**E1**	**A5**