

The Prevalence Rate of Pressure Ulcers in the Acute Hospital Setting and Investigating Three Methods of Prevalence Measurement.

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The Prevalence Rate of Pressure Ulcers in the Acute Hospital Setting and
Investigating Three Methods of Prevalence Measurement.

A Research Study

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School of Nursing

RCSI

A thesis submitted to the School of Postgraduate Studies, Faculty of Medicine and
Health Sciences, Royal College of Surgeons in Ireland, in fulfilment of the degree
of MSc by Research

I declare that this thesis, which I submit to RCSI for examination in consideration of the award of a higher degree MSc by Research is my own personal effort. Where any of the content presented is the result of input or data from a related collaborative research programme this is duly acknowledged in the text such that it is possible to ascertain how much of the work is my own. I have not already obtained a degree in RCSI or elsewhere on the basis of this work. Furthermore, I took reasonable care to ensure that the work is original, and, to the best of my knowledge, does not breach copyright law, and has not been taken from other sources except where such work has been cited and acknowledged within the text.

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Abbreviations

EPUAP: European Pressure Ulcer Advisory Panel

NPUAP: National Pressure Ulcer Advisory Panel

S.E.M: Sub-epidermal Moisture

U.K: United Kingdom

U.S.A United States of America

I.A.S.P: International Association of the Study of Pain

N.R.S: Numeric Rating Scale

D.P.U: Dermal Phase Units

I.C.U: Intensive Care Unit

H.D.U: High Dependency Unit

P.A.C.U: Post Anaesthetic Care Unit

E.D: Emergency Department

B.M.I: Body Mass Index

B.G.L: Blood Glucose Levels

C.O.P.D: Chronic Obstructive Pulmonary Disease

A.C.L: Anterior Cruciate Ligament

E.N.T: Ear Nose & Throat

M.S. Multiple Sclerosis

H.I.Q.A: Health Information & Quality Authority

P.P.P.I.A: Pan Pacific Pressure Injury Association

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Aim: The aim of this study is to determine the prevalence of pressure ulcers in an acute hospital setting and investigate the value of using 3 different methods of pressure ulcer prevalence measurement.

Method: A prospective quantitative research method was used. Pressure ulcers prevalence and risk was measured using Waterlow scores with visual inspection (using EPUAP guidelines), sub epidermal moisture measurement (using the S.E.M scanner) and pain associated with pressure ulcer development. A cohort of patients in acute hospital, who were mainly short stay surgical patients, were followed over a three day period with the measures of prevalence being taken each day.

Results / Discussion: Of the 31 participants who took part the mean (\pm SD) of the Waterlow score was 6.8 (\pm 4.0) indicating that 93.5% of participants were deemed low risk of pressure ulcer development. 2 patients (6.4%) showed visible signs of pressure ulcer (grade 1) development. The S.E.M. scanner revealed that 16 (51.4%) participants demonstrated signs of pressure injury. Pain was reported at all anatomical sites. All pain was reported as 'mild'. On average 12.8% (n=4) of participants verbalised pain at one or more of the anatomical sites. Correlational statistics demonstrate statistically significant association between immobility and S.E.M scores ($r=.527$, $p=.010$) and between EPUAP scores and S.E.M reading on the sacrum ($r=.762$, $p=.000$). No associations were found between pain and EPUAP scores or S.E.M scores.

Conclusion: The result of this study indicate that there a possible underestimation of pressure ulcer prevalence rates when using Waterlow and visual inspection and that sub epidermal moisture scanning is more sensitive in picking up early pressure damage. Pain measurement as a method of detecting pressure ulcers is not well supported in this study. The results call in to the question current methodologies in pressure ulcer risk assessment and detection particularly in short stay surgical patients.

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I would like to dedicate this study to my new baby girl Clara. Clara you arrived in the middle of it all and made completing this study so worthwhile.

Chapter One - Introduction and Significance of the study.

1.0. Introduction

A pressure ulcer is defined by the European Pressure Ulcer Advisory Panel and the National Pressure Ulcer Advisory Panel (EPUAP/NPUAP 2009) as the injury to a localised area of the skin, which takes place over a bony prominence. Complications of pressure ulcers can include pain, depression, infection of bone, muscle and tendon and can lead to death (McGinnis *et al.* 2014). Therefore, it is vital, that all healthcare professionals, understand the importance of determining all those who are at risk. Understanding who is at risk of developing a pressure ulcer means that effective prevention methods can be implemented. Determining the number of patients who have or who are at risk of developing any condition is by performing a prevalence study. To date, the most common method of assessing those at risk of pressure ulcer development, is by utilising visual risk assessment scales such as the Waterlow score. Then the pressure ulcers are categorised using grading tools such as EPUAP/NPUAP's pressure ulcer grading tool. However, NPUAP (2007) have advised that pressure ulcers are developing in the deep tissues which are not visible to the naked eye until they reach an advanced stage. This begs the question if assessing patients for signs of pressure ulcer development, through the method of visual risk assessment, is the most appropriate. If this is not the case, the traditional method of visual skin inspection alone will no longer suffice. It is of great importance that we implement pressure ulcer prevention strategies early, as according to O'Tuathail & Taqi (2011), pressure ulcers are one hundred percent avoidable and their development is widely regarded as a quality of care indicator.

Therefore, the aim of this study was to determine the prevalence of pressure ulcers in an acute hospital setting and investigate the value of using three different methods of pressure ulcer prevalence measurement. To gather data, the researcher included the use of visual skin inspection (Waterlow score), but also determined pressure ulcer prevalence by assessing the participant's pain levels and the sub-epidermal moisture (S.E.M) of the skin. The researcher chose to include the assessment of pain as pain is a known symptom of pressure ulcer

development. Measuring S.E.M demonstrated the presence of pressure damage, if any (Bates-Jensen *et al.* 2007, 2008, 2009). It is the belief of the researcher that such information provides a more in-depth overview of the prevalence rate of pressure ulcers within the acute hospital setting.

1.1. What are Pressure Ulcers?

Pressure ulcers are not a new phenomenon. They have been referred to by several different titles over the years including bed sores, pressure sores and decubitus sores (O'Tuathail & Taqi 2011). As mentioned EPUAP/NPUAP (2009) define a pressure ulcer as the injury to a localised area of the skin, which takes place over a bony prominence. This is due to pressure or as a combination of both pressure and shear. There are four mechanisms associated with the development of pressure ulcers (Ceelen 2003). These four mechanisms are local ischemia, reperfusion injury, impaired interstitial fluid flow and cell deformation (Ceelen 2003). To get a better understanding of pressure ulcers, the researcher will provide an in depth description of their aetiology in chapter two.

According to EPUAP/NPUAP (2009) guidelines, pressure ulcers can be categorised in to four grades, grade one to grade four. Grade one pressure ulcers are also known as non-blanching erythema. Grade four pressure ulcers were once considered the most severe stage of pressure ulcer development as full thickness tissue loss was recorded. Having developed a stage four pressure ulcer meant that bone or indeed tendon and muscle were visible (EPAUP/NPUAP 2009). This now appears to be outdated as there are two new stages of pressure ulcer development identified, namely, unstageable and suspected deep tissue injury (EPUAP/NPUAP/PPPIA 2014). Possibly suspected deep tissue injury is of most concern. Clinically these pressure ulcers present themselves similar to a bruise, often making them difficult to detect and diagnose. They are especially proving troublesome in their diagnoses for those with darker skin tones (EPUAP/NPUAP/PPPIA 2014). All stages of pressure ulcer development have been described in chapter two. The most popularly used pressure ulcer grading

tools are the EPUAP/NPUAP's pressure ulcer classification system and Stirling's pressure ulcer severity scale. Both of these scales, including their strengths and limitations have also been discussed in chapter two.

1.2. Pressure Ulcer Prevalence.

The prevalence rate of pressure ulcers in Ireland is consistent with international figures, 12-38% (Health Service Executive 2009) (H.S.E.). Prevalence is defined as the number of people within a population with a particular condition or disease (Parahoo 1997, Polit & Beck 2008). The most commonly used methods to determine prevalence are point, period and lifetime prevalence. Point prevalence allows the researcher to determine the number of people with a certain disease at a certain point in time which is then divided by the total number of the population (Parahoo 1997, Polit & Beck 2008). Whereas period prevalence is the number of persons with a disease in a time interval (e.g. one year), this is then divided by the number of persons in the population (Parahoo 1997, Polit & Beck 2008). Lifetime prevalence studies are the proportion of a population that at some point in their life have experienced the condition for example pressure ulcer development (Parahoo 1997, Polit & Beck 2008).

Although not a method of determining prevalence, to date pressure ulcer prevalence rates have been measured with the use of the visual risk assessment tool (e.g. Waterlow score), in conjunction with pressure ulcer grading tools (e.g. EPUAP/NPUAP grading tool). The purpose of completing a visual risk assessment tool is to determine those at risk of pressure ulcer development. They were not designed to measure prevalence. However due to the type of information visual risk assessment tools obtain, they allow researchers to gather information needed to measure prevalence. This is similar to pressure ulcer grading tools, they too are widely used to aid determine pressure ulcer prevalence rates. Yet their purpose is to assist the health care practitioner in the pressure ulcer classification process.

This study employed a prospective, quantitative research design to complete this prevalence study. The visual risk assessment tools that have been used in this study to gather data were, the Waterlow score and the EPUAP's pressure ulcer classification tool. However, as stated EPUAP/NUAP/PPPIA (2014) are educating healthcare professionals regarding the increased number of pressure ulcers that develop in the deep tissues. Such pressure ulcers do not reach the skin surface until they reach an advanced stage (EPUAP/NPUAP/PPPIA 2014). This calls in to question if the current methods of assessing pressure ulcer prevalence are indeed the most appropriate and effective. With this in mind, it was decided upon to include the measurement of pain and S.E.M, to determine pressure ulcer prevalence rates more accurately. In chapter two the researcher has provided an in-depth analysis of some of the previously conducted pressure ulcer prevalence studies that have been performed.

1.3. Implications of Pressure Ulcers

“Wounds do not have a one dimensional impact but rather can impact under three domains; that is, to the individual, the health service and to society” (HSE 2009 p.15).

In 2005 Gethin *et al.* performed a prevalence study to calculate the costs of treating pressure ulcers in Ireland. Gethin *et al.* (2005), estimated that, it costs 119,000 Euro to treat a grade four pressure ulcer successfully. In the United Kingdom (U.K.) Dealey *et al.* (2012) looked at the cost of pressure ulcer management. The cost of nursing time was included in this cost analysis. From the work of Dealey *et al.* (2012), it was suggested that nursing time accounts for 90% of costs associated with wound management and 96% of costs for grade 1-2 pressure ulcers. Severe ulcers such as grade 3-4 costs were based on the complications that regularly occur, such as infection which leads to delayed healing (Dealey *et al.* 2012). Other costs associated with pressure ulcers such as dressings and pressure relieving devices were significantly lower, accounting for only 3.3% of overall costs (Dealey *et al.* 2012). In the United States of America

(U.S.A.) it is estimated that pressure ulcers cost the U.S health system \$9.1-11.6 billion (Leaf Healthcare 2014) (online).

The World Health Organisation (WHO) (1997) defines the term 'quality of life', as the way people view their position in life and the emphasis that they place on different concepts, such as health. Therefore, quality of life is difficult to measure, as people place different emphasis on what is important to them (Benbow 2009). Over the years, research in healthcare has focused on the disease and the development of successful interventions (Moore & Cowman 2009). Yet until recently, there was little evidence to suggest the impact that such interventions have on individual lives. However, as patient's have become more empowered there has also been a surge of interest in patients' perception of quality of life (Moore & Cowman 2009).

Spilsbury *et al.* (2007) explored how pressure ulcers and their treatment affected patients' quality of life using qualitative semi-structured interviews. Ninety-one percent of participant's, stated that their pressure ulcers impacted them negatively, affecting them emotionally, mentally and socially. The participants in this study highlighted that they suffered pain and were left embarrassed due to wound malodour and wound leakage. Similarly, Fox (2002) conducted a small study of five participants to get an overview of their quality of life, living with a pressure ulcer. Like Spilsbury *et al.* (2007) these participants' also highlighted that exudate levels and loss of independence greatly affected their quality of life. In 2014, Lourenco *et al.* measured health related quality of life for patient's living with spinal cord injuries, who had developed pressure ulcers. Lourenco *et al.* (2014) used a controlled cross-sectional study design. There were a total of one hundred and twenty patients, with spinal cord injuries that were included, of which sixty patient's had existing pressure ulcers and were allocated to the study group. The remaining sixty participant's displayed no signs pressure ulcers and were allocated to the control group. Statistical analysis was performed using the chi-square test, Fisher's exact test, and Student's t-test (Lourenco *et al.* 2014). The patient's in the study group reported significantly lower quality of life scores when

compared with the control group ($p \leq 0.0013$) (Lourenco *et al.* 2014). Pressure ulcers have a negative impact on the health related quality of life and the self-esteem of patients with spinal cord injuries (Lourenco *et al.* 2014).

Pressure ulcers cause pain, with most patient's reporting the pain as constant (Gunes 2008). Gunes (2008) believes that assessment of pain caused by pressure ulcers should be included in all patient care plans (Gunes 2008). Gunes (2008) conducted a descriptive study examining pressure ulcer pain. Of the 47 included patient's, 44 (96.4%) verbalised that they experienced pain as a result of their pressure ulcers. Words used to describe such pain were 'discomfort', 'horrible' and 'burning sensation' (Gunes 2008 p. 58). Such pain may be a result of infection, dressing changes, debridement, operative procedures, and other treatments (Pieper *et al.* 2009). According to Pieper *et al.* (2009) the use of established reporting instruments (such as the numeric pain scale), that allows the patient to self report their pain, is the most accurate form of identifying and treating pain. The reliability and validity of the chosen pain assessment tool (universal pain scale) has been discussed at great length in chapter two.

1.4. Pressure Ulcers and the Surgical Patient

In determining pressure ulcer prevalence in an acute hospital setting, means that the researcher was able to include both medical and surgical patients. The inclusion of the surgical patient was very important to this study as the chosen study site performs what is considered 'minor' surgery only. In other words, those admitted for surgery are elective admissions who do not require prolonged hospital stay or admittance to an intensive care unit (I.C.U.) It appears that surgical patients who have been previously studied in the area of pressure ulcers/pressure damage development had undergone lengthy surgical procedures (>2.5 hours) (Cherry & Moss 2011., Jackson *et al.* 2011 and Primiano *et al.* 2011). At the chosen study site patients are usually discharged twenty-four hours post-operatively. As mentioned they are elective surgical admissions, therefore, not emergency cases that do not require increased time spent in the emergency department (E.D.) or admitted to the hospital for medical intervention pre-

operatively. To discover if the surgical patient's would demonstrate any signs of pressure damage post 'minor' surgery was of great importance to this study's outcomes.

Factors which contribute to the incidence of surgery-related pressure ulcers include the fact that, during surgery patients are immobile. Also they are not able to feel pain caused by prolonged pressure on the operating table secondary to anaesthesia (Chen *et al.* 2012). The use of anaesthetic agents can cause a loss of muscle tone that increases pressure over bony prominences. Such prolonged pressure causes decreased perfusion which leads to ischemia and cell death (Chen *et al.* 2012). With this in mind, this researcher wanted to establish if patients undergoing 'minor' surgery were at risk of early pressure damage as 'minor' surgery would be shorter in length to that compared to the types of surgeries included in the literature review. The researcher reviewed previous work carried out which explored the relationship between surgery and pressure ulcer development. The relationship between pressure ulcer development and the surgical patient has been discussed in detail in chapter two.

1.5. The Evidence Base for the Current Risk Assessment Model

Typically pressure ulcer prevalence studies have utilised visual risk assessment tools and pressure ulcer grading tools to collect their data. Yet it is important to remember that, the primary purpose of risk assessment tools is to determine those at risk of pressure ulcer development. Pressure ulcer grading tools were designed to correctly stage the developed pressure ulcer. Neither tools were designed for measuring pressure ulcer prevalence, yet they are used as methods of data collection in prevalence studies, as they provide researchers with information necessary to successfully completing a prevalence study. There have been numerous studies completed exploring the validity and reliability of such tools. The studies exploring the various visual risk assessment tools and pressure ulcer grading tools have been included in chapter two. Furthermore, this research study has included the use of pain assessments and S.E.M. measuring to

determine pressure ulcer prevalence. Therefore, the reliability and validity of the pain assessment tools and S.E.M. measuring has also been discussed.

1.6. Definition of Terms

Pressure Ulcer: the injury to a localised area of the skin which commonly takes place over a bony prominence.

Prevalence: the number of people within a population with a pressure ulcer divided by the number of people in the population at a certain point in time.

Hospital Setting: for the purpose of this study is defined as admitted to hospital.

Aetiology: the cause or set of causes that contribute to pressure ulcer formation.

Heterogeneity: signifies diversity and variety.

Risk Assessment Tool: a guideline utilised by healthcare professionals to determine if a patient is at risk of pressure ulcers, malnutrition, etc.

Pain: highly unpleasant physical sensation caused by injury.

Sub-epidermal Moisture Scanner: a hand held device used for the early indication of pressure ulcers and deep tissue injury.

Quality of Life: the way an individual views their position in life and the emphasis they place on different domains such as health.

Reliability: the ability of two separate observers to achieve similar results from the tool in question.

Validity: the results of the tool is consistent regardless of the variables such as age and timing of assessment.

1.7. Study Overview

The aim of this study was to measure pressure ulcer prevalence in the acute hospital setting and to investigate the value of using three different methods of

pressure ulcer prevalence measurement. There were three objectives of this study. Firstly, to evaluate if the current methods of pressure ulcer risk assessment are indeed the most accurate to determine pressure ulcer prevalence. Secondly, to determine if incorporating the measurement of pain and S.E.M. scanning will lead to more successful rates of early pressure ulcer detection. And finally, to identify which patients are at high risk of pressure ulcer development.

To complete this study, a prospective quantitative research method was used. The rationale for choosing this research method has been discussed in chapter three. Pressure ulcers prevalence and risk was measured using the Waterlow score with visual inspection (using EPUAP guidelines), sub epidermal moisture measurement (using the S.E.M scanner) and pain associated with pressure ulcer development. Patient's in an acute hospital, who were mainly short stay surgical patient's, were followed over a three-day period with the measures of prevalence being taken each day.

Thirty-one participants took part in this study. The mean (\pm SD) of the Waterlow score was 6.8 (\pm 4.0) which indicates that 93.5% of participants were deemed low risk of developing a pressure ulcer. Two patient's (6.4%) showed visible signs of pressure ulcer (grade 1) development. The S.E.M. scanner revealed that 16 (51.4%) participants demonstrated signs of pressure injury. Immobility and S.E.M scores significantly correlated ($r=.527$, $p=.010$) as did the EPUAP scores and S.E.M readings on the sacrum ($r=.762$, $p=.000$). No associations were found between pain and EPUAP scores or S.E.M readings.

The findings of this study suggests that the use of a visual risk assessment tool alone may underestimates the prevalence rate of pressure ulcers. The effectiveness of the inclusion of measuring S.E.M. has been illustrated throughout the literature (Bates-Jensen *et al.* 2007, 2008, 2009 & Guihan *et al.* 2012). Pain did not illustrate to indicate the onset of early pressure damage. The results of this study calls in to question if the current methodologies in pressure ulcer risk

assessment and detection, especially for short stay surgical patients is most appropriate.

1.8. Summary

Although there has been an increase in pressure ulcer prevention efforts they remain a significant clinical problem (O'Tuathail & Taqi 2011). Pressure ulcers can cause pain and suffering to the patient therefore reducing their quality of life. National prevalence rates in Ireland are echoing international figures of 12-38%. As our understanding of pressure ulcer development is becoming more sophisticated, it is now becoming apparent that pressure ulcers are developing in the deep tissues making them difficult to detect. Previous pressure ulcer prevalence studies have focused on gathering their data, using visual risk assessment tools and pressure ulcer grading tools as their only methods of data collection. Yet if there is a rise in the number of suspected deep tissue pressure ulcers being reported, it begs to question if using such assessment tools are one hundred percent effective. It is with this in mind that it was decided upon to delve further in to this area and investigate the value of using three methods to determine pressure ulcer prevalence. To do this, the researcher collected data by using the Waterlow score, by assessing pain and measuring S.E.M. Fully understanding the prevalence rates of pressure ulcers should ultimately increase the quality of care delivered to patient's in Ireland by leading to the early recognition of pressure ulcer development.

Chapter Two - The Literature Review

2.0 Introduction

For the purpose of this research study an in-depth literature review was performed. Literature that was reviewed included pressure ulcer prevalence studies which looked at both national and international studies dating from 2005. The literature review also includes the concept of the relationship between the

surgical patient and pressure ulcer development. The reliability and validity of risk assessment tools in particular the Waterlow score and the pain scale is discussed. To date, four research studies measuring the effectiveness of assessing S.E.M readings have been conducted. As measuring S.E.M was a significant step of this research study, they too will have been reviewed. Finally, the methodological issues of the included studies have been discussed. For the purpose of the academic literature review, the writer performed an in-depth search strategy to retrieve current literature pertaining to the three concepts of the visual skin inspection, pain assessment and the S.E.M scanning.

Burns & Grove (2001) defines a literature review as the basis of which the gaps in the current research are identified. However, some view literature reviews as lacking a scientific approach to the inclusion and exclusion of material. Therefore, this raises the issue that literature reviews may produce findings that include a limited analysis of the evidence (Gregoire *et al.* 1995). For example, if one decides to read research articles only written in the English language this gives the risk of excluding important, relevant studies. This indicates that the results of such a literature review can be considered biased which in return can damage its believability or confidence. The studies included in this literature review were written in the English language only.

2.1 Search Strategy

A number of databases were used to complete this literature review. These databases included CINAHL, Pubmed, Medline and Cochrane. In addition to the articles retrieved from the databases, their reference list was examined to determine if further literature was eligible, but not retrieved in the primary search. With the exception of one (Nay & Fetherstonhaugh 2012) all research studies were quantitative in nature. All retrieved articles were written in the English language only. Date limitations were not applied for the purposes of this study.

For successful completion of the search strategy, the following search terms were used:

1. Pressure ulcers
2. Pressure Ulcer Aetiology
3. Pressure Ulcer Prevalence
4. Risk assessment Tools/ Risk assessment Scales
5. Braden Scale/Norton Scale/ Waterlow Scale
6. Reliability of Braden Scale/ Norton Scale/ Waterlow Scale
7. Validity of Braden Scale/ Norton Scale/ Waterlow Scale
8. Pain/Pain Assessment Tools
9. Sub-epidermal Moisture/Sub-epidermal Moisture Skin Scanner

2.2. Pressure Ulcers

As discussed in chapter one pressure ulcers have been of concern for mankind for centuries. The definition of pressure ulcers is understood as the injury to a localised area of the skin. This takes place over a bony prominence. Examples of bony prominences include the sacrum, bilateral shoulders and bilateral heels (EPUAP/NPUAP 2009). Pressure ulcers are one hundred percent avoidable (O'Tuathail & Taqi 2011). They cause distressing symptoms such as pain, infection, sepsis and in extreme circumstances can result in death (O'Tuathail & Taqi 2011). For healthcare professionals the development of pressure ulcers can be somewhat disheartening as they are viewed as indicators of poor quality of care (O'Tuathail & Taqi 2011). The development of pressure ulcers can result in an increased length of stay in hospital for the patient. This places huge strain on both the patient (emotionally and financially) and the healthcare organisation (financially). Therefore, it is imperative that all healthcare professionals understand the importance of determining all those who are at risk of developing a pressure ulcer. Understanding who is at risk of developing a pressure ulcer means that effective prevention methods can be implemented (O'Tuathail & Taqi 2011).

2.3. Pressure Ulcer Aetiology

It has been mentioned in chapter one that the aetiology is relatively unknown. It is believed that there are four mechanisms that contribute to pressure ulcer development. These mechanisms are local ischemia, reperfusion injury, impaired interstitial fluid flow and cell deformation (Ceelen 2003). Previously a systematic review was conducted to determine if a relationship existed between cell deformation and the most common risk factors associated with pressure ulcer development (O'Connor 2014). For the purpose of that systematic review, pressure ulcer aetiology was described in great detail. It is having been done so again in this study.

2.3.1 Local Ischemia

Husain (1953) studied the effect of pressure applied to the legs of rats. With a sample of 93 rats, a pressure of 100-800mmHg was applied for the duration of one to ten hours. Such pressure led to skin and underlying tissue damage. It was interesting to read that the pressure that was applied to the rat's leg caused more damage to their muscle rather than to the subcutaneous tissues (Husain 1953). This is an example of deep tissue injury, which is under investigation in this prevalence study. Also important to note is that Husain (1953) discovered that the application of low pressure for a long period of time, in fact, had a more negative impact than high pressures which were applied for a shorter time. Microscopic changes were detected from pressure of as low as 100mmHg for as little time as one hour (Husain 1953).

Kosiak (1959) explored the effect of pressure applied to the legs of dogs. In this study there were 16 dogs who were subjected to pressures ranging from 100-500mmHg for periods of one to 12 hours. Like Husain (1953), Kosiak (1959) concluded that tissue damage occurred when high pressure was applied for short periods of time and when low pressure was applied for long periods of time.

Kosiak (1959) draws the reader's attention to the fact that, clinically, patients in a health care setting are rarely turned more often than every two hours. This means that each bony prominence was exposed to six hours of pressure per twenty-four hours. Kosiak (1959) suggests that frequent turning of patients every few minutes is optimal. However, it is important to consider the practicalities of such a suggestion in a time when it appears that medical services are fully stretched to their limits.

2.3.2 Reperfusion Injury.

Reperfusion injury is defined as '*cellular injury resulting from the reperfusion of blood to a previously ischemic tissue*' (Pierce *et al.* 2000 p.68). Reperfusion injury plays a major role in the pressure ulcer development process (Sisco *et al.* 2007). Pierce *et al.* (2000) performed a study using rats as their sample and to create ischemia a metal plate was inserted to their legs. Pressure was periodically applied of 50mmHg using a magnet. Their results showed that the incidence of tissue injury increased with an increasing number of ischemia-reperfusion cycles. The researchers highlighted that damage to the tissue was significantly increased when the duration of the ischemia was increased from one to two hours (Pierce *et al.* 2000). Ischemia/reperfusion cycles caused 13% of tissue damage in comparison to continuous ischemia which caused 8% of tissue damage (Pierce *et al.* 2000).

2.3.3. Impaired Interstitial Fluid Flow.

Normal cell functioning depends on normal metabolism. This is achieved when a sufficient supply of nutrients and oxygen is transported through the blood to the tissue cell with the elimination of waste. Ideally this happens through the lymphatic system. If any disturbance in this cycle occurs the cell becomes stressed which in turn may lead to cell damage and death (Ceelen 2003). Reddy's (1990) hypothesis on the role of the lymphatic system in pressure ulcer formation shows that tissue pressure can damage or directly block the lymphatic system.

This in return leads to the absorption of lymph from the interstitium being impaired (Reddy 1990). If absorption of the lymph is impaired then there is a build-up of metabolic waste products, proteins and enzymes which leads to tissue necrosis (Reddy 1990). This suggests that the lymphatic system, because of its role in maintain tissue integrity, when impaired due to pressure or shear, then contributes to pressure ulcer formation.

2.3.4. Cell Deformation

Cell deformation is explained as the result of excess compression of soft tissue. Such compression is known to lead to both collapse of blood vessels and cell deformation within the tissue (Stekelenburg *et al.* 2008). Cell deformation has been shown to result in the onset of tissue damage (Stekelenburg *et al.* 2008). For example, the results of an in vivo study carried out by Stekelenburg *et al.* (2008) indicated that compressive loading for two hours led to irreversible damage to the muscle tissue (i.e. deep tissue pressure damage) (Stekelenburg *et al.* 2008). This damage to the muscle tissue is of great concern as it is not often visible to the naked eye, until it has reached an advanced stage (Stekelenburg *et al.* 2008).

Early pressure damage has been recognised since the 1950's. This is highlighted in the studies by Husain (1953) and more recently by Stekelenburg *et al.* (2008) as they found that muscle damage did indeed precede pressure ulcers that became visible to the naked eye. Also what is common amongst the included studies examining pressure ulcer aetiology is that the authors found that pressure damage occurred even when pressure was applied for as little as one hour (Husain 1953). As stated the surgery performed at the chosen study site is considered 'minor' where patients are usually discharged within twenty-four hours post-operatively. The purpose of including these surgical patients was to determine if pressure ulcers are a concern for the short stay surgical patient.

2.4. Stages of Pressure Ulcer Development

'Accurate assessment of pressure ulcers is essential to plan pressure ulcer prevention and management regimens' (Moore 2005 p. 59).

According to EPUAP/NPUAP (2009) pressure ulcers can be broken down into four categories, grade one to grade four. A stage one pressure ulcer is also referred to as non-blanching erythema. With non-blanching erythema the skin is intact. An area of redness is noted over a localised area usually over a bony prominence (EPUAP/NPUAP/PPPIA 2014). Stage one pressure ulcers can prove difficult to diagnose for those with darker skin tones. For patients the area may be painful, warm/cool, soft or firm when compared to surrounding tissue (EPUAP/NPUAP/PPPIA 2014). Stage two pressure ulcers are also known as partial thickness skin loss. A stage two pressure ulcer can present as a shallow open ulcer that has a pink wound bed (EPUAP/NPUAP/PPPIA 2014). Slough is never present with a stage two pressure ulcer. Stage two pressure ulcers can also present as an open or intact blister (EPUAP/NPUAP/PPPIA 2014). With stage three pressure ulcers there is full thickness tissue loss. Stage three pressure ulcers will never expose bone or muscle. Unlike stage two pressure ulcers, slough may be present with a stage three pressure ulcer. Also there may be undermining of the wound (EPUAP/NPUAP/PPPIA 2014). There is full thickness tissue loss with a stage four pressure ulcer. In this case bone and muscle are exposed. Similar to stage three pressure ulcers, they can also include the presence of slough and undermining (EPUAP/NPUAP/PPPIA 2014).

NPUAP (2007) recognised that the severity of some pressure ulcers may indeed go beyond the grade one to four spectrums. NPUAP (2007) has added two more pressure ulcer defining stages. These are, unstageable and suspected deep tissue injury. With an unstageable pressure ulcer the depth of the ulcer is unknown. Also the base of the ulcer is covered with slough and/or eschar. Until the slough and eschar is removed exposing the wound bed, its depth and stage, cannot be determined (NPUAP 2007). With suspected deep tissue injury the depth of the wound is also unknown. The skin is intact but appears purple in colour. Suspected deep tissue injury can also present as a blood-filled blister due

to damage of underlying soft tissue secondary to pressure (NPUAP 2007). For those with darker skin tones deep tissue injury may prove difficult to diagnose. Like a stage one pressure ulcer, suspected deep tissue injury may be preceded by tissue that is painful, firm or soft, warm or cool compared to surrounding tissue (NPUAP 2007).

The EPUAP/NPUAP pressure ulcer classification system appears to be a very popular tool to grade pressure ulcers. Most commonly used in the U.K. another tool used to grade pressure ulcers is the Stirling's pressure ulcer severity scale. This is a new grading tool for the researcher. Like EPUAP/NPUAP's grading tool, it too, divides the pressure ulcers into different categories. However, the Stirling pressure ulcer severity scale includes grade zero. This is the absence of a pressure ulcer. Grades one to four echo those outlined by (NPUAP 2007). The scale has several variations, with the most common being the one and two digit scales. This is where the nature and severity of the ulcer are graded (Eng & Chan 2013). The one-digit scale, allows the nurse to report the severity of the ulcer from zero to four, according to the stage definitions. With the two-digit scale, nurses report the severity of the ulcer according to the stage definitions and specific descriptors. For example, for stage zero pressure ulcers there are three descriptors. These descriptors include 0.1 - the skin is normal in appearance and the skin is intact, 0.2 - there is healed with scarring and finally 0.3 - tissue damage is evident, but it is not assessed as a pressure ulcer (Eng & Chan 2013). A useful tool that EPUAP/NPUAP/PPPIA (2014) quick reference guidelines has included however, is the use of clinical photographs which illustrates each pressure ulcer stage. The Stirling pressure ulcer severity scale does not use photographs to differentiate between pressure ulcers (Eng & Chan 2013). Instead the Stirling pressure ulcer grading system divides into two scales, the one and two digit scales as discussed. Like using any tool for the first time, Eng and Chan (2013) recommend training prior to the implementation of this tool.

In 2004, Pedley undertook a study to compare pressure ulcer grading tools. The two tools that were included were EPUAP's pressure ulcer grading tool and

Stirling's pressure ulcer severity scale (Pedley 2004). The inter-observer agreement of the Stirling pressure ulcer severity scale (one and two digit versions) and the EPUAP's pressure ulcer grading tool, using Cohen's kappa and percentage agreement was measured (Pedley 2004). Two registered nurses made thirty-five observations. There were thirty participants in total. The levels of agreement obtained between the two nurses were better than previously reported. This may be a result of the methodology used in this study. The two digit Stirling pressure ulcer severity scale gave the best level of chance corrected agreement ($\kappa=0.457$). It was also the scale preferred by the two nurses (Pedley 2004). The one digit Stirling pressure ulcer severity scale performed the least favourably. The reliability and clinical utility of EPUAP was then tested, ($\kappa= 0.308$) with agreement of 85.7% (Pedley 2004). The inter-rater agreement and accuracy of response using the EPUAP pressure ulcer grading tool and Stirling pressure ulcer severity scale was then tested. The consistency was highest for the EPUAP pressure ulcer grading tool (61.9% of cases) in comparison to 30.2% for the Stirling pressure ulcer severity scale (Pedley 2004).

For the purpose of this prevalence study, the EPUAP pressure ulcer grading tool was used to grade visible pressure ulcers. It was chosen as it is the grading tool used at the study site. Therefore, the researcher had been trained in its use prior to the commencement of this study. The pressure ulcer prevalence studies that have been discussed throughout this literature review used the EPUAP/NPUAP pressure ulcer grading tool only. However, it is important to stress that these tools, like visual risk assessment tools are not a method of measuring pressure ulcer prevalence. They provide researchers with important data that contributes to the overall findings. Important to remember is that these tools also have their limitations. For example, there may be a difference of opinion between those grading pressure ulcers despite having photographic aids such as EPUAP/NPUAP. It has been noted that conditions such as incontinence dermatitis, maceration and excoriation of the skin has been confused as grade one pressure ulcers (EPUAP/NPUAP/PPPIA 2014).

2.5. Pressure Ulcer Prevalence.

The prevalence rates of pressure ulcers in Ireland are consistent with international figures, 12-38% (HSE 2009). As described in chapter one, prevalence is defined as the number of people within a population with a pressure ulcer divided by the number of people in the population at a certain point in time (Parahoo 1997, Polit & Beck 2008). Prevalence studies or as they are also known as cross-sectional studies are the most common population-based epidemiological studies. A prevalence study is viewed as a simple method to measure the burden of a disease (Parahoo 1997, Polit & Beck 2008) Researchers determining prevalence can choose from different types of measuring prevalence in order to complete their study. The most commonly used methods to determine prevalence are point, period and lifetime prevalence. As described in chapter one, point prevalence allows the researcher to determine the number of people with a certain disease at a certain point in time. This number is then divided by the total number of the population (Parahoo 1997 and Polit & Beck 2008). Period prevalence is the number of persons with a disease in a set time frame. To determine prevalence, that number is then divided by number of persons in the population (Parahoo 1997, Polit & Beck 2008). Lifetime prevalence studies look at a sample of the population, that at some stage of their life, have experienced the condition in question, which in this instance is pressure ulcer development (Parahoo 1997, Polit & Beck 2008).

In 2014 EPUAP, NPUAP and PPPIA published pressure ulcer prevention and treatment guidelines. Within these guidelines there is emphasis placed on the importance of understanding pressure ulcer prevalence so that prevention strategies can be implemented. A list of recommendations to successfully complete a pressure ulcer prevalence study was issued in these guidelines. According to EPUAP/NPUAP/PPPIA (2014) a pressure ulcer prevalence study should include the following seven stages. Firstly, the researcher should employ a rigorous methodology. A rigorous study should include a clear definition of the study population prior to data collection (EPUAP/NPUAP/PPPIA 2014). A rigorous study will include the establishment of inter-rater reliability and will also include

skin assessments to stage the pressure ulcer with two people inspecting the skin (EPUAP/NPUAP/PPPIA 2014). EPUAP/NPUAP/PPPIA (2014) recommends that researchers determining prevalence must compare their findings to organisational, national and international results to truly understand prevalence rates. Facility acquired pressure ulcers should be measured only. The most common anatomical locations for pressure ulcer development should be reported. When reporting pressure ulcer prevalence rates, the results should be reported by pressure ulcer risk level (EPUAP/NPUAP/PPPIA 2014). Clearly indicate if stage one pressure ulcers were included and finally include but do not stage mucosal membrane pressure ulcers (EPUAP/NPUAP/PPPIA 2014).

To date pressure ulcer prevalence has been measured with the use of the visual risk assessment tool only. The most popularly used tools are the Braden, Norton and Waterlow scores. However as stated, EPUAP/NPUAP/PPPIA (2014), are educating healthcare professionals regarding the increased number of pressure ulcers that develop in the deep tissues. If pressure ulcers do not reach the skin surface until they are at an advanced stage (EPUAP/NPUAP/PPPIA 2014), this calls to question if the current methods of assessing pressure ulcer prevalence are indeed the most appropriate and effective. In chapter two the researcher has provided an analysis of some of the previously conducted pressure ulcer prevalence studies that have been performed both nationally and internationally. They have been discussed in great detail below.

2.6. Previous Prevalence Studies

To date, pressure ulcer prevalence studies have focused their data collection on the use of various risk assessment tools (Braden, Norton and Waterlow scores) and pressure ulcer grading tools (EPUAP/NPUAP grading tool). Yet as mentioned, this technique may not be as reliable as researchers once thought due mainly to current thinking surrounding the existence of pressure damage prior to it being visually detectable.

For the purpose of this literature review, several national and international quantitative studies which explore the prevalence rate of pressure ulcers were examined. To estimate the cost of pressure ulcers in the acute hospital setting in Ireland, Gethin *et al.* (2005) performed a two-part study. The first part of the study focused on the prevalence rate of pressure ulcers in the acute hospital setting. Whereas the second part of the study set out to determine the best estimate of the cost of managing pressure ulcers (Gethin *et al.* 2005). This study was conducted in a 626 bed acute Irish hospital. Gethin *et al.* (2005) utilised the EPUAP pressure ulcer grading tool to collect their data pertaining to pressure ulcer prevalence. The data were collected by tissue viability nurses who were trained in the data collection tool. Of the included participants, there was a pressure ulcer prevalence rate of 12.5%.

The researcher then examined the study by Vanderwee *et al.* (2007). Like Gethin *et al.* (2005) Vanderwee *et al.* (2007) also looked at pressure ulcer prevalence rates. However unlike Gethin *et al.* (2005), Vanderwee *et al.* (2007) conducted a multi site study examining the prevalence rate of pressure ulcers in five different hospitals across Europe. General and university hospitals from the United Kingdom, Portugal, Belgium, Italy and Sweden took part. In this study there were 5947 participants from 25 different hospitals. The researchers concluded that there was a prevalence rate of 18.1% of grade one to four pressure ulcers (Vanderwee *et al.* 2007). As Vanderwee *et al.* (2007) used five hospitals to collect their data, the number of participant's is also significantly larger than that of Gethin *et al.* (2005). The fewer participant's may explain why Gethin *et al.* (2005) reported a lower pressure ulcer prevalence rate.

Similarly, to Vanderwee *et al.* (2007), Gallagher *et al.* (2009) conducted a multi site prevalence study. Gallagher *et al.* (2009) undertook a pressure ulcer prevalence study across three university hospitals in Ireland. Each participant was visually examined and pressure ulcers were graded using the EPUAP pressure

ulcer grading tool. However, Gallagher *et al.* (2009) also recorded each participants mental test score, Barthel index, length of stay, support surface type and serum albumin levels. The findings of Gallagher *et al.* (2009) showed a pressure ulcer prevalence rate of 18.5%, which is in keeping with international pressure ulcer prevalence figures. Gallagher *et al.* (2009) do discuss the risk factors they believe to have contributed to the development of the pressure ulcers found. Significantly associated with pressure ulcer development was reduced mobility, urinary incontinence, cognitive impairment, prolonged length of stay and low albumin levels (Gallagher *et al.* 2009). Gallagher *et al.* (2009) recommend that regular audits are performed to raise awareness which may influence resource allocation which in return may decrease future pressure ulcer prevalence rates. The limitations of this study were not discussed. It is also not discussed whether the data were collected by internal or external personnel. Therefore, it can be argued if objectivity was indeed maintained throughout this study.

Further a field in Jordon, Tubaishat *et al.* (2011) examined pressure ulcer prevalence rates. The overall prevalence rate was 12%. Looking at some of the available literature regarding pressure ulcer prevalence it is clear that the researchers used different data collection tools to gather information. It is important to remember that there are discrepancies that exist between people's judgement and knowledge regarding pressure ulcer development and grading. Therefore, we cannot assume that all assessors are grading ulcers in the same way. This impacts the interpretation of these results. One is reminded to bear these factors in mind when interpreting these research articles (Moore & Cowman, 2012).

Another multi site pressure ulcer prevalence study was performed by Schluer *et al.* (2009). Schluer *et al.* (2009) explored the prevalence of pressure ulcers across four paediatric healthcare settings. All participants were aged between nought to eighteen. Schluer *et al.* (2009) conducted a point prevalence study using visual risk assessment tools only to collect their data. The risk assessment tool of choice was the Braden Scale and pressure ulcers were graded using the EPUAP

pressure ulcer grading tool (Schluer *et al.* 2009). The collection of data was undertaken by a rater pair for each patient. A total of ten rater pairs were involved in the study of which one was an internal rater and the other an external rater (Schluer *et al.* 2009). Schluer *et al.* (2009) highlights that if there was disagreement between the rater's, a second external rater's opinion was then sought. Prior to study commencement, rater's received preparatory training and needed a minimum of two years paediatric nursing experience. Again in keeping with international prevalence rates, Schluer *et al.* (2009) findings revealed a pressure ulcer prevalence rate of 27.7%. Schluer *et al.* (2009) found that the leading cause of pressure ulceration was the use of external medical devices. Like Gallagher *et al.* (2009), study limitations are not discussed by the authors. Objectivity appears to be adhered to as the researchers provided preparatory training and did not only have an internal rater to collect the data. Also in the case of disagreement between the rater's findings, a further external rater was brought in (Schluer *et al.* 2009). Schluer *et al.* (2009) chose to use the Braden Scale to determine those at risk. The high validity and reliability of the Braden Scale has been widely published internationally.

Moore and Cowman (2012) explored the prevalence rate of pressure ulcers in the Irish long term care setting. Data were collected using visual skin assessment only with the use of the Braden Scale and the EPUAP pressure ulcer grading tool. Like Schluer *et al.* (2009), Moore and Cowman (2012) had an internal and external rater pair to collect the data. This ensured objectivity was maintained. It is not highlighted if preparatory training was provided for the internal rater prior to study commencement. Data were collected on 1100 participant's. Post data collection findings revealed a pressure ulcer prevalence rate of nine percent. Of this, fifty-six percent of pressure ulcers developed in those who were aged between 80-89. Moore and Cowman (2012) discussed the limitations of this study. Prevalence studies provides the reader with 'snapshot' (p. 368) of the problem, that is, pressure ulcers at one point in time. One cannot conclude with the exact risk factors that contribute to pressure ulcer development. However, as Moore and Cowman (2012) have stated, the purpose of this study was to provide an insight in to the problem of pressure ulcers in the long term care setting.

Primiano *et al.* (2011) looked at the prevalence rate of pressure ulcers and the associated risk factors for the surgical patient. Like Gethin *et al.* (2005), Tubaishat *et al.* (2007) and Moore & Cowman (2012) this study was a multi site study. Participants were aged eighteen or older and were scheduled for same day surgery that would last a minimum of three hours. To be included the participants also had to stay twenty-four hours in hospital post procedure (Primiano *et al.* 2011). Data were collected on 258 participants with twenty-one (8.1%) having developed a pressure ulcer. Similarly, to Schluer *et al.* (2009) and Moore & Cowman (2012), the Braden Scale was utilised to determine those at risk. Instead of using EPUAP pressure ulcer grading tool, Primiano *et al.* (2011) employed the NPUAP pressure ulcer grading system. External researchers collected the data relevant to this study ensuring objectivity (Primiano *et al.* 2011). Of the 8.1% who did develop a pressure ulcer, 73.3% were between the ages of forty-six to seventy-five (Primiano *et al.* 2011). Primiano *et al.* (2011) discussed the limitations of this study. They stated that this study is not a multi-site study; as data were only collected at one study site. Also Primiano *et al.* (2011) recognised that their findings cannot be generalised to all types of surgeries as they only included those which were guaranteed to last longer than three hours. As it was essential that the included participant's were scheduled for same day surgery as their admission day, it meant that those who were inpatients for a number of hours/days prior to surgery were not included, which could influence their pressure ulcer development risk (Primiano *et al.* 2011).

The final multi site study reviewed was carried out by Briggs *et al.* (2013). Briggs *et al.* (2013) who undertook a study examining the prevalence of pressure ulcers and pain at the pressure areas. This study was conducted across three large teaching hospitals during their annual pressure ulcer prevalence audits. Data were collected, like Schluer *et al.* (2009), and Moore and Cowman (2012), Briggs *et al.* (2013) using the EPUAP's pressure ulcer grading tool and a visual risk assessment tool. They did not specify which risk assessment tool was used in their study. The data were collected by a designated ward nurse who was previously trained in the use of the data collection form (Brigg *et al.* 2013). Regarding the collection of data regarding pain, it is stated if the patient was

reported 'well' (p. 2), a member of the tissue viability team proceeded with two pain questions. It is not highlighted throughout the study which pain questions were asked nor is specified what constituted the patient as 'well' (p.2). From the use of the visual skin assessment, the prevalence of pressure ulcers was recorded at 14.8%. Of the 2010 participant's who answered the two pain questions, pain prevalence was recorded at 16.3%. Pain was reported at pressure sites by 1769 participant's who displayed no visual signs of pressure ulcer development. The remaining 241 participants with pressure ulcers, the prevalence of pain was 43.2% (Briggs *et al.* 2013). The authors suggested that all patients should be assessed for pain even if they do not have a pressure ulcer. Briggs *et al.* (2013) discussed the methodological limitations of their study. Highlighted in chapter three of this dissertation is the importance of objectivity when conducting quantitative research. Briggs *et al.* (2013) stressed that data were collected by a designated ward nurse which may have resulted in the under reporting or misclassification of pressure ulcers. Also pain was recorded at the patient level and not by skin site. Therefore, it was possible to assess the level of pressure ulcer pain (Briggs *et al.* 2013). As the overall prevalence of pressure ulcers throughout the study sites was higher than the prevalence of pain, it is suggested that there was an under-estimation of the true prevalence of pain (Briggs *et al.* 2013). To conclude, Briggs *et al.* (2013) stated that these results provide a clear indication that a patient's pain must be measured at pressure sites even if they do not have a pressure ulcer.

In this current prevalence study elective surgical patients were included. Therefore, it was interesting to discover if other prevalence studies like Primiano *et al.* (2011) focused on the surgical patient. Webster *et al.* (2015) conducted a prevalence study which examined the prevalence rate of pressure ulcers in the peri-operative setting. Differing from Primiano *et al.* (2011), participant's had to undergo surgery which only had to last a minimum of thirty minutes. There were five hundred and thirty-four adult patients included (Webster *et al.* 2015). Again prevalence was measured by using visual skin assessment only. Visual skin assessment was carried out pre and post procedure (in the post anaesthetic unit). Skin health was not assessed again before discharge. Prior to study

commencement, training was provided in the use of the data collection tools (Webster *et al.* 2015). Similarly, to Schluer *et al.* (2011), Webster *et al.* (2015) had internal and external personnel to collect their data, ensuring objectivity throughout the study. Seven patient's (1.3%) had existing pressure ulcers and a further six (1.3%) developed a surgery-related pressure ulcer (Webster *et al.* 2015). Interestingly length of surgical procedure was found not to be associated with the development of the pressure ulcers. Rather, Webster *et al.* (2015) found that the risk factors associated with surgery-related pressure injuries were similar to non-surgically related risks as age, skin condition and being admitted from a location different from the patients' home. It is not specified if the included participant's had to spend a minimum amount of time in the study site post procedures so further assessment was not reported. In the study by Primiano *et al.* (2011), participant's had to be in patients for a minimum of twenty-four hours post procedure. Although limitations were not discussed, Webster *et al.* (2015) concluded their study by recommending that the peri-operative nurse undergo essential training regarding pressure ulcer assessment and classification. The prevalence of surgically acquired pressure ulcers was low in this study, careful skin inspection before and after surgery provides an opportunity for early treatment. This process may prevent existing lesions progressing to higher stages (Webster *et al.* 2015).

Table 1: International Pressure Ulcer Prevalence Rates of Included Studies

Authors (Country)	Prevalence Rates
Gethin <i>et al.</i> (2005) (Ireland)	12.5%
Vanderwee <i>et al.</i> (2007) (Europe)	18.1%
Gallagher <i>et al.</i> (2009)(Ireland)	18.5%
Schluer <i>et al.</i> (2009) (Switzerland)	27.7%
Moore & Cowman (2011) (Ireland)	9%
Primiano <i>et al.</i> (2011) (U.S.A)	8.1%
Tubaishat <i>et al.</i> (2011) (Jordan)	12%
Briggs <i>et al.</i> (2013) (U.K.)	14.8%
Webster <i>et al.</i> (2015) (U.S.A.)	1.3%

It appears that Ireland's pressure ulcer prevalence rates are in keeping with international figures (HSE 2009). All studies used the EPUAP/NPUAP's pressure ulcer grading tool to classify the pressure ulcers. The Braden scale appeared most popularly used tool to aid determine prevalence. With the reported rise in deep tissue injury/early pressure damage, one could question how visual risk assessment tools and pressure ulcer staging tools, would be the most appropriate method to measure pressure ulcer prevalence. Visual risk assessment tools and pressure ulcer grading tools assess the patient's skin health. Therefore, they would simply not detect those experiencing early pressure damage. Therefore, the aim of this study was to measure pressure ulcer prevalence in the acute hospital setting by investigating the value of using three different methods of pressure ulcer prevalence measurement. Visual risk assessment tools will now be discussed.

2.7. Visual Risk Assessment Tools

The purpose of risk assessment tools is to determine those at risk of pressure ulcer development. They are not a method to determine prevalence. Yet the use of visual risk assessment aids has been the most popular means of data collection in relation to pressure ulcer prevalence. However, risk assessment tools have been used to measure prevalence due to the type of information that they gather. Such crucial information includes but is not limited to activity status, age, gender continence and nutritional status which are believed to contribute to pressure ulcer development.

The most commonly used risk assessment tools are the Braden, Norton and Waterlow Score. The Braden score assesses aspects of the patient's level of risk of pressure ulcers development. The Braden scale uses six indicators: sensory perception, moisture, activity, mobility, nutrition, and friction or shear (see appendices one). A lower Braden scale score indicates a lower level of functioning and, therefore, a higher level of risk for pressure ulcer development. A score of 19 or higher indicates that the patient is at low risk, with no need for intervention (Bergstrom 1998). In 1998 Bergstrom *et al.* performed a multi-site study exploring the predictive validity of the Braden scale. This study was conducted in a variety of settings including tertiary care hospitals, Veterans Administration Medical Centres and skilled nursing facilities (Bergstrom *et al.* 1998). There were 843 participants'. Participants were randomly selected and had to be nineteen years old or older, who did not demonstrate any signs of pressure ulcer development to be included The participant was assessed on admission then at forty-eight hours and then at seventy-two hours (Bergstrom *et al.* 1998). Of the 843 participants, 108 developed a pressure ulcer (Bergstrom *et al.* 1998). The Braden scale scores were significantly lower in those who developed ulcers ($p=.0001$) (Bergstrom *et al.* 1998). Bergstrom *et al.* (1998) concluded that risk assessment on admission is highly predictive of pressure ulcer development in all settings (Bergstrom *et al.* 1998).

The Norton scale is also used to predict those at risk of pressure ulcer development. The Norton scale was the first pressure ulcer risk assessment that was developed (Eng & Chan 2013). Initially it was intended for use within a geriatric hospital population. The Norton scale is based on the researcher's clinical expertise and considers five domains relevant to skin condition (Eng & Chan 2013). The five domains include physical condition, mental condition, activity, mobility and incontinence. They are measured on a scale from one to four (Eng & Chan 2013) (see appendices two).

In 2015 Šáteková *et al.* conducted a study to determine the levels of predictive validity of pressure ulcer risk assessment tools. The Braden, Norton and Waterlow scales were chosen. This study was performed in the Slovak clinical setting. One hundred patient's staying in a long term care ward from April to August 2014 were included in this study (Šáteková *et al.* 2015). Like Bergstrom *et al.* (1998), to be included participant's had to be aged eighteen or older with no pressure ulcers on admission. The predictive validity of the risk assessment scales was evaluated based on sensitivity, specificity, positive and negative predictive values and the area under the receiver operating characteristic (ROC) curve (Šáteková *et al.* 2015). This study concluded by stating that the risk assessment tool with the best validity values was the Braden scale. In second place was the Norton scale and the Waterlow scale came in third place (Šáteková *et al.* 2015).

Although it scored poorly in the study by Šáteková *et al.* (2015), the Waterlow score is the risk assessment tool that the researcher was most familiar with and was used to gather data for the purpose of this study. The reliability and validity of the Waterlow score has been questioned numerous times. As it is the risk assessment tool of choice in this research study, the benefits and limitations of the Waterlow score have been discussed in great detail.

2.8. The Waterlow Score

The Waterlow score is the most popular pressure ulcer risk assessment tool used to detect visible pressure ulcers in Ireland and across the U.K. (Chamanga 2009). Looking at multiple risks it assesses the patient. Such risks included are as weight to height ratio, mobility, nutritional status, continence, age/gender, tissue malnutrition, neurological defects and surgery/trauma. Each risk is allocated a score. Patient's who score ≤ 10 are not at risk, those who score ≥ 10 are at risk, with ≥ 15 being high risk and finally scoring ≥ 20 one is considered very high risk of pressure ulcer development (see appendices three) (Chamanga 2009). The Waterlow score has been critiqued over the years. One apparent criticism is the lack of guidance on the scale itself making it difficult for novice clinicians to complete (Chamanga 2009). However, Waterlow herself insists that staff training is essential prior to the implementation of the tool.

Chamanga (2009) broke down each component of this tool and assessed if it was reliable. Considering the area of skin type Chamanga (2009) challenged the Waterlow score. Chamanga (2009) demonstrated that this is not specific regarding the location of the fragile or broken skin. For example, an individual may have fragile skin which results in a skin tear on the back of their hand. However, this skin tear does not impact their mobility which in return leads to the patient scoring an unnecessary high score on the Waterlow score (Chamanga 2009). This reinforces Cherry & Moss's (2010) study outcomes that mobility is the major cause of pressure ulcer development rather than other risk factors such as fragile skin. The Waterlow scale can effectively highlight areas of patient care which requires extra input from health care professionals, but Chamanga (2009) believes its use does not necessarily lead to the prevention of pressure ulcers alone.

2.8.1. Reliability of the Waterlow scale.

In order to be deemed reliable, the tool in question should reproduce similar results over time. Reliability is described as the ability of the same observer (intra-

rater reliability) or another observer (inter-rater reliability) to get the same scores. They should achieve the same scores in the absence of a change of condition (Thompson 2005).

Kelly (2005) conducted a study to determine why a lack of inter-rater reliability of the Waterlow scale existed. Kelly (2005) set out to discover if this lack of inter-rater reliability was a result of different perceptions of the patient by the nurse, or was it due to different interpretations of the Waterlow score by the nurse. A sample of 110 nurses who used the Waterlow scale on a daily basis were selected to take part. They attended a one-day refresher course focusing on pressure ulcer prevention. At the end of the session the nurse's were given an incomplete Waterlow score and asked to complete it using a case study that was provided the participant's were also instructed not to confer with each other (Kelly 2005). Collected data were analysed using Wilcoxon Signed Rank Test. This test is a non parametric test and is used to test if a median of a distribution is different from a specified value (Kelly 2005). The results of this study showed that nurses tend to over predict ($n=72$, 65%) rather than under predict ($n=25$, 23%) those who are at risk of pressure ulcer development (Kelly 2005). The Wilcoxon Signed Rank Test rejected the null hypothesis. There was no difference in the risk scores arrived at by the nurse's and the patients score ($T=827$, $P<0.001$) (Kelly 2005). There was no evidence of bias in this study as this type of study was not suitable to have participant's allocated to a specific group eliminating allocation bias and blinding. The Wilcoxon Signed Rank Test is a valid tool used for analysis. Similarly, to Saleh *et al.* (2009) the limitations of this study are not discussed. Although this study did prove poor inter-rater reliability of the Waterlow scale, it is important to note that health professionals are not applying them correctly (Kelly 2005). Like Saleh *et al.* (2009), Kelly (2005) recommends revisiting this health organisation to assess if improvements have been made and see that the Waterlow score is being used correctly.

2.8.2. Waterlow Validity.

According to Thompson (2005), to determine if a tool is valid is to assess its predictive ability. The results are consistent regardless of variables such as age or timing of assessment. There are two subcategories within predictive validity, sensitivity and specificity. Sensitivity is defined as, of those who develop pressure ulcers how many were identified by the tool as being of risk (true positive). Specificity looks at the patients who did not develop a pressure ulcer, the patients who were identified by the tool as not being at risk of pressure ulcer development (true negative) (Thompson 2005).

Webster *et al.* (2010) performed a longitudinal cohort study to assess the validity of the Waterlow screening tool. A total of 274 patients were included in the study. The mean age was 65.3 years (Webster *et al.* 2010). Fifteen participant's (5.5%) had existing pressure ulcers prior to hospital admission. A further 12 participants' (4.4%) developed a pressure ulcer during their hospital stay (Webster *et al.* 2010). Selection bias was not evident in this study as all participants' admitted to an internal medical ward were deemed suitable for inclusion. Validation of the Waterlow score prior to study commencement was not necessary as this study set out to validate the risk assessment tool. Seven research nurses performed the data collection which ensured objectivity throughout. Pressure ulcers were graded using NPUAP's pressure ulcer staging system. Two hundred participants were included in this study, of which forty-five (22.5%) were deemed at high risk of developing a pressure ulcer as they scored > 15 on the Waterlow scale. As discussed a score of >15 indicated that they are at very high risk of pressure ulcer development. Of the forty-five patient's, six patients' (13.3%) actually did develop a pressure ulcer (Webster *et al.* 2010). There were 155 participants' who were deemed not at risk and three (1.9%) of these participant's did actually go on to develop a pressure ulcer ($p=0.005$). Sensitivity was calculated at 0.67 (95% CI: 0.35-0.88) and specificity was calculated at 0.79 (95% CI: 0.73-0.85) (Webster *et al.* 2010). High false readings such as the ones reported in this study can lead to the misuse of resources (Webster *et al.* 2010). The authors highlighted that if they were to order pressure reducing equipment for those who scored high in this

study it would be unnecessary and furthermore unsustainable. Webster *et al.* (2010) suggested that more accurate methods to identify those at risk must be taken into consideration. The limitations of this study were acknowledged. Firstly, it was not always possible for the research nurse to directly view all of the patient's pressure points. When this happened the research nurse relied on the information that came from either the nurse caring for the patient, or from the patients' medical chart. This may have lead to an underestimation of pressure incidence because pressure ulcer development can reflect poor practice on behalf of the health care professional. Therefore, it may not be verbally reported or written in the medical notes (Webster *et al.* 2010 and O'Tuathail & Taqi. 2011).

In 2006 Pancorbo *et al.* conducted a systematic review to assess the validity of risk assessment tools. Pancorbo *et al.* (2006) included thirty-three studies. Three of the studies focused on clinical effectiveness while the remaining thirty studies focused on risk assessment validation. In the included studies the Braden, Norton and Waterlow scales are reviewed. Also considered are nurses' clinical judgement and how it contributed to pressure ulcer prevention. Like the study by Šáteková *et al.* (2015), their results showed that the Braden scale showed optimal validation with the best sensitivity (57.1%)/ specificity (67.5%) balance. The Braden scale was found to be a good pressure ulcer predictor (odds-ratio (OR) = 4.08, CI 95% = 2.56-6.48) (Pancorbo *et al.* 2006). The Norton scale proved to be a reasonable pressure ulcer predictor with its sensitivity calculated at 46.8% and specificity calculated at 61.8% and risk prediction (OR=2.05, CI 95% = 1.03-4.54). The Waterlow scale yielded a high sensitivity score of 82.4% but low specificity at 27.4%. The Waterlow scale risk predictor was noted to be good (OR= 2.05, CI 95% = 1.11- 3.76). This indicated that the scale over predicts those who are at risk. Therefore, prevention measures could be applied inappropriately. This echo's the study by Webster *et al.* (2010). This means greater expenditure on prevention equipment and more nursing time needed. (Pancorbo *et al.* 2006). This systematic review included three studies where the nurses' clinical judgement was considered. Clinical judgement yielded moderate results for sensitivity (50.6%) and specificity (60.1%). However clinical judgement was found to be a poor pressure ulcer risk predictor (OR=1.69, CI 95% = 0.76-3.75) (Pancorbo *et al.*

2006). Pancorbo *et al.* (2006) concluded their review by stating that risk assessment tools do not decrease the incidence of pressure ulcers, instead they offer guidelines for prevention intervention (Pancorbo *et al.* 2006).

In 2014 Moore & Cowman conducted a systematic review with its objective being to see if any pressure ulcer risk assessment used in any healthcare setting actually reduced the incidence of pressure ulcers. Moore & Cowman (2014) reviewed randomised control trials (RCTs) that compared the traditional pressure ulcer risk assessment tool with no structured pressure ulcer risk assessment, or with unaided clinical judgement. Moore & Cowman (2014) also reviewed RCTs which compared the use of different pressure ulcer risk assessment tools. To collect their data, two review authors independently assessed identified by the search strategy as suitable for inclusion. Two studies were included in this review. The first study was a small cluster RCT. There participants were allocated in to one of three groups. The first group were assessed using the Braden Scale, the second group were assessed by nurse's who were provided with training but did not utilise the Braden scale, and instead they employed a non-structured method of risk assessment. Finally the third group were assessed by nurse's who used the unstructured risk assessment tool alone, they did not receive any training. (Moore & Cowman 2014) Within the three groups no statistical difference was found between those who were assessed using the Braden risk assessment tool (n=74), those who were assessed by nurse's who had received training and also used non-structured risk assessment (n=76) (RR 0.97, 95% CI 0.53 to 1.77) and those who were assessed using the unstructured risk assessment tool only (n=106) (RR 1.43, 95% CI 0.77 to 2.68) (Moore & Cowman 2014). The second of the reviewed studies was a large single blind RCT which compared the effect of risk assessment tools on pressure ulcer incidence (Moore & Cowman 2014). These researchers used the Waterlow risk assessment tool (n=411), the Ramstadius risk assessment tool (n=420) and no formal risk assessment tool (n=420). Moore & Cowman (2014) stated that there was no statistical difference between the three groups Waterlow 7.5% (n=31), Ramstadius 5.4% (n=22) and clinical judgement 6.8% (n=28) (RR 1.10, 95% CI 0.68 to 1.81; Waterlow vs. clinical judgement), (RR 0.79, 95% CI 0.46 to 1.35; Ramstadius vs. clinical

judgement), (RR 1.44, 95% CI 0.85 to 2.44; Waterlow vs. Ramstadius). Moore & Cowman (2014) concluded that there is no evidence to suggest that the use of pressure ulcer risk assessment tools reduce the risk of pressure ulcer development. One of the studies that Moore & Cowman (2014) included is indeed the study conducted by Saleh *et al.* (2009), which is discussed previously. Like Moore & Cowman (2014), the writer also noted its' methodological limitations.

From studying the available literature regarding risk assessment tools, it is evident that the use of the Waterlow score alone is a poor pressure ulcer predictor (Kelly 2005, Webster *et al.* 2010, Pancorbo *et al.* 2006 and Moore & Cowman 2014). It has been stressed that the purpose of the Waterlow score or any visual risk assessment tool is to determine those at risk of pressure ulcer development. They are not a method of determining pressure ulcer prevalence. Yet the information that they gather draws researchers to them when conducting prevalence studies. Pressure ulcer grading tools examine the patient's skin only. However, expert's in tissue viability have reported that pressure ulcers are developing in the deep tissue, which is not visible to the healthcare professional until they reach an advanced stage. Therefore, it appears that the use of visual risk assessment tools and pressure ulcer grading tools alone will no longer suffice to determine those at risk of pressure ulcer development. With this indeed being reality, then it is possible pressure ulcer prevalence has been underestimated. Underestimating pressure ulcer prevalence could lead to necessary prevention strategies not being implemented and the inefficient allocation of nursing time and equipment.

2.9. Pressure Ulcers and Pain

Pressure ulcers cause pain with most patient's reporting the pain as constant (Gunes 2008). Words used to describe pressure ulcer pain are 'discomfort', 'horrible' and 'burning sensation' (Gunes 2008 p. 58). Langemo *et al.* (2000) stated that sometimes healthcare professionals are guilty of assuming what it is like to live with a pressure ulcer. In a qualitative study performed by Langemo *et al.* (2000), the development of pressure ulcers had a significant impact on the

participant's lives which included their social and physical status, loss of independence and change of body image. While Langemo *et al.* (2000) recognised that some feelings were shared among the participant's, it is essential that the healthcare professional views and treats all cases based on the individual patient's needs (Langemo *et al.* 2000).

2.10. What is Pain?

'Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage' (I.A.S.P 2002) (online).

It is believed that pain is what the patient says it is (Arber 2004). Initially pain appears straightforward, but is indeed quite complex in nature (Moseley 2007). It is important to consider that pain involves shock and loss of control. Pain can also leave one humiliated with loss of function (Nay & Fetherstonhaugh 2012). According to the reflective paper written by Nay & Fetherstonhaugh (2012) pain can present itself in three forms such as emotional, cognitive and physical (both acute and chronic) pain. Drawn from the authors (Nay & Fetherstonhaugh 2012) experiences, this study highlighted different themes and how these different themes can have huge effect on ones' life. The major theme that emerged to the writer was the importance of the nurse/patient relationship when it comes to effective pain management. Nay & Fetherstonhaugh (2012) highlighted that not all types of pain can be assessed using a pain scale. Nor is an assessment tool such as the pain scale suitable for all patient use. It cannot be stressed enough that how healthcare professionals responds to pain is vital (Nay & Fetherstonhaugh 2012).

There has been a surge of interest in the area of pain management with development of the pain medicine movement and the hospice and palliative care movement (Arber 2004). While these movements have been largely successful, some patients are still experiencing difficulties in relation to pain management (Arber 2004). van Dijk *et al.* (2012) recognise that effective pain management is

depends on reliable and appropriate pain assessment. While the writer does recognise the use of the numeric pain scale may not be suitable for all patient use, they understand that is still a universally used assessment tool.

2.11. Prevalence of Pain and Pressure Ulcers

Firstly, the researcher examined if the concept of measuring pain to determine pressure ulcer prevalence was previously carried out. Secondary to extensive reading this does not appear to be the case. Therefore, determining if pain is a predictor of pressure damage may be unique to this study. However, there have been numerous studies which measure pressure ulcer associated pain due to a developed pressure ulcer. While they examined pressure ulcer prevalence rates, Briggs *et al.* (2013), also examined the prevalence rate of pressure ulcer associated pain. This study was conducted across three large teaching hospitals and took place during their annual pressure ulcer prevalence audits. The data were collected by a designated ward nurse who received training in the use of the data collection form (Brigg *et al.* 2013). Briggs *et al.* (2013) stated that if the patient voiced they were 'well' (p. 2), then a member of the tissue viability team proceeded with two pain questions. As previously highlighted, it is not reported throughout the study which pain questions were asked by the nurse. In this study pain prevalence was recorded at 16.3%. Pain was reported at pressure sites by 1769 participant's who displayed no visual signs of pressure ulcer development. The remaining 241 participants with visible pressure ulcers demonstrated a pain prevalence rate of 43.2% (Brigg *et al.* 2013). It is suggested by Briggs *et al.* (2013), that all patients should be assessed for pain even if a pressure ulcer is not visible. Briggs *et al.* (2013) discussed the methodological limitations of their study. Pain was recorded at the patient level and not by skin site. Therefore, it was possible to assess the level of pressure ulcer pain (Briggs *et al.* 2013). Due to strict inclusion/exclusion criteria, not all participants were deemed 'well' (p.2). This meant that they were unable to partake in the pain prevalence audit. To conclude, Briggs *et al.* (2013) state that these results provide a clear indication that the presence of pain at pressure sites must be measured even if the patient does not have a visible pressure ulcer.

McGinnis *et al.* (2014) conducted a research study which examined pressure ulcer related pain in the community setting. This was a prevalence study which was conducted in two community National Health Service (NHS) sites in the North of England. It was the aim of McGinnis *et al.* (2014) to estimate the prevalence of pressure ulcer related pain. McGinnis *et al.* (2014) also explored the severity of the pain and looked at its association with pressure ulcer classification. To arrive at their findings McGinnis *et al.* (2014) conducted a cross sectional study of community nurse's case loads to identify adult patients with pressure ulcers and associated pain. Exclusion criteria included paediatric, obstetric, those close to death and psychiatric patients. Those suitable for inclusion were aged 18 and above and had an existing pressure ulcer. There were 176 participants'. Data were collected by community nurse's who were trained in the data collection process. It is unclear if these nurses' also provided direct patient care. The clinically validated Leeds assessment of Neuropathic Symptoms and Signs (LANSS) Scale (see appendices four) was used to assess pain. It allows the measurement of neuropathic and inflammatory pain (McGinnis *et al.* 2014). The skin assessments were performed by the community nurse, which was then verified through nursing records or the research nurse clinical assessment (McGinnis *et al.* 2014). These authors concluded that 75.6% of those with pressure ulcers reported pain. Interestingly pain intensity was not related to the severity of the pressure ulcer. The findings of this study had clinical significance for community nursing staff. Nurse's need to pay particular attention to the presence of pain, as it may be a clinical indicator of further pressure damage. Pressure ulcer associated pain needs to be recognised with the implementation of prevention strategies as an increase in pain levels may result decreased movement which will increase the risk of further pressure damage (McGinnis *et al.* 2014).

2.12. The Numeric Rating Scale

The reliability of the numeric pain scale has been discussed below as it is the pain assessment tool of choice for this prevalence study. While it focused on the diagnostic value of the numeric pain rating scale (NRS)/universal pain scale in

older patient's in the postoperative phase, van Dijk *et al.* (2012) set about examining the reliability of the NRS in the clinical setting. To complete their research, van Dijk *et al.* (2012) performed a cross-sectional study comparing an 11- point NRS against the verbal adjective rating scale (VRS). This VRS included no pain, little pain, painful but bearable, considerable pain and terrible pain. There were 2674 participant's. Exclusion included those who were admitted to the ICU post operatively, those with cognitive impairment and those who could not speak the Dutch language (van Dijk *et al.* 2012). Data were collected by trained research nurse's who were not involved in caring for the patient in the postoperative phase. This helped to eliminate bias. The collected data were then analysed using descriptive statistics. The NRS of >3 for unbearable pain demonstrated a sensitivity of 72% with a specificity of 97.2%. With the NRS reading >4, sensitivity increased to 83% with specificity at 96.7%. And a NRS >5 demonstrated a sensitivity of 94% while specificity was 85%. 75% of the participant's (>75 years) with painful but bearable pain considers NRS 4, 5 and 6 to this VRS category (FM van Dijk *et al.* 2012). van Dijk *et al.* (2012) concluded by stating that a large group of the participants with bearable pain would be incorrectly diagnosed with having unbearable pain. This could lead to the overtreatment with analgesics which in return may lead to dangerous adverse effects (van Dijk *et al.* 2012). van Dijk *et al.* (2012) recommended that pain management should be individualised rather than using the same cut off score for all older patient's. The limitations of this study were highlighted. Firstly, the authors only measured pain while the patient was at rest. Secondly the authors feel the order in which the two pain scores were asked may be considered a limitation. Like Nay & Fetherstonhaugh (2012). van Dijk *et al.* (2012) realised the importance of a good patient/nurse relationship in the effective management of pain. Nurse's should not solely rely on assessment tools such as the NRS/universal pain scale to determine their patient's pain.

Another study which explored the popular method of assessing pain, using NRS or as it's commonly referred to the universal pain scale (see appendices five) was performed by Krebs *et al.* (2007). This was a prospective diagnostic accuracy study. There were 275 participants. The NRS is frequently used in the primary care setting (Krebs *et al.* 2007). Krebs *et al.* (2007) explored the accuracy of the

NRS for patients with clinically important pain. In this study pain was broken down into two parts. Firstly, there was brief pain, this type of pain interfered with everyday functioning and secondly there was pain that motivates a physician visit (Krebs *et al.* 2007). The common locations for the participant's pain were lower extremities (21%) and back/neck (18%). The area under the receiver operator characteristic curve for the NRS as a test for pain that interferes with functioning was 0.76, indicating fair accuracy (Krebs *et al.* 2007). A pain screening NRS score of 1 was 69% sensitive (95% CI 60-78) for pain that interferes with functioning. The results were similar when NRS scores were evaluated against the pain that motivates a physician visit (Krebs *et al.* 2007). Krebs *et al.* (2007) concluded that further research and evaluation of the NRS is needed to ensure quality care is delivered in the primary care setting, as the most commonly used measure for pain screening may have only modest accuracy (Krebs *et al.* 2007).

The use of clinical judgement and effective communication skills is of course a vital step in the delivery of high quality patient care (van Dijk *et al.* 2012). This sentiment is echoed in the studies examined regarding the use of the Waterlow Scale. While assessment tools have been devised to assist the nurse in the deliverance of care, they are to be used as a guide and are not to be considered a replacement for clinical skills.

2.13. Alternative Pain Assessment Tools

Of course there are alternative pain assessment tools in circulation. Stites (2013) discussed these pain assessment tools throughout her review of observational pain scales. Firstly, Stites (2013) described the nonverbal pain assessment tool. This tool incorporates five domains which include emotion, movement, verbal cues, facial expressions and anatomical guarding (Stites 2013). There are two separate scoring systems on the instrument. These scoring systems can be used for both verbal and nonverbal patients (Stites 2013). Similarly, to the numeric pain scale, scores range from 0 to 10 points. The higher the score indicates the higher severity of pain (Stites 2013). Stites (2013) goes on to discuss the nonverbal adult pain scale. There are three domains within the nonverbal adult pain scale. Similarly, to the nonverbal pain assessment tool, the nonverbal pain scale

includes behavioural dimensions such as changes in facial expressions and anatomical guarding (Stites 2013). It also includes physiological dimensions such as heart and respiratory rates (Stites 2013). Finally, the third domain of the nonverbal pain scale includes autonomic indicators. These anatomical indicators include dilated pupils, diaphoresis, flushing, or pallor. Like the NSR and nonverbal pain assessment tool, the nonverbal pain scale uses a scoring system to determine pain severity with a score of zero indicating no pain and ten indicating maximum pain (Stites 2013).

Stites (2013) then described the behavioural pain scale. The behavioural pain scale identifies certain behaviours present in patients undergoing a noxious stimulus. The behavioural pain scale is composed of three observational items. These items are facial expression, upper limbs movement, and compliance with ventilation. They are scored from one to four, with higher numbers indicating higher levels of discomfort (Stites 2013). Finally, Stites (2013) discusses the critical care pain observation tool. Designed for use in both intubated and non-intubated critical care patients. It includes four domains. These domains are facial expressions, movements, muscle tension, and ventilator compliance (Stites 2013). Patient's are scored from zero indicating no pain to eight indicating high levels of pain (Stites 2013).

Pain is what the patient says it is, but it is important to take into consideration that some patients are not always truthful regarding their pain levels and may mask how their pain is actually affecting them. It is apparent that pain has a strong relationship with developed pressure ulcers. However, it does not appear evident that the concept of pain as a pressure damage indicator had been explored prior to the commencement of this study. To assess the pain levels of the participant's, the universal pain scale was chosen due to familiarity. Yet the existence of alternative pain assessment tools has been noted. The last method that was measured to determine pressure ulcer prevalence was the assessment of the participant's S.E.M. readings. Measuring S.E.M. and its possible benefits have been discussed

2.14. S.E.M.

2.14.1. Skin Physiology

To begin with, it is essential that the physiology of the skin is understood. The skin is the body's largest organ. Composition of the skin is made up of three layers, the epidermis, dermis and hypodermis (WHO 2009). The average epidermal thickness is 0.1mm and it renews itself approximately every 28 days. The most superficial layer of the epidermis is known as the stratum corneum. The function of the stratum corneum is to reduce water loss, protect against abrasives and act as a barrier to the environment (WHO 2009). The dermis, the middle layer of the skin, is a fibrous network of tissue that provides structure and resilience to the skin. On average the dermis is about 2 mm thick (WHO 2009). Finally, the third layer of the skin is the hypodermis. The function of the hypodermis is to store nutrients and energy. The hypodermis also insulates the body from cold temperatures and provides shock absorption (WHO 2009).

S.E.M is the water present in the tissue beneath the skin's surface. S.E.M. is a biophysical measure which means that it measures the physical changes that take place over a period of time. It can be used to assess the functional reliability of the epidermal barrier (Bates-Jensen *et al.* 2007, 2008, 2009 and Guihan *et al.* 2012). The relationship between elevated S.E.M readings and pressure ulcers are significant. This is evident in the studies by Bates-Jensen *et al.* (2007, 2008 and 2009) and Guihan *et al.* (2012) Elevated S.E.M readings that are associated with suspected deep tissue injury have been reported as early as three to ten days prior to visible skin damage in pressure ulcer development (Guihan *et al.* 2012).

2.14.2. The S.E.M Scanner

As previously discussed pressure ulcers are developing in the deep tissues and are not visible to the naked eye until they have reached an advanced stage (EPUAP/NPUAP 2014). This causes significant challenges to the early detection of pressure ulcer development. It is thought that measuring S.E.M may prove

useful in the early detection of pressure damage. Elevated S.E.M readings are indicative to an early inflammatory response that if left undetected and unresolved, could result in visible pressure damage. S.E.M is the water present in tissue beneath the skin's surface that if disturbed by pressure can lead inflammation. Being able to identify such inflammation is an ideal opportunity to detect tissue damage that is not yet visible. To successfully detect this inflammation a S.E.M. scanner would be used. In essence the S.E.M scanner measures the amount of moisture in the skin by projecting a low intensity electric current into the top layer of the skin (i.e. the dermis) (Bates-Jensen *et al.* 2007, 2008 and 2009). If the moisture readings recorded read 0.5 or above, then the person is potentially at risk of visible pressure damage at that site (Bruin Biometrics 2014). S.E.M levels are calculated by taking three readings at each anatomical site in question. The assessor then subtracts the lowest reading from the highest reading. This provides the assessor with their patient's S.E.M reading. Knowing the S.E.M readings allows prevention strategies to be implemented.

In 2015, Clendenin *et al.* performed a study examining the inter-rater and inter device agreement and the reliability of the S.E.M. scanner. There was a total of thirty-one participants'. To be included the participant's had to be eighteen years of age or older and free from pressure ulcers. They also had to be deemed fit to undergo the study's physical assessments (Clendenin *et al.* 2015). Prior to collection of the S.E.M. readings, the participant's remained in the supine position for a minimum of fifteen minutes. Three raters operated three devices (Clendenin *et al.* 2015). Four anatomical sites were chosen to take the S.E.M. readings from. These were the sternum, sacrum and the bilateral heels. The sternum was chosen as it is the least likely site to develop a pressure ulcer. Whereas the sacrum and the bilateral heels were chosen as they are the most popular areas to develop a pressure ulcer (Clendenin *et al.* 2015). The results of this study demonstrated that the agreement between raters was good with mean differences ranging from 0.01 to 0.11. Inter-rater and inter-device reliability exceeded 0.80 at all anatomical sites assessed (Clendenin *et al.* 2015). Clendenin *et al.* (2015) concluded by stating that the results of this study demonstrated the high reliability

and good agreement of the S.E.M. scanner across different raters and devices. Therefore, the S.E.M. scanner may prove beneficial as an objective, reliable tool in the assessment of pressure damage (Clendenin *et al.* 2015).

Remembering the four mechanisms of pressure ulcer aetiology, all are a direct result of compression of the tissues. Immobility is a risk factor that causes compression which results in pressure ulcer development. The compression of the tissues begins under the surface of the skin which is where measuring S.E.M. will be most effective. It appears that visual skin inspection will longer suffice as the only method to understand pressure ulcer prevalence rates. This is why the researcher will include the use of both pain and SEM assessments to collect their data. The understanding of the contribution deep tissue damage to the development of pressure ulcers is becoming more widely accepted. Hence, it vital, that healthcare professionals have the tools necessary to assist with early pressure ulcer detection.

2.14.3. Current S.E.M. Studies

To date there have been four research articles published examining the S.E.M and its relationship with early pressure ulcer detection. In 2007 Bates-Jensen *et al.* examined the relationship between a measure of S.E.M and visual skin assessment of erythema and stage one pressure ulcers. This descriptive, cohort study was conducted across two nursing homes with a total of 35 participants. The participant's had to be taking part in a larger nutritional study in order to be deemed suitable for inclusion. The rationale for this is unclear. As the participant's were not allocated in to different groups, bias did not appear evident. In order to complete this study, the research staff performed visual skin assessments and took S.E.M readings once a week over a 52-week period. The areas of inspection were the sacrum, ischial tuberosities, buttocks and right and left greater trochanters (Bates-Jensen *et al.* 2007). Research staff extracted the appropriate information from the participant's medical chart. The medical charts were reviewed monthly to document any changes in care. The Braden Scale was used

as the risk assessment tool of choice. It is presumed by the writer that these staff members received mandatory training in relation to the use of the Braden Scale however this is not specified. Often used in the medical and cosmetic industry, S.E.M was measured using the NOVA Petite dermal phase metre. This is a handheld device used for measuring skin hydration (Bates-Jensen *et al.* 2007). The common sites were assessed with this device one week after the visual skin assessment took place. The higher the reading indicated greater SEM (range - 999 dermal phase units [DPUs]). The visual skin inspections were rated as normal, erythema/stage one pressure ulcer, or stage 2+ pressure ulcers (Bates-Jensen *et al.* 2007). The S.E.M was modelled as a predictor for erythema of visual skin inspection and pressure ulcers one week later with concurrent moisture, Braden Scale pressure ulcer risk status, anatomic site and ethnicity as covariates (Bates-Jensen *et al.* 2007). Bates-Jensen *et al.* (2007) found that S.E.M readings were lowest for normal skin (97+/-122 DPU), higher for erythema/stage one (192+/- 188 DPU) and highest for stage 2+ pressure ulcers (569+/-320 DPU) across all sites ($P<0.001$). The S.E.M was found to be responsive to changes in visual skin assessments. The higher the S.E.M predicted the likelihood of erythema/stage one pressure ulcers the following week (Bates-Jensen *et al.* 2007). These researchers concluded that S.E.M readings indicated erythema, pressure ulcers and the future development of stage one pressure ulcers. Bates-Jensen *et al.* (2007) recommended the assessment of S.E.M, as it may predict the early stages of pressure ulcer development. Early detection will allow for earlier diagnosis and the commencement of appropriate treatment, to prevent further skin and tissue damage. Limitations of the study were not discussed by the authors.

A year later Bates-Jensen *et al.* (2008) re-conducted the study again taking place in two nursing homes. With 28 participants' this time, it appeared that the same method of data collection took place. Conducted over a 20-week period, the results of this study (Bates-Jensen *et al.* 2008) yielded similar results to that of the previous study (Bates-Jensen *et al.* 2007). Again visual assessment was rated as normal, erythema; stage 1 pressure ulcer or stage 2 pressure ulcers (Bates-

Jensen *et al.* 2008). Using a dermal phase meter, S.E.M was again measured. The higher the reading indicated the higher the S.E.M (range: 0-999 dermal phase units [DPU]) (Bates-Jensen *et al.* 2008). In this study the mean age of participants was 84.1 years, with 83% being female and 72% being non-Hispanic white (Bates-Jensen *et al.* 2008). Again S.E.M readings were lowest for normal skin (104 DPU, SD114). It gradually increased as the severity of the pressure ulcers increased, erythema (185 DPU, SD 138), stage 1 pressure ulcers (264 DPU, SD 208) and were highest for stage 2 and higher (727 DPU, SD 287) across all sites ($p<0.01$) (Bates-Jensen *et al.*2008). As proven in the previous study by Bates-Jensen *et al.* (2007), S.E.M was responsive to all visual assessment changes, differentiated between stage 1 pressure ulcers and erythema. The higher S.E.M reading predicted the greater chance of pressure ulcer development (Bates-Jensen *et al.* 2008). The findings of Bates-Jensen *et al.* (2008) supported the findings of the earlier work (Bates-Jensen *et al.* 2007), S.E.M may be useful for the early prediction of pressure ulcer development, and therefore early intervention can be implemented to prevent further pressure ulceration.

In 2009 using the data collected from the previously conducted studies, Bates-Jensen *et al.* (2009) set out to determine the relationship between S.E.M and pressure ulcer development for those with darker skin tones. Using a descriptive, cohort study design again, Bates-Jensen *et al.* (2009) had 66 participants' from across four nursing homes. Data were collected similarly to the previous two studies and recorded at the same time intervals. The results of this study also indicated that the higher the S.E.M reading increases the likelihood of pressure ulcer development for those with dark skin tones when re-assessed one week later (OR=1.88 for every 100 DPU increase in SEM, $P=0.004$) (Bates-Jensen *et al.* 2009). Interestingly when S.E.M was greater than 50, 150 and 300 DPU, those with darker skin tones were 8.5, 13 and 10 times more likely to develop stage 2 or higher pressure ulcers (Bates-Jensen *et al.* 2009). Bates-Jensen *et al.* (2009) compared these findings to those with lighter skin tones. Those with lighter skin tones were 7.2, 3.5 and 4.3 times more likely to present with stage 2 or higher pressure ulcers when SEM was 50, 150 and 300 DPU. S.E.M of 50 DPU was also

proven significant for detecting stage 1/erythema for those with dark skin tones (OR=5.3, 95% CI, 1.87-15.11, $P<0.001$). The results of this study also proved the benefits of measuring S.E.M as it can predict early pressure ulcer development. It may prove more difficult to perform visual skin inspection for people with darker skin tones; therefore, measuring S.E.M is an ideal method to detect early pressure damage and pressure ulcer development. Due to its small sample size, further research is recommended by the authors (Bates-Jensen *et al.* 2009).

While measuring S.E.M has proven useful for the early detection of pressure ulcers, it is not clear if measuring S.E.M would be possible for all types of patient's. In the studies by Bates-Jensen *et al.* (2007, 2008 & 2009), it is not specified if the participants were mobile or could be conveniently repositioned. Guihan *et al.* (2012) however did explore the effectiveness of S.E.M for the immobile patient. Guihan *et al.* (2012) examined those with spinal cord injuries (SCI), as it is well known that people with SCI are at high risk of pressure ulcer development. This is because of their mobility status, decreased sensory perception and other physiological changes (Guihan *et al.* 2012). Guihan *et al.* (2012) employed a prospective observational research design for their pilot study. The sample consisted of 34 veterans from two SCI centres. Twelve of the participant's received daily S.E.M and existing visual skin assessments while 22 were reviewed weekly for a period of 16 weeks. Like the studies performed by Bates-Jensen *et al.* (2007, 2008 & 2009), research staff collected the data. It is unclear which visual skin assessment tool was used, but unlike the previous studies Guihan *et al.* (2012) did make reference that the pressure ulcers were graded according to the NPUAPs 1998 staging classification. Like Bates-Jensen *et al.* (2007, 2008 & 2009), S.E.M was lowest for normal skin (39.3 DPU, SD 12.6). S.E.M was higher for stage 1 pressure ulcers/erythema (40.8 DPU, SD 10.4) across all anatomic sites (Guihan *et al.* 2012). Guihan *et al.* (2012) concluded that while this pilot study does indicate that measuring S.E.M for those with SCI may be beneficial, further research is needed (Guihan *et al.* 2012).

Healthcare professionals are reporting an increase in the number of deep tissue pressure ulcers, which is of great concern, as they are proving difficult to detect. To date, determining those at risk of pressure ulcer development is completed by carrying out visual risk assessment, but with the increase in deep tissue injury pressure ulcers being detected this method may no longer suffice. In recent years measuring S.E.M has proved successful in the early detection of pressure ulcers by researchers Bates-Jensen *et al.* (2007, 2008 & 2009) and Guihan *et al.* (2012). A hand held portable device the S.E.M. scanner provides the healthcare professional with objective readings. S.E.M. scanning is non invasive and provides rapid results (Bruin Biometrics 2014).

2.15. The Surgical Patient and Pressure Ulcer Development

It appears that the studies to date, that explored the relationship between pressure ulcer development and the surgical patient, have focused on surgeries that lasted >2.5 hours. (Cherry & Moss 2011, Jackson *et al.* 2011 and Primiano *et al.* 2011). Remembering pressure ulcer aetiology, muscle damage occurred when pressure was applied for as little as one hour (Husain 1953). If surgical patients have been experiencing pressure damage that has gone undetected then we may have been grossly underestimating pressure ulcer prevalence. As mentioned the majority of participant's (n=20) in this study were short stay surgical patient's. With this in mind, the existing studies that focus on the relationship between the surgical patient and pressure ulcer development have been examined.

The Dutch study by Schoonhoven *et al.* (2002) was performed to gain an insight in the problem that is surgical induced pressure ulcers. The aim of this study was to explore the incidence, clinical features and progression of pressure ulcers in patients undergoing surgery. Surgery in this study lasted longer than four hours (Schoonhoven *et al.* 2002). Schoonhoven *et al.* (2002) conducted a prospective follow up study in a university teaching hospital. Two hundred and eight patients were included in this study. The skin of each patient was assessed pre-operatively, in the immediate post-operative phase and then daily for fourteen

consecutive days, or until the patient was discharged, whichever occurred first (Schoonhoven *et al.* 2002). Skin was assessed with the use of a visual risk assessment tool only. Of the two hundred and eight participants, forty-four patients (21.2%) developed seventy pressure ulcers. These pressure ulcers occurred within the first two days post-operatively. More than half (52.9%) of the pressure ulcers developed on the heels with 15.7% having developed in the sacral area. Twenty-five (12%) of the participants were described as impaired by the pressure ulcers they developed (Schoonhoven *et al.* 2012). Taking the results of this study in to consideration, pressure ulcer development during a surgical procedure is a serious problem. Schoonhoven *et al.* (2002) suggested that preventative measures should be taken during surgery and in the first few days' post operatively, until the patient is able to mobilise independently.

To ensure objectivity throughout this study, the nurse's who delivered patient care did not collect the data. Data collection was carried out by the researcher and three observers (Schoonhoven *et al.* 2002). The observers were trained in data collection especially in the observation of pressure ulcers. Details such as length of surgery, posture during surgery and type of mattress on the operating table were noted. A qualitative description of the symptoms was then made (Schoonhoven *et al.* 2002). Statistical analysis was not appropriate due to the qualitative nature of the data collection (Schoonhoven *et al.* 2002).

Baumgarten *et al.* (2003) conducted a study that estimated the incidence of hospital acquired pressure ulcers among elderly patients, who were admitted to hospital due to a hip fracture (Baumgarten *et al.* 2003). This study took place across twenty hospitals in the USA. Data were collected by chart review, from admission to the 30th day post-surgery or until discharge (Baumgarten *et al.* 2003). The data were collected by trained study personnel using a standardised data extraction form. The cumulative incidence (CI) of pressure ulcers was defined as the number of patients with pressure ulcers at discharge divided by the number of patient's in total (Baumgarten *et al.* 2003). Baumgarten *et al.* (2003) used conditional logistic regression to estimate the association between pressure ulcers and the extrinsic risk factors collected. The presence of a pressure ulcer at

discharge was the outcome variable in this multivariable analysis (Baumgarten *et al.* 2003). Each extrinsic risk factor was entered as independent variables. Also entered was a comprehensive set of confounding variables which represented known or suspected risk factors for pressure ulcer development. These included age; sex, diabetes and activity of daily living (ADL) score (Baumgarten *et al.* 2003).

Lindquist *et al.* (2003) performed a retrospective chart review to determine if a relationship existed between sedative use and pressure ulcer development among older patient's. All participant's had to have been admitted to hospital with an existing skin ulcer. Lindquist *et al.* (2003) compared ulcer severity in those who had and who had not received sedative therapy during their admission. T-tests were used for continuous variables and chi-square tests were used for categorical variables in addition to multiple logistic regression analysis (Lindquist *et al.* 2003). While the researchers were aware that surgical patients were not included in this study, it demonstrated how the use of sedation which causes immobility leads to pressure ulcer development.

Cherry & Moss (2011) explored pressure ulcer development in surgical patient's too. Their findings suggested that a surgical procedure that lasts 2.5 hours or more, increases the risk of pressure ulcer development. Cherry & Moss (2011) also stated that in-fact anaesthetic agent's cause hypotension which in return causes peripheral hypo-perfusion.

Jackson *et al.* (2011) explored the area of pressure ulcer prevention in the intensive care unit (ICU). Here the authors stated that these clients are a greater risk of pressure ulcer development, due to their medical or surgical condition. They have usually undergone lengthy surgical procedures, have periods of paralysis and may be heavily sedated. The authors also highlighted that when

admitted to the I.C.U., patients tend to be in critical condition, therefore regular repositioning of the patient is difficult to achieve.

Primiano *et al.* (2011) looked at the prevalence rate of pressure ulcers and the associated risk factors for the surgical patient. This study is discussed at great length in relation to measuring prevalence in chapter two, the literature review. Surgery would last a minimum of three hours. Data were collected on 258 participants with twenty-one (8.1%) having developed a pressure ulcer. Like Schoonhoven *et al.* (2002), external researchers collected the data relevant to this study ensuring objectivity (Primiano *et al.* 2011). As it was essential that the included participant's were scheduled for same day surgery as their admission day, it meant that those who were inpatient's for a number of hours/days were not included, which could have influenced the outcomes of the study regarding pressure ulcer development risk (Primiano *et al.* 2011).

Chen *et al.* (2012) performed a systematic review which explored the incidence of pressure ulcers for the surgical patient over the past five years. The included studies were performed internationally. Seventeen studies which included 5, 451 patients were deemed suitable for inclusion. Of the seventeen studies, five were conducted in the United States (U.S.), three in the Netherlands, two in Brazil and the seven remaining studies were performed in the United Kingdom (U.K.), Canada, Korea, Czech Republic, Turkey, Sweden and Pan European countries (Chen *et al.* 2012). The included patients were divided in to four categories. Those who underwent surgery for hip fractures, those who underwent cardiac surgery, patients from the surgical intensive care unit (I.C.U.) and those patients who underwent other procedures such as shoulder surgeries, neurological surgeries and cardiothoracic surgery (Chen *et al.* 2012). The data extraction tool was not identified throughout this systematic review. However, it is stated that two reviewers extracted the data from the studies independently. Disagreements were resolved by a third reviewer. For the seventeen included studies, pressure ulcer incidence with 95% confidence intervals (C.I.) was computed. To complete the

meta-analysis, the overall pooled pressure ulcer incidence with 95% C.I. was estimated using Der Simonian and Lairds random-effects model (Chen *et al.* 2012). Using Cochran's Q test and I^2 statistic, heterogeneity was analysed. A P value of <0.05 indicated heterogeneity and an $I^2 >50\%$ indicated significant heterogeneity. All analysis was performed using Meta DiSc 1.4 (version 0.6) (Chen *et al.* 2012). The combined incidence of surgical related pressure ulcers was 0.15 (95% C.I. 0.14-0.16, I^2 98.2%). For those who underwent cardiac, hip and those from the surgical I.C.U. the combined incidence was 0.18 (95% C.I. 0.14-0.22, I^2 62.8%), 0.22 (95% C.I. 0.20-0.24, I^2 98.4%) and 0.11 (95% C.I. 0.09-0.13, I^2 98.5%) respectively (Chen *et al.* 2012). Chen *et al.* 2012 concluded that effective monitoring was essential, due to the significant number of surgery related pressure ulcers recorded.

In 2014, Wright *et al.* conducted a study which estimated the incidence of and identified the associated risks factors of pressure ulcer development. To be included in this study, participant's must have undergone surgery in the treatment of head and neck cancers. Participants were admitted under the care of the Combined Head and Neck Service, John Hunter Hospital from 2010 to 2012. Surgery had to last a minimum of 5 hours in duration (Wright *et al.* 2014). The predictor variables included a range of demographic, co-morbidity, and operative factors. The development of a pressure ulcer was the outcome variable. A multivariate logistic regression model was conducted to assess the relationship between the predictor variables and the outcome variable. Eighty-eight participants were deemed suitable for inclusion in this study. Thirteen patient's (14%) developed a pressure ulcer. Specifically, an increased risk of pressure ulcer development was seen with increasing patient age (54.5 ± 11.6 yr for pressure ulcer versus 63.1 ± 10.8 yr for no pressure ulcer, $P=0.01$) and increased time spent on the operating table (729 ± 79 minutes for pressure ulcer development versus 625 ± 158 minutes for no pressure ulcer development, $P=0.02$) (Wright *et al.* 2014). Wright *et al.* (2014) concluded their study by stating that pressure ulcer develops in patients who undergo prolonged head and neck surgery. As previously mentioned decreasing age and increasing operative time

were shown to be statistically significant factors in the development of pressure ulcers for this group of patient's (Wrights *et al.* 2014).

Recently, an American study examined the relationship between the time the patient spends in the operating theatre and hospital acquired pressure ulcers (Hayes *et al.* 2014). The researchers discovered that there were 931 hospital acquired pressure ulcers at their study site. Theatre time in the twenty-four hours prior to the pressure ulcer being recorded was associated with pressure ulcer development. Five percent of the hospital acquired pressure ulcers occurred within twenty-four hours post-operatively of surgeries, that lasted longer than four hours. 58% of hospital acquired pressure ulcers occurred five days post-operatively (Hayes *et al.* 2014). These researchers have discovered that extended surgery time was a risk factor for pressure ulcer development. They found that the majority of pressure ulcers do not appear in the immediate postoperative period. They concluded their study by stating that prevention efforts should focus on postoperative patient care, as this is when most hospital acquired pressure ulcers develop (Hayes *et al.* 2014).

From reading the literature above it is evident that relationship exists between surgery and pressure ulcer development (Schoonhoven *et al.* 2002., Baumgarten *et al.* 2003., Cherry & Moss 2011., Jackson *et al.* 2011, *Primiano et al.* 2011., Chen *et al.* 2012 and Vanderbilt University Medical Centre 2015). With the exception of Webster *et al.* (2015), what these research studies have in common is that the surgeries included all lasted > 2.5 hours. It was the intention of this researcher to determine if pressure damage is also a direct result of 'minor' surgery. While the findings of Webster *et al.* (2015) indicated that minor surgery does not result in pressure ulcer development, it is important to remember that the patient's skin was only visually examined. Therefore, the presence of pressure damage cannot be ruled out. As discussed surgery performed at this study site is elective surgery. There is no I.C.U. in the chosen study site as twenty-four hour anaesthetic cover is not available. There is however a high dependency unit

(H.D.U.), which is rarely needed for surgical admissions in the immediate post-operative phase.

2.16. Methodological Issues

2.16.1 Studies Pertaining to Waterlow

Of the studies that the writer included regarding the Waterlow scale, three were quantitative in nature (Kelly 2005, Saleh *et al.* 2009 & Webster *et al.* 2010). Two were systematic reviews (Pancorbo *et al.* 2006, Moore & Cowman 2014). Sample sizes varied across the three quantitative research studies, Kelly (2005) stated the sample size was 110 nurses' while Webster *et al.* (2010) had 200 in their sample. Saleh *et al.* (2009) did not mention the number of participant's they had for their study. Kelly (2005) described their sampling method. The sample were nurses who completed the Waterlow scale on a daily basis (Kelly 2005). Saleh *et al.* (2009) demonstrated bias, as they did not highlight how the healthcare professionals were allocated to each group. It also did not mention if the researchers were blinded to the allocation of the groups. Allocation bias was not an issue in the study by Webster *et al.* (2010). All patients admitted to an internal medicine ward were included. The author's did not need to obtain written consent from the participant's as visual skin inspection is part of the care provided. Saleh *et al.* (2009) also did not to obtain written consent for the same rationale. Research nurse's who were not involved in direct patient care, collected the data in all the included studies. Saleh *et al.* (2009) did not state which data collection tool was utilised; therefore, it was unclear if it was indeed a validated tool. Kelly (2005) used the validated Wilcoxon Signed Rank Test for data analysis. As the study by Webster *et al.* (2010) set about examining the validity of the Waterlow scale, it did not have to be deemed valid prior to the commencement of the study. Kelly (2005) and Saleh *et al.* (2009) did not discuss any limitation of their studies. However, Webster *et al.* (2010) did highlight their study limitations. As the research nurse collecting the data were not always able to directly view the patients pressure points, they relied either on the ward nurse providing direct patient care or the patients' medical records.

The writer also included two systematic reviews in their literature review (Pancorbo *et al.* 2006, Moore & Cowman 2014). For the purpose of appraising the included systematic reviews, the writer used the quality appraisal for systematic review tool (see appendices six). It appeared that the two included systematic reviews adhered to the five stages of conducting a systematic review. All the included literature concludes that, while the current risk assessment tools are useful, they are meant to act as a guide for healthcare professionals.

From reviewing the literature, it appears that the Waterlow score is not always accurate in predicting risk. Therefore, it is vital that all healthcare practitioners remember that a visual risk assessment score does not confidently predict those at risk of suspected deep tissue injury or replace clinical judgement. All patients should be considered at risk of developing a pressure ulcer if their mobility status is impaired.

2.16.2. Studies Pertaining to Pain

With the exception of one (Nay & Fetherstonhaugh 2012), all included studies relating to pain were quantitative (Krebs *et al.* 2007, van Dijk *et al.* 2012, McGinnis *et al.* 2014). The sample size for all of the included studies were large ranging from 176 -2675 participant's. Sampling methods were discussed by van Dijk *et al.* (2012) and McGinnis *et al.* (2014) but not by Krebs *et al.* (2007). Of the three studies, Krebs *et al.* (2007) did not mention how the data were collected. However, both studies by van Dijk *et al.* (2012) and McGinnis *et al.* (2014) did clarify their data collection methods. van Dijk *et al.* (2012) eliminated the chance of bias, as the research nurse's who collected the data were not involved in caring for the patient. This was unclear in the study by McGinnis *et al.* (2014). Regarding if the collection tools were validated, the studies by Krebs *et al.* (2007).and van Dijk *et al.* (2012) did not state what tools they used to collect their data. On the other hand, the study by McGinnis *et al.* (2014) did highlight that the clinically validated LANSS Scale was used to assess pain. van Dijk *et al.* (2012) are the only researchers to include study limitations. As mentioned one reflective paper

was included. Totally different in nature, a reflective paper does not have a sample or employ sampling methods. It does not utilise a data collection tool. Rather the purpose of a reflective paper is to dig deep in to a subject matter (Nay & Fetherstonhaugh 2012).

Neither study by Krebs *et al.* (2007) or by van Dijk *et al.* (2012) ensured the reader that the chosen pain scales were validated prior to study commencement.

2.16.3. Studies Pertaining to S.E.M.

All included studies were quantitative in nature. Three of the four studies regarding S.E.M were descriptive, cohort studies (Bates-Jensen *et al.* 2007, 2008 & 2009). The study by Guihan *et al.* (2012) used a prospective observational design. The sample sizes were small in all of the studies and sampling methods were described. Bates-Jensen *et al.* (2007, 2008 & 2009) recruited participant's who involved in a larger nutritional study only. In the study by Guihan *et al.* (2012), the sample were those with a SCI. Research staff collected the data in all four studies. While the three studies by Bates-Jensen *et al.* (2007, 2008 & 2009) utilised the Braden Scale which has been clinically validated, it was unclear if a validated tool was used by Guihan *et al.* (2012). There was no evidence of bias, as all the participant's received identical care in all the included studies (Bates-Jensen *et al.* 2007, 2008 & 2009, Guihan *et al.* 2012). The limitations that all studies highlighted were the small sample size. All author's recommended conducting further research (Bates-Jensen *et al.* 2007, 2008 & 2009, Guihan *et al.* 2012).

While the benefits of measuring S.E.M may seem clear, it is important to remember that there have only been four studies carried out which examine elevated S.E.M readings as an indicator of visible pressure ulcer development. As outlined by Bates-Jensen *et al.* (2007, 2008 & 2009) and Guihan *et al.* (2012) further research is warranted. Another consequence of these studies is that

sample sizes were small. Again this warrants further trials among a larger number of participants.

2.17 Summary.

To date, pressure ulcer prevalence studies have focused on using visual skin inspections only. As a result of this, it was decided upon to conduct a prevalence study which not only used visual skin inspection (the Waterlow score/EPUAP grading tool) but also incorporated assessing pain and S.E.M measures. While the Waterlow score is a popular visual skin assessment tool it has been found to over-predict those at risk of pressure ulcer development (Kelly 2005, Chamanga 2009 and Webster *et al.* 2010).

The latest understanding of pressure ulcers, is that they develop first in the deep tissues and are not visible to the naked eye. Therefore, determining those at risk of pressure ulcer development using a scale such as the Waterlow score is no longer deemed effective, as it assesses skin health only (Bouten *et al.* 2003).

Therefore, two new methods to determine pressure ulcers were included to see if they could predict early pressure damage. The additional methods used were pain assessment and S.E.M. assessment. The short stay surgical patient was included to determine if they too were at risk of elevated S.E.M readings. Armed with this information, enabled the researcher to better understand pressure ulcer prevalence rates in the acute hospital setting, especially for short stay surgical patients.

2.18 Conclusions

Until recently the first stage of pressure ulcers have been considered skin deep. Visual risk assessment tools have focused on visible skin health and therefore have been used to collect data pertaining to visible pressure ulcer prevalence. However, the rise in the number of suspected deep tissue injury has made us question if using visual risk assessment scores alone is sufficient. Therefore, to determine prevalence in this research study, it was decided upon to investigate

the value of using three methods to measure pressure ulcer prevalence. These methods are visual risk assessment, pain assessment and the assessment of S.E.M. readings.

When examining previously conducted prevalence studies, it was noted that a visual risk assessment tool alone (primarily the Braden score) was used to measure prevalence. Risk assessment tools are not intended to determine prevalence, but have been used by researchers to do so due to the relevance of the information they gather. As it is the traditional method to collect data regarding pressure ulcer prevalence, it was also included as a data collection tool in this study. It is fully realised that pain and developed pressure ulcers have a strong relationship. Yet it is unclear if the presence of pain at pressure sites could be considered a predictor to pressure ulcer development and therefore was included as a data collection tool in this study. To detect pressure damage, researchers such as Bates-Jensen *et al.* (20007, 2008 & 2009) along with Guihan *et al.* (2012) have focused some of their research in determining if elevated S.E.M. readings do result in the development of visible pressure ulcers. S.E.M. readings can be elevated from three to ten days prior to visible ulceration (Guihan *et al.* 2012).

The inclusion of the short stay surgical patient is invaluable to this study as a study objective was to identify what subset of this patient group is at risk of developing a pressure ulcer. Previous studies have explored the relationship between pressure ulcer development and the surgical patient (Cherry & Moss 2011, Jackson *et al.* 2011 and Primiano *et al.* 2013). However, with the exception of Webster *et al.* (2015), surgeries included in those studies lasted longer than 2.5 hours.

Using these three tools, may have given the researcher, a clearer insight into pressure ulcer prevalence rates in Ireland and determine who is at risk of pressure ulcer development. Throughout chapter three, the research process

including sampling techniques, data collection methods and data analysing, has been described in great detail.

Research Question:

What is the prevalence of pressure ulcers in an acute hospital setting while investigating the value of using three different methods of pressure ulcer prevalence measurement?

Chapter Three - Research Design

3.0 Introduction

In this chapter the most commonly used research methods, quantitative and qualitative, has been discussed. Positivism and interpretivism as research paradigms has been also briefly touched upon. Looking at previously conducted prevalence studies, their research designs have been examined with the advantages and disadvantages of such designs highlighted. The research method chosen for this prevalence study was explored. The rationale for using this research design was discussed. From here the chosen sampling methods was explored, again examining the previous prevalence studies sampling methods. The data collection and analysis methods used in the study was described. Finally, chapter three demonstrated how throughout this prevalence study reliability and validity were ensured.

3.1. Aims and Objectives

The aim of this study was to determine the prevalence of pressure ulcers in an acute hospital setting and investigate the value of using three different methods of pressure ulcer prevalence measurement.

Objectives

1. To evaluate if the current methods of pressure ulcer risk assessment are indeed the most accurate to determine pressure ulcer prevalence.
2. To determine if incorporating the measurement of pain and S.E.M will lead to more successful rates of early pressure ulcer detection.
3. To examine which patients are largely at risk of pressure ulcer development.

To answer the above, a prospective quantitative research method was used. Pressure ulcers prevalence and risk was measured using the Waterlow score with visual inspection (using EPUAP guidelines), sub epidermal moisture measurement (using the S.E.M scanner) and pain associated with pressure ulcer development. Patient's in an acute hospital, who were mainly short stay surgical patients, were followed over a three-day period with the measures of prevalence being taken each day. Recruitment took place from April to May 2105.

3.2 Research Methods

Research in healthcare is extremely important as it contributes to the ongoing success of medical intervention, in the treatment of chronic illness and disease. This is a result of research allowing the exploration of the effectiveness of services and care (Jones 2014). According to Rutherford-Hemming & Feliciano (2015), the most important component of the research study is the research question, as it guides the methodology.

It is thought that the chosen research methodology is the 'blueprint' of the study, as it outlines how the study will be conducted. (Rutherford-Hemming & Feliciano 2015 p.186). According to Parahoo (1997), Polit & Beck (2008) and Farrelly (2012) research design methods are divided into two main groups quantitative and qualitative. Quantitative research is a way to examine the hypothesis by exploring the relationship among variables (Ingham-Broomfield 2015). When one thinks of quantitative research they might be inclined to think of statistics and

numbers, as the quantitative research design focuses on gathering numerical data to explain a certain phenomenon (Parahoo 1997, Polit & Beck 2008 & Babbie 2010). Quantitative research is based on objective measurement and observation and is concerned with correlation and 'causation' (Ingham-Broomfield 2015 p. 33).

The other popular research design is qualitative research. Qualitative research focuses on answering questions, by collecting narrative data using a flexible research data collection tool, such as the use of questionnaires or by conducting interviews (Polit & Beck 2008, Farrelly 2012). Apart from nursing being considered a science, it is also considered an art, as it is patient centred and holistic (Parahoo 1997). Qualitative research design embraces this ethos, as it collects verbal data from the participant's usually in their natural and comfortable environment (Parahoo 1997, Polit & Beck 2008). Qualitative research can be broken down in to three categories such as fixed, flexible and responsive (Parahoo 1997, Polit & Beck 2008).

3.2.1. Philosophical Underpinnings

Quantitative research falls within the philosophical underpinning positivism. According to Polit and Beck (2008) positivism is based on the belief that the world is driven by natural causes. The researcher is always external and objectivity is essential (Parahoo 1997, Dodd 2008, Polit & Beck 2008 and Farrelly 2012). To achieve objectivity, the researcher and those under investigation must be independent of each other. In other words, the researcher must be capable of studying a phenomenon without influencing it or being influenced by it (Parahoo 1997, Dodd 2008, Polit & Beck 2008 and Farrelly 2012). The researcher has full control over the context of the study and all data is analysed statistically. The use of the positivist paradigm allows the researcher to statistically analyse the collected data. The aim of positivism is to measure and analyse relationships between variables within a 'value-free' environment (Farrelly 2012 p. 508).

Just as quantitative research is based on the philosophical underpinning of positivism, qualitative research is based on interpretivism. Qualitative researchers are of the opinion that there are multiple truths based on the participant's view of reality (Parahoo 1997, Dodd 2008, Polit & Beck 2008, and Farrelly 2012). In other words, people are constantly making sense of the world around them. Therefore, different people may have different interpretations of the same phenomena, for example living with pressure ulcers (Parahoo 1997, Polit & Beck 2008, and Farrelly 2012). In contrast to positivism, objectivity is not essential as interpretivism allows the investigator and participant to interact, integrating human interest in the study, thus creating findings that can be mutually created (Farrelly 2012).

In general, interpretivism is based on the following concepts. Firstly, there is relativist ontology. Relativist ontology perceives reality as inter-subjectively based on meanings and understandings at social and experiential levels (Farrelly 2012). Secondly, there is transactional or subjectivist epistemology. With transactional or subjectivist epistemology it is thought that we cannot be separated from what we know. In other words, there is a clear link between the researcher and research subject (Farrelly 2012).

3.3. Research Designs

A research design is the plan of how, when and where the data is to be collected and analysed (Parahoo 1997). There are four main research design categories that quantitative research is associated with. These are known as Descriptive, Correlational, Experimental and Quasi-experimental designs (Ingham-Broomfield 2015).

A descriptive research design looks at the characteristics of individuals or groups and the frequency of which certain phenomena occur (i.e. who are at risk of pressure ulcer development and when). To describe and summarise the data, descriptive research employs the use of statistics (Ingham-Broomfield 2015). Sampling in descriptive research can be simple random, stratified sampling,

proportionate stratified sampling and cluster sampling (Ingham-Broomfield 2015). In correlation studies, the relationship between the variables of interest are explored (i.e. SEM readings and pressure ulcer development). This takes place without any interference on the part of the researcher. Random sampling is used for this research design. Experimental research studies are best known as randomised control trials (RCT). Randomised control trials are viewed as the gold standard of research. Experimental research studies attempt to allow the researcher to take full control of the independent variable and then randomly allocate the participants to different groups (Ingham-Broomfield 2015). Sampling is random. Lastly, there are quasi-experimental research studies. Like randomised control trials, the researcher controls the independent variable, but the participants cannot be randomised to a particular group. Quasi-experimental studies are viewed as less influential secondary to the lower level of control of the researcher. Sampling in quasi-experimental studies are either for convenience or accidental (Parahoo 1997, Dodd, 2008, Polit & Beck 2008, Ingham-Broomfield 2015).

3.4. Research Designs of Previous Prevalence Studies

Looking at the previously conducted prevalence studies, it was noted that different research designs have been utilised. Four studies employed the cross-sectional study design (Schluer *et al.* 2009, Gallagher *et al.* 2009, Moore & Cowman 2012 & Briggs *et al.* 2013). The cross-sectional design was used by Gallagher *et al.* (2009) who examined the prevalence of pressure ulcers across three university teaching hospitals. Schluer *et al.* (2009) also used a cross-sectional study design to perform their research study examining the prevalence rate of pressure ulcer in the paediatric setting. Like Gallagher *et al.* (2009) and Briggs *et al.* (2013), Schluer *et al.* (2009) also conducted their study in a multicentre study environment. Moore and Cowman (2012) conducted a prevalence study across twelve long term care settings in the Republic of Ireland. A cross-sectional study design was used by these researchers. In 2013 Briggs *et al.* undertook a prevalence study which examined the prevalence of both pressure ulcers and pressure ulcer pain. To complete this study, Briggs *et al.* (2013) conducted a

multi-centre, cross sectional design. All of the included studies were conducted across multi-centre sites. A cross sectional study or as it is also known an observational study, allows the researcher to record information about their participant's without manipulating the environment. Cross-sectional studies compare different groups at a single point in time. An advantage of using cross-sectional research design is that, the researcher can compare many different variables at the same time (e.g. mobility and S.E.M readings with pressure ulcer development). However cross-sectional studies do not provide the reader with clear information regarding cause and effect relationships (Parahoo 1997, Polit & Beck 2008). As the data is collected from a single period in time it is not possible to examine the participant's more than once (Parahoo 1997, Polit & Beck 2008). In the study of Briggs *et al.* (2013), information was gathered from nine hospitals using a pressure ulcer pain survey during their annual pressure ulcer prevalence audits.

In 2011, Primiano *et al.* performed a pressure ulcer prevalence study using a prospective study design. Also known as a cohort study, a prospective study watches for outcomes, such as the development of a condition (such as pressure ulcer), during the study period and relates this to other factors such as suspected risk factors (e.g. increased pain/S.E.M readings). Prospective studies involve taking a cohort of participant's and examining them over a period of time. The outcome of interest should be common. If not, the number of outcomes observed will be too small and will not be statistically significant. There are many advantages and disadvantages regarding the use of the prospective research design documented in the literature. The main disadvantages are prospective studies can be financially costly as they may take a considerable amount of time to complete. Also they may be time consuming for the researcher. Finally, the researcher may have to follow a large group of participants for a very long time (Boston University School of Health 2015). However, prospective designs do have their advantages. Prospective studies allow the researcher to study more than one outcome and the incidence of the outcome can also be measured. Prospective studies allow the researcher to examine if the exposure which is seen to occur before outcome, gives some indication of cause of the effect (i.e. does

immobility cause pressure ulcer development) (Boston University School of Health 2015).

As outlined above, different researcher's have chosen different methods of research designs to conduct their prevalence studies. For the purpose of this research study, a prospective research design was used. The advantages of employing this research design has been briefly explained. A prospective research design allows the researcher to investigate a current concept, by seeking data that will be collected and then re-tested in the future (Parahoo 1997). Researcher's use the prospective design to gather information regarding their care practices on their patient's outcomes, over a period of time. The use of a cross-sectional study design would not be appropriate to use as this study will be performed over a three-day period. As previously stated, a cross-sectional study is used to determine prevalence at a single moment in time. Also, this research study aimed to challenge the methodologies of previously conducted prevalence studies. To do this, it was essential that the researcher explored the relationship and outcomes of the different variables. This was vital to discover if, the variables such as pain and elevated S.E.M readings, were indeed a precursor to pressure ulcer development. It was not possible to assess this if the researcher has used a cross-sectional study design. Therefore, the prospective design was the most appropriate design to use. As discussed there are many advantages of using a prospective research design, it allows the researcher to have full control over whom they include in their study and the researcher also has full control over how the data is collected (Parahoo 1997).

3.5. Population, Sample and Sampling

There are several considerations researcher's must take into account when choosing a sampling method (Kandola *et al.* 2014). These considerations include the research question, the target audience and the researcher's own experience (Kandola *et al.* 2014). To begin with, it is imperative that the researcher fully gathers data on the population under investigation as they may need to know

information regarding their gender, clinical status and reason for admission for example. Once the researcher has identified the target population, then sampling techniques can be considered (Kandola *et al.* 2014).

3.5.1. Sampling Techniques

Probability sampling is a sampling technique where the participant's are recruited in a process that gives all the participant's equal chances of being selected (LoBiondo-Wood & Haber, 2013). According to Bowling (2009), there are two main types of sampling techniques, probability sampling and non-probability sampling. Highly associated with the quantitative research method, probability sampling is ideal where a high level of control is necessary (Kandola *et al.* 2014). There are advantages and disadvantages to using the probability sampling technique. Probability sampling ensures a high level of representativeness. However, it is also can also be tedious and expensive to carry out. There are five main types of probability sampling. These are simple random sampling, systematic random sampling, stratified random sampling, cluster sampling and multi-stage sampling (Kandola *et al.* 2014).

Non-probability sampling is defined as the selection of participants from the population using non-random methods (Polit & Beck 2008). Such methods include convenience sampling, purposive sampling and snowball sampling (Kandola *et al.* 2014). These methods are used for where the researcher does not have access to the data needed, to use random sampling techniques (Kandola *et al.* 2014). There are advantages to using the non-probability sampling technique. Firstly, non-probability sampling allows the researcher to make descriptive comments, regarding the sample if desired. Also the non-probability sampling technique is quick, non-expensive and convenient. The disadvantage for using non-probability sampling is that, it can be viewed as biased, as the participant's are not chosen at random. They also might not represent what another population thinks (Kandola *et al.* 2014). In non-probability sampling, there is the concept of the convenience sampling method. With convenience sampling the researcher selects the sample

based on convenience. This is ideal for research being undertaken in the hospital setting as the participants selected to be part of the study's sample are there and are available to be tested (Kandola *et al.* 2014).

3.5.2 Sampling Techniques of Previous Prevalence Studies

Schluer *et al.* (2009) used the convenience sampling technique in their study. Looking at the prevalence rate of pressure ulcers in the paediatric setting, the sample included all hospitalised children that ranged from the age of twenty-four hours to seventeen years (Schluer *et al.* 2009). To be included, the children must have been admitted to the hospital for a minimum length of stay of twenty-four hours. Exclusion criteria included those who were admitted for less than the twenty-four-hour period; those admitted to the psychiatric units and children whose legal representatives did not allow participation (Schluer *et al.* 2009). Examining pressure ulcer prevalence and risk factors during prolonged surgical procedures Primiano *et al.* (2011) also utilised the convenience sampling technique. Inclusion criteria for this study included participant's over the age of eighteen only, who were scheduled for surgery that was expected to last a minimum of three hours. Also to be deemed suitable for inclusion, the participant must have been cared for in hospital for a minimum of twenty-four hours post-operatively. Exclusion criteria included pregnant women and prisoners (Primiano *et al.* 2009). Moore & Cowman (2012) appeared to have included a census of all patients across the twelve study sites. Determining the prevalence rate, 1100 residents were included. The convenience sampling technique was used by Briggs *et al.* (2013), who explored the prevalence of pressure ulcers and associated pain levels in hospitalised patients. Inclusion criteria for the pressure ulcer prevalence study were, all those over the age of eighteen who were admitted in hospital the day the prevalence study took place. Regarding the pain prevalence study, paediatric obstetric and psychiatric patients were deemed unsuitable for inclusion (Briggs *et al.* 2013).

3.5.3. Sampling Technique used in this Research Study

For this prevalence study, a convenience sampling technique was adopted. It is evident from the literature that this is a popular sampling method to use by researchers performing prevalence studies. Convenience sampling allowed the researcher to select participant's simply because they are accessible and available (Kandola *et al.* 2014). There are advantages and disadvantages to using a convenience sample. Firstly, a convenience sample may introduce selection bias and lead to under-representation of the population. Yet, it allowed the researcher to sample from an accessible population (Kandola *et al.* 2014).

All those eligible for inclusion were invited to take part. To be deemed eligible, the participant's needed to have been admitted to hospital, for twenty-four hours or more. Only those who were able to give informed consent were approached. Exclusion criteria included those who were cognitively impaired, as the ethics committee felt that approaching those or the families of those with cognitive impairment would have been inappropriate. Also those admitted for less than twenty-four hours (to the endoscopy suite or for day procedures) were excluded as they could not be followed up in the set time frame. This is where the convenience sampling method is evident. The use of convenience sampling was the most appropriate for this research study as it is a useful sampling method to use in the hospital setting, which is where this study took place. It was also an inexpensive method of sampling. Using convenience sampling allowed the researcher access to all suitable patient's in the study site to be tested.

3.6. Informed Consent

The selection criterion was applied to all patients admitted to the study site. Eligible participants were invited to enrol in the study by the researcher and were provided with a participant information leaflet (see appendices seven). The information leaflet described the rationale of the study, the study protocols and a sample of the consent form (see appendices eight). Participants were made aware of their ethical right to withdraw from the study without giving reason. The

patient was given a twenty-four-hour period of time to allow comprehension of the information given. Once informed consent was gained by the researcher, data collection began.

3.7. Data Collection Methods

The process of data collecting is described as the vital element of any research study (Rutherford-Hemming & Feliciano 2015). Rutherford-Hemming & Feliciano (2015) outline that if the study is of small sample size, the collection of data can be carried out by one researcher. Similarly, to the included prevalence studies used in this chapter (Gallagher *et al.* 2009, Primiano *et al.* 2009, Schluer *et al.* 2009, Moore & Cowman 2012 & Briggs *et al.* 2013), all data were collected and recorded using visual risk assessment tools and EPUAP's pressure ulcer grading tool. As discussed in chapters one and two, the purpose of using a risk assessment tool is to determine those at risk of pressure ulcer development. They were not designed to measure pressure ulcer prevalence. However, due to the type of information they gather (age, mobility and gender) they are used in prevalence studies to collect all relevant data. This is can also be said of pressure ulcer grading tools. This study had also employed a visual risk assessment tool, to assist in the data collection methods. However, while the aim of this study was to measure pressure ulcer prevalence, it was to complete this by investigating the value, of using three different methods (visual, pain and S.E.M.) to collect essential data and determine prevalence. The assessment of each patient over the three-day period is now briefly described.

3.8. Description of Participant Assessment

Day One: Each potential participant was provided with the patient information leaflet and given twenty-four hours to decide if they would like to partake. Participant assessment took place over three consecutive days. On day one, all participants who had consented, were risk assessed using the Waterlow screening tool. Visual skin inspections were carried out at the agreed anatomical

sites (bilateral shoulders, heels and sacrum) using EUAP's pressure ulcer grading tool. Pain at each anatomical site was then measured using the universal pain scale. Finally, S.E.M. readings were taken and recorded to confirm or deny the presence of pressure damage indicative of pressure ulcers.

Day Two: The above steps were repeated.

Day Three: The above steps were repeated.

Like Schoonhoven *et al.* (2002), the purpose of conducting this study over a three-day period was to gain insight into the problem of pressure ulcer development by describing the prevalence, clinical features and progression of pressure ulcers.

The application of this study method took about approximately fifteen minutes each day per subject. The data collection instruments for this study included the Waterlow screening tool, the universal pain scale and SEM measurements. EPUAP's grading pressure ulcer tool was used if visible pressure ulcers were detected. It is important to note that, whichever data collection tool is selected, the reliability and validity of the instrument are essential (Ingham-Broomfield 2015). These elements have been discussed throughout the literature review; however, have been touched upon again in this chapter.

3.9. EPUAP Grading Guidelines

The EPUAP minimum data set was used as the visual skin inspection tool. NPUAP, redefined the pressure ulcer in 2007. While they continued to use the four original stages of pressure ulcer development, they did however add two more stages of pressure ulcer development to their classification system (NPUAP 2007). In partnership with NPUAP and the Pan Pacific Pressure Injury Alliance (PPPIA), EPUAP (2014) released guidelines to assist all healthcare professionals in the prevention and treatment pressure ulcers. Its aim was to produce guidelines that were user friendly and which were suitable for use across all healthcare

settings, such as hospitals, long term care settings, the community setting and rehabilitation setting (EPUAP, NPUAP, PPPIA 2014). According to EPUAP, NPUAP and PPPIA (2014) pressure ulcers can be broken down in to four categories, grade 1 to grade 4. As discussed, grade 1 is the early onset of a pressure ulcer, where the skin appears intact but with non-blanchable erythema. Grade 4 is the other end of the spectrum, where there is full thickness tissue loss consisting of a deep wound cavity and tissue necrosis. It was NPUAP (2007) that suggested two new categories of pressure ulcers should be considered, unstageable and deep tissue injury.

In 2004, Defloor and Schoonhoven explored the inter-reliability of the EPUAP's pressure ulcer grading system using pressure ulcer photographs. A survey design method was used among pressure ulcer experts. Fifty-six photographs were presented to forty-four pressure ulcer experts. The multi-Rater-Kappa for the entire group of experts was 0.80 ($P < 0.001$). Various groups of experts obtained comparable results. Differences in classifications were mainly limited to one degree of difference. The inter-rater reliability of the EPUAP's classification system appears to be good, for the assessment of pressure ulcer photographs by experts (Defloor and Schoonhoven 2004).

3.10. The Waterlow Score

As discussed in chapter two, the Waterlow scale was devised as a guide for student nurses, and was introduced in to practice in 1985 and is the most commonly used risk assessment tool used to detect pressure ulcers across the United Kingdom and Ireland (Chamanga 2009). It assesses the patient looking at multiple risk factors and the scoring method is divided in to four categories. Those who score ≤ 10 are low risk, ≥ 10 are at risk, ≥ 15 are at high risk and those who score ≥ 20 are at very high risk (Chamanga 2009). The study by Kelly (2005) examined the inter-reliability of the Waterlow Scale. The results of this study shows that nurses tend to over predict rather than under predict those who are at risk of pressure ulcer development using the Waterlow score (Kelly 2005).

Webster *et al.* (2010) performed a study to assess the validity of the Waterlow screening tool. Sensitivity was calculated at 0.67 and specificity was calculated at 0.79 (Webster *et al.* 2010). The author's suggested that, more accurate methods to identify those at risk must be explored (Webster *et al.* 2010). Pancorbo *et al.* (2006) performed a systematic review to also assess the validity of popular risk assessment tools. In the studies the Braden, Norton and Waterlow scales were reviewed. The Waterlow scale yielded a high sensitivity score of 82.4% but low specificity at 27.4%, which indicated that the scale over predicts those who are at risk.

3.11. Numeric Pain Scale/Universal Pain Scale

It is understood that pain is a direct result of pressure ulcer development (Gunnes 2008, McGinnis *et al.* 2014). With this in mind, with the prevalence of deep tissue injury becoming more apparent, one would expect those at risk of the development of pressure ulcers would indeed experience pain before the ulcer becomes visible. Therefore, pain levels were assessed to determine if pain could be considered an indicator of early pressure damage and pressure ulcer development. Each participant's pain was measured using the universal pain scale. The universal pain scale allows the healthcare provider to assess the patient's pain, implement an action plan and evaluate if the action plan has been successful. Pain was assessed at each anatomical site where pressure ulcer development is most common. These sites (bilateral heels, shoulders and sacrum) are collectively known as pressure points. As described, the universal pain scale is divided in to three components of mild, moderate and severe pain. Each component is then assigned a range of numbers from one to ten, mild (1-4), moderate (5-7) and severe (8-10). The participant's pain levels were assessed (at the chosen anatomical sites) once a day over the three days. Examining on the diagnostic value of the numeric pain scale in older post-operative patient's, van Dijk *et al.* (2012) examined the reliability of the universal pain scale in the clinical setting. A score of >3 for unbearable pain, demonstrated a sensitivity of 72% and a specificity of 97.2%. With a pain reading >4, sensitivity increased to 83% with specificity at 96.7%. And a pain score >5, demonstrated a sensitivity of 94% while

specificity was 85 (van Dijk *et al.* 2012). van Dijk *et al.* (2012) concluded by stating that a large group of the patients with bearable pain would be incorrectly diagnosed with having unbearable pain. This could lead to the overtreatment with analgesics (van Dijk *et al.* 2012). Krebs *et al.* (2007) explored the accuracy of the numeric pain scale for patients who were deemed to have clinically important pain. A pain screening NRS score of 1 was 69% sensitive for pain that interferes with functioning. Like van Dijk *et al.* (2007), Krebs *et al.* (2007) concluded that further research is warranted, as the most commonly used measure for pain screening may have only modest accuracy (Krebs *et al.* 2007).

3.12. SEM

At each patient assessment, S.E.M readings were obtained, to determine if the included participants were experiencing signs of early pressure damage. S.E.M was measured once per day over the three-day period. The aim of using the S.E.M scanner in this study was, to provide information that health care professionals can use, in conjunction with the current standard of care methods for the early indication of pressure damage and deep tissue injury (Bruin Biometrics 2014). A hand held portable device that is easy to use, the S.E.M is non-invasive and provides the healthcare practitioner with immediate results (Bruin Biometrics 2014). Placed over the pressure point (i.e. sacrum), the S.E.M scanner provides the assessor with a reading. Five readings are taken at each site (one middle reading with four surrounding readings). To calculate the patients overall S.E.M score, the assessor subtracts the lowest reading from the highest reading. Those who score between 0-0.4 are not at risk of pressure damage. If the patient scores 0.5 or higher, this might indicate an inflammatory response of the skin which if left undetected/misdiagnosed could lead to the development of a visible pressure ulcer.

To date, four research studies have taken place which examined the validity and reliability of measuring S.E.M (Bates-Jensen *et al.* 2007, 2008, 2009 & Guihan *et al.* 2012). These studies in question have been described in great detail

throughout the literature review. In 2007 Bates-Jensen *et al.* examined the relationship between measuring S.E.M and visual skin assessment of erythema and stage one pressure ulcers. The S.E.M was found to be responsive to changes in visual skin assessments. The higher the S.E.M predicted the likelihood of erythema/stage one pressure ulcers the following week (Bates-Jensen *et al.* 2007). A year later Bates-Jensen *et al.* (2008) re-conducted the study again taking place in two nursing homes. S.E.M readings were lowest for normal skin. It gradually increased as the severity of the pressure ulcers increased, erythema, stage 1 pressure ulcers and were highest for stage 2 and higher (Bates-Jensen *et al.* 2008). As proven in the previous study by Bates-Jensen *et al.* (2007), S.E.M was responsive to all visual assessment changes and differentiated between stage 1 pressure ulcers and erythema. The higher S.E.M reading predicted the greater chance of pressure ulcer development (Bates-Jensen *et al.* 2008). In 2009 using data collected from the previously conducted studies, Bates-Jensen *et al.* (2009), looked at the relationship between S.E.M and pressure ulcer development for those with darker skin tones. The results of this study also indicated that the higher the S.E.M reading, increased the likelihood of pressure ulcer development for those with dark skin tones when re-assessed one week later (Bates-Jensen *et al.* 2009). As already highlighted, when S.E.M was greater than 50, 150 and 300 DPU, those with darker skin tones were 8.5, 13 and 10 times more likely to develop stage 2 or higher pressure ulcers (Bates-Jensen *et al.* 2009). Bates-Jensen *et al.* (2009) compared these findings to those with lighter skin tones. Those with lighter skin tones were 7.2, 3.5 and 4.3 times more likely to present with stage 2 or higher pressure ulcers when SEM was 50, 150 and 300 DPU. S.E.M of 50 DPU was also proven significant for detecting stage 1/erythema for those with dark skin tones. Guihan *et al.* (2012) explored the effectiveness of S.E.M for the immobile patient. The sample consisted of 34 veterans from two SCI centres. Like Bates-Jensen *et al.* (2007, 2008 & 2009), S.E.M was lowest for normal skin. S.E.M was higher for stage 1 pressure ulcers/erythema across all anatomic sites (Guihan *et al.* 2012). Guihan *et al.* (2012) concluded that while this pilot study does indicate that measuring S.E.M for those with SCI may be beneficial, further research is needed (Guihan *et al.* 2012).

3.13. Data Analysis

For the purpose of this research study, descriptive statistics were used to describe the data. Correlation was then employed to explore the relationships between the variables. Statistical Package for the Social Sciences for statistical analysis version 21.0 was used to analyse the data. SPSS is a Microsoft Windows based programme that can be used to perform data entry and analysis and to create tables and graphs. SPSS handles large amounts of data and can perform all of the analyses covered in the text. SPSS is commonly used in the healthcare. To analyse the collected data, simple descriptive statistics were employed to describe the demographic and to determine prevalence/incidence and reporting of risk factors. These have been presented using tables and graphs in chapter four. This was the most appropriate type of data analysis to utilise, as Parahoo (1997) highlights, those who undertake quantitative research use agreed terminologies or phrases to present their findings. The researchers present the main features of their study, which provides the reader with a good idea of the findings without having to use 'crude data' (Parahoo 1997 p.342). Pearson Correlation (r) 2-tailed analysis was used to determine which factors (EPUAP, pain or SEM), most accurately indicated the risk of pressure ulcer development. Statistical significance was determined by *p* values which were <0.01 and <0.05 respectively. Correlations were run using different combinations of variables.

Rutherford-Hemming & Feliciano (2015) states that data analysis can prove to be a tedious process if large quantities of data needs to be analysed. It is recommended that, a statistician may be the best resource to help complete this process as they can verify the findings before publication (Rutherford-Hemming & Feliciano 2015). As clinical healthcare providers are usually unfamiliar with statistical analysis, it is suggested that a collaborative approach between a research team is most desirable (Rutherford-Hemming-Feliciano 2015).

3.14. Rigour and Trustworthiness of this Study

The reliability and validity of the Waterlow scale, pain scale and S.E.M has been previously discussed in this chapter. It is acknowledged that the Waterlow and pain scale performed moderately in these included studies. S.E.M. appeared to yield more positive results, yet it could be argued that it is still a relatively new product, with further research deemed necessary. All the data was collected by the researcher ensuring that there will be no discrepancies within the scoring method. Throughout the study, the researcher assessed the participant's themselves only ensuring objectivity. This meant that there was no change in the normal care provided to the participant/patient. This produced more reliable results. It is not unusual to note in clinical practice, that there might be a difference of opinion when for example grading pressure ulcers. This idea has been highlighted by previous researcher's and also this researcher in the literature review of this study. Also as stated in positivism research, the researcher is always independent of the participant ensuring objectivity at all times. While hospital staff was informed of the study, it was stressed that their clinical practice was not under scrutiny. And it was explained that this research study would include fresh risk assessment tools. In this, it should not have influenced their normal care for their patient.

3.15. Ethical Consideration

Ethical approval was sought and gained by the appropriate ethics committee. The ethics committee was provided with all the relevant data pertaining to the study. A meeting was then held by the ethics board where they have the opportunity to put questions to the researcher regarding the research proposal. The study was ready for commencement once ethical approval was gained, once granted participant recruitment could commence. To ensure confidentiality, each participant's identity was completely anonymous. This was achieved by assigning a unique identification number to each participant. All data were recorded electronically. Electronic records were stored on a password protected laptop computer at the study site. Paper records were stored in a locked cabinet on the ward at the study

site. As per the RCSI policy, the collected data will be stored securely for five years (on the V drive) then destroyed.

Nursing research studies require the permission of an ethics committee. This is because, the researcher is obliged to take in to consideration the implications of the proposed research for the participant's (Ingham-Broomfield 2015). It is the nurses' responsibility to maintain confidentiality at all times and this is the same in nursing research. Obtaining the participant's consent is vital after full explanation of the studies intent, prior to the commencement of the study. Finally, it is essential that the participants fully understand that they are fully entitled to withdraw from the study at any stage without penalty (Ingham-Broomfield 2015).

3.16. Summary

In this chapter, the research methods that was be employed by previous researchers in order to complete their studies has been discussed. While there have been numerous prevalence studies conducted in the acute hospital, there have been no prevalence studies conducted to date, which include examining pain and S.E.M levels to aid determine pressure ulcer prevalence. Upon the completion of the data collection, simple descriptive analysis was used to analysis the data. To ensure reliability and validity, the study was performed independently, to ensure no discrepancies occurred while assessing the patient's. Ethical approval was sought and gained prior to the commencement of the study. In chapter four the findings of this research study has been presented.

3.17 Conclusions

The aim of this study was to measure pressure ulcer prevalence in the acute hospital setting and investigate the value of using three different methods of pressure ulcer prevalence measurement. To successfully complete this study, it was essential that the researcher employed the appropriate research design, data collection methods and analysis methods. This provided the researcher with the

tools necessary to measure pressure ulcer prevalence rates. The findings of this study has been explored in chapter four.

Chapter Four - Findings

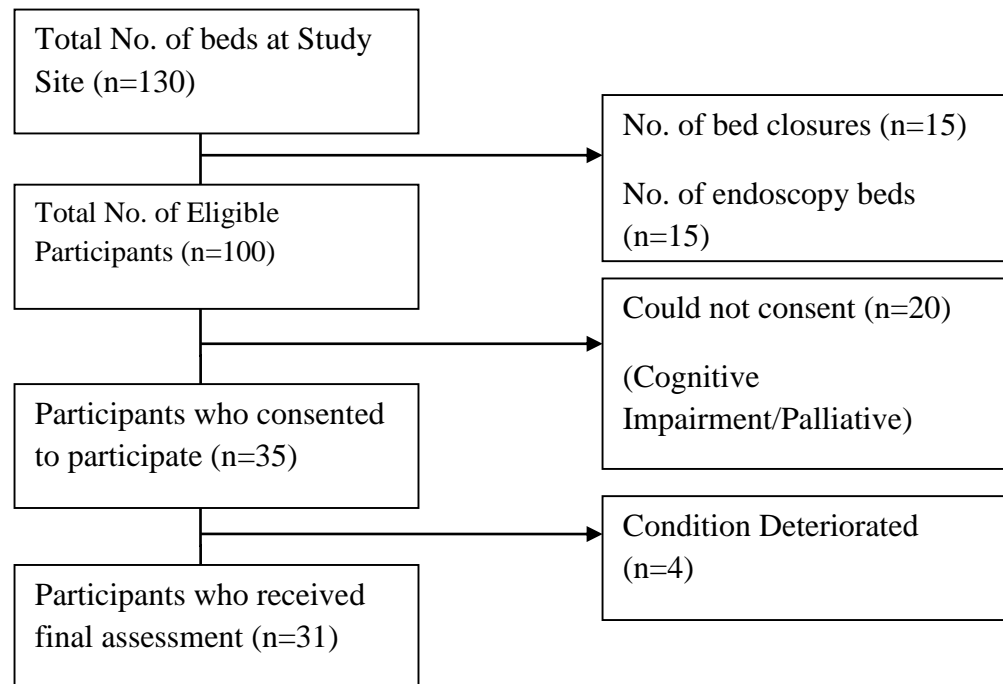
4.0 Introduction

The aim of this study was to determine the prevalence of pressure ulcers in an acute hospital setting and challenge the methodologies currently in use to determine pressure ulcer prevalence. Previous prevalence studies have focused their data collection on the traditional method of visual risk assessment. This study was carried out by completing yet another prevalence study that also used visual risk assessment but with also the addition of evaluating pain levels and measuring S.E.M. readings. Assessing pain levels were included, as pressure ulcers have a strong association with pain. S.E.M was measured as there has been a surge in the number of deep tissue pressure ulcers identified in clinical practice.

4.1. Recruitment

Recruitment took place from April to May 2015. The chosen study site has a 130 bed capacity. Those admitted for greater than twenty-four hours were deemed suitable for inclusion only. The endoscopy suite holds a capacity of fifteen patients', therefore 115 patients were eligible to be included. Bed closures eliminated another fifteen patients'. Thirty-five patient's were deemed eligible for inclusion, thirty-one patient's consented to take part. The flow of patients in the study is outlined below.

Fig 1: Recruitment flow chart



4.2. Sample Description

The majority of participants in this study were 14-49 age with 67.7% of participants under the age of 65. From the beginning there was an interest in the inclusion of the surgical patient. There is a common misconception that pressure ulcers are developed by the frail and elderly. Yet if we are to look at the work of Primiano *et al.* (2011) it is evident that, this is not the case.

All those suitable for inclusion were invited to take part. To be deemed suitable, the participant's needed to have been admitted to hospital for more than twenty-four hours. Only those who were independently able to give consent to take part were approached. Exclusion criteria included those who were cognitively impaired. The ethics committee felt that the inclusion of these patients would have been inappropriate. There were thirty-one participants' in total. Twenty (64.5%) of the participants were elective surgical patients. Various surgeries are performed at the study site ranging from ear, nose and throat (ENT) to orthopaedic, to gynaecological, to general surgery i.e. laparoscopic cholecystectomy/hernia

repairs. Table two outlines the number of participants who underwent each surgical procedure.

Table 2: Surgical Patients

Types of Surgeries	No. of Surgical Patients
Laparoscopic Cholecystectomy	3
Anterior/Posterior Vaginal Repair	3
Hernia Repair	3
Anterior Cruciate Ligament Repair	2
Bladder Tumour Check	1
Corrective Foot Surgery	3
Tonsillectomy	3
Septoplasty	1
Colostomy Commencement	1

Surgeries lasted on average 1.2 hours. All participant's spent time in the post anaesthetic recovery unit (PACU). It is the study sites policy that the minimum time a patient should spend in the PACU is thirty minutes. This of course is subject to change due to the type of surgery carried out and as a person's recovery time is very individual. It was not evident that these participants' spent more than the recommended time frame in the PACU. It is routine practice that patients are admitted to the elective surgical unit for approximately two to four days. Again the length of stay per patient was dependent on the type of surgery performed.

4.3. Sample Demographics

The study was performed in an adult clinical setting. Of the thirty-one included patient's fourteen (45.2%) were male and seventeen (54.8%) were female. The

largest number of participant's (41.9%) was in the 14-49 age group with twenty-one (67.7%) participant's under the age of 65. Twenty (64.5%) of the participants were elective surgical patients. The remaining eleven (35.4%) participants were admitted through the Emergency Department (ED) secondary to exacerbation of chronic obstructive pulmonary disease (COPD) (6.4%), investigation of chest pain (6.4%), unstable blood glucose levels (3.2%), shortness of breath (3.2%), general malaise (9.6%) and social circumstances (6.4%).

4.3.1. Waterlow Scores

All participants were risk assessed by staff using the Waterlow score. The mean (\pm SD) of the Waterlow score was 6.8 (\pm 4.0). In this study the lowest score was two while the highest score was sixteen. Based on the overall Waterlow scores of the participant's, the majority of participant's (93.5%) were considered low risk as they scored below ten. The Waterlow score is divided into subcategories including B.M.I. readings, skin type, mobility status, nutritional status and continence status. The participant's mobility status was the only fluctuating subheading for the included participant's. This is a direct result of twenty participants' (64.5%) were indeed surgical patients, that experienced general or spinal anaesthesia, therefore changing their mobility status for a period of time. Mobility is measured through the use of five subheadings which are fully mobile, restless, apathetic, restricted, chair bound and bed bound. Table three below demonstrates the changes in mobility over the course of the study period and shows how the majority of participants went from being fully mobile on day one, immobile on day two and back to being fully mobile on day three.

Table 3: Mobility Scores

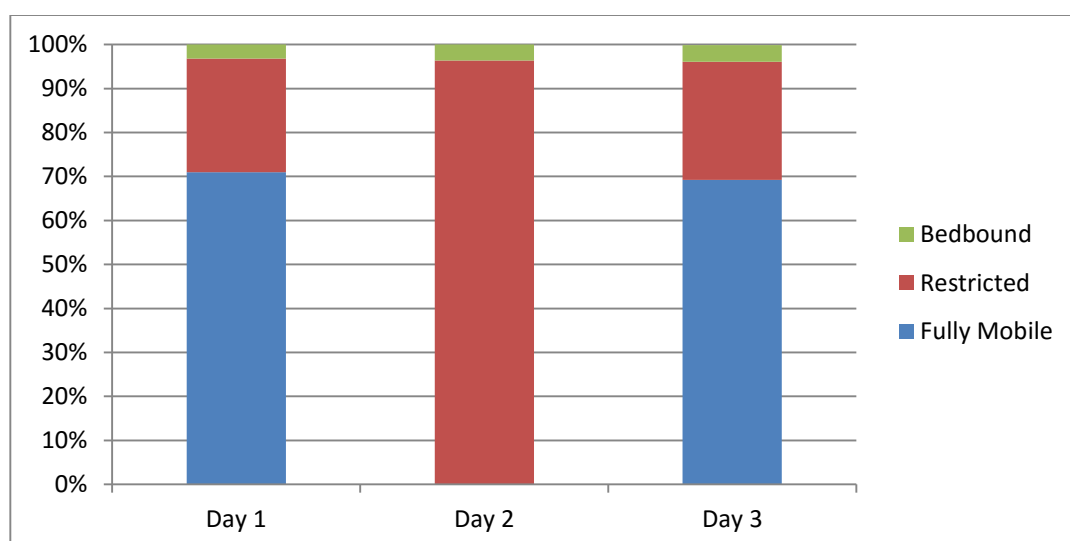


Table four below demonstrates the overall demographic data of this study and how the participant's scored in each sub-category throughout the Waterlow score. It is evident from the above chart that on days one and three the majority of patients were fully mobile. It was on day two that the highest incidence of immobility was documented. This is a direct result that twenty of the thirty-one participants were surgical patients and underwent their procedures on day two. They were assessed in the immediate post-operative phase.

Table 4: Overall Demographic Data (n=31)**Baseline Characteristics**

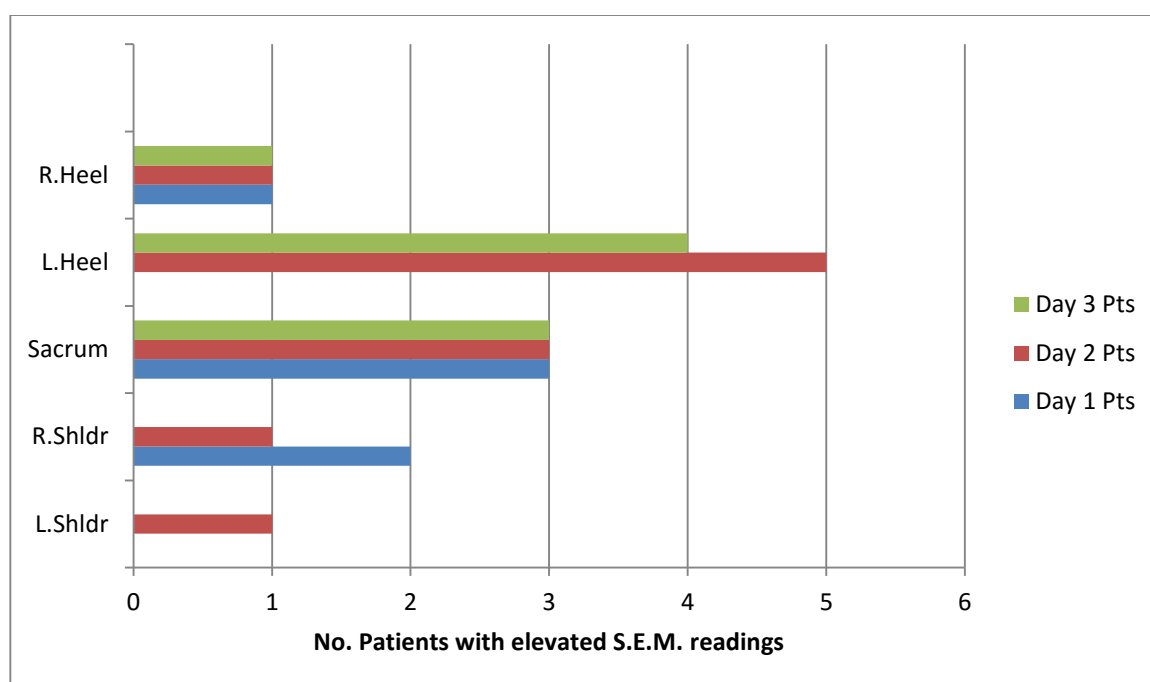
		% (n=no. of participants)
Gender	Male	45.2% (n=14)
	Female	54.8% (n=17)
Presenting Condition	Surgery	64.5% (n=20)
	Exacerbation of C.O.P.D.	6.4% (n=2)
	Chest Pain	6.4% (n=2)
	Unstable BGL	3.2% (n=1)
	Increased S.O.B.	3.2% (n=1)
	Social Acopia	6.4% (n=2)
	General Malaise	9.6% (n=3)
Individual Components of Risk Scores		
<u>BMI</u>	Average	80.6% (n=25)
	Above Average	6.5% (n=2)
	Below Average	12.9% (n=4)
<u>Skin Type</u>	Healthy	64.5% (n=20)
	Dry/Oedematous	35.5% (n=11)
<u>Weight Loss</u>		
	Yes	3.2% (n=1)
	No	96.8% (n=30)
<u>Continent</u>	Yes	100% (n=31)
<u>Tissue Malnutrition</u>		
	Yes	41.9% (n=13)
	No	58% (n=18)
<u>Neurological Defects</u>	No	100% (n=31)
<u>Major Surgery/Trauma</u>	No	100% (n=31)
Mobility Status		
Day 1	Fully Mobile	71% (n=22)
	Restricted	25.8% (n=8)
	Bedbound	3.2% (n=1)
Day 2	Fully Mobile	0% (n=0)
	Restricted	96.4% (n=27)
	Bedbound	3.6% (n=1)
Day 3	Fully Mobile	69.2% (n=18)
	Restricted	26.9% (n=7)
	Bedbound	3.8% (n=1)

(*Day 2 figures are based on 28 participants; Day 3 figures are based on 26 participants)

4.4. S.E.M. Readings

S.E.M. was measured at each anatomical site (bilateral shoulders, heels and sacrum) once a day over the three-day period. As per Bruin Biometrics (2014) guidelines, those who scored between 0-0.4 were considered not to be predisposed to early stage pressure damage/pressure ulcer development. Scores of ≥ 0.5 are indicative of an early inflammatory response. To determine the patient's S.E.M levels, the lowest reading is subtracted from the highest reading. This is the number of interest, as it informs the assessor if the patient is illustrating abnormal S.E.M levels. One participant (3.2%) illustrated elevated S.E.M. readings on day two for the left shoulder. For the right shoulder elevated S.E.M. readings were noted to be elevated for two participants on day one (6.4%) and returned to one participant on day two (3.2%) but had resolved by day three. Elevated S.E.M. readings were recorded on all three days for the sacral area for two participants (9.6%). On day two five participant's (16.2%) and on day three, four participants' (12.9%) demonstrated that S.E.M. was elevated on the left heel. Finally, the right heel showed elevated S.E.M. readings for one participant on days one to three (3.2%). Over the three days, participants were lost due to early discharge. Three (9.7%) were lost on day two with five (16.1%) lost on day three. Those whose S.E.M. readings ranged between 0-0.4 are illustrated below in table five.

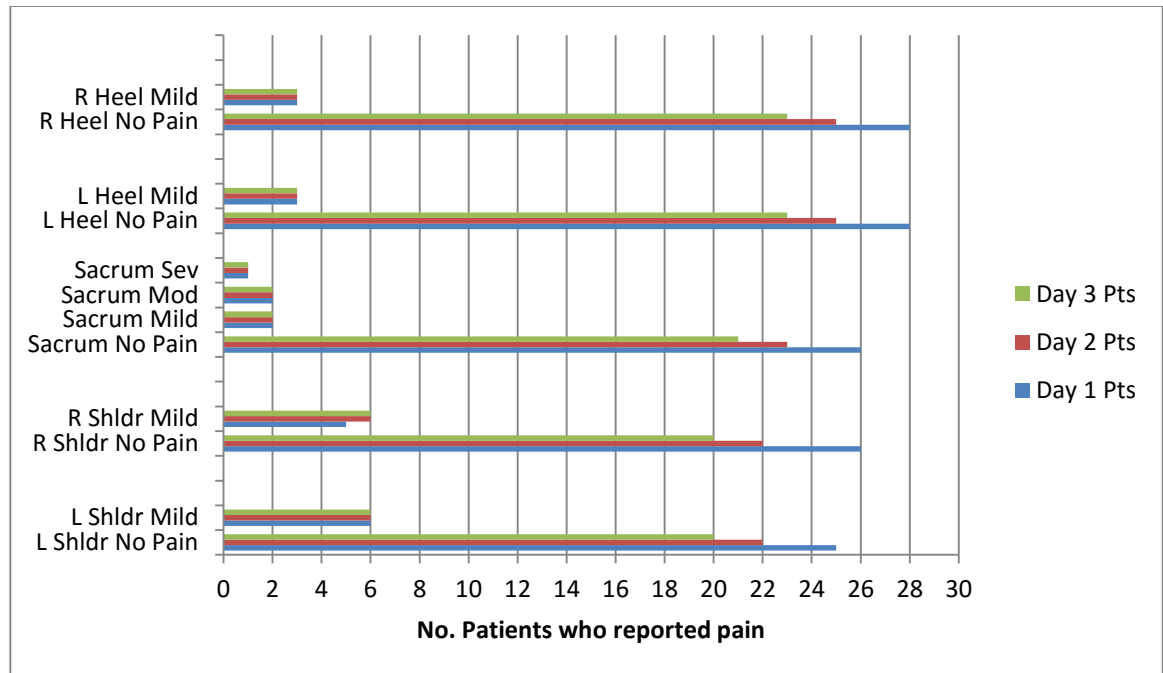
Table 5: SEM Readings



4.5. Pain Readings

Each participant's pain was measured using the universal pain scale. It is already understood that the universal pain scale is divided into three components of mild, moderate and severe pain. Each component is then assigned a range of numbers from one to ten, mild (1-4), moderate (5-7) and severe (8-10). The participant's pain levels were assessed once a day over the three days. The sacral area was the only anatomical site to score for moderate and severe pain. The bilateral shoulders and heels demonstrated mild or no pain. These findings are illustrated below.

Table 6: Pain Score Bar-Chart



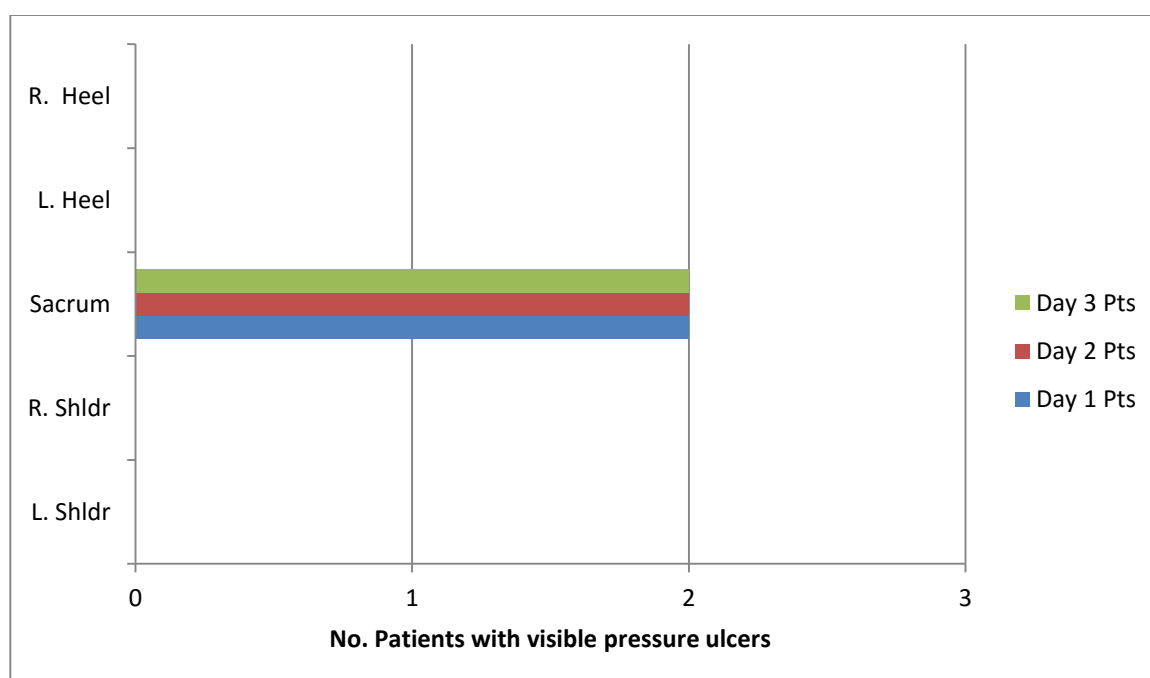
*Day 2 figures are based on 28 participants

*Day 3 figures are based on 26 participants

4.6. EPUAP Pressure Ulcer Grading

Next the participant's existing pressure ulcers were graded using the EPUAP pressure ulcer grading system. Each anatomical site was graded once per day over the three days. The bilateral shoulders and heels showed no visible signs of pressure ulcer development. However, two participant's (6.5%) had visible grade one pressure ulcers on their sacrum. These findings are illustrated below.

Table 7: EPUAP Pressure Ulcer Bar-chart



4.7. Prevalence

4.7.1. Visible Pressure Ulcers

As described in chapter one, prevalence is defined as the number of people within a population with a pressure ulcer divided by the number of people in the population at a certain point in time (Parahoo 1997, Polit & Beck 2008). There are different methods from which researchers can determine prevalence in order to complete their study. As discussed, the most popular methods to determine prevalence are point, period and lifetime prevalence. Point, period and lifetime prevalence studies have already been described earlier in this dissertation.

Traditionally pressure ulcer prevalence has been determined using visual risk assessment tools such as the Braden, Norton and Waterlow scores and pressure ulcer grading tools such as EPUAP's grading tool. However as previously mentioned they are not designed to measure pressure ulcer prevalence rates. Their sole purpose is to determine those at risk of pressure ulcer development and to classify pressure ulcers. The prevalence rate of visible pressure ulcers was

confirmed at 6.4% as two of the thirty-one participants demonstrated visible pressure ulcers. Both visual pressure ulcers were located on the sacrum and were graded as grade one.

4.7.2. Pain Readings

Pain was reported at all anatomical sites. All pain was reported as 'mild'. On average 12.8% (n=4) of participant's verbalised pain at one or more of the anatomical sites. The highest incidence of pain was reported at the bilateral heels (20.7%). The incidence of pain at the bilateral shoulders yielded an average of 10.6%. The lowest scoring anatomical site for pain was at the sacrum. Pain at the sacral site yielded an incidence rate of 7.1%, yet both visual pressure ulcers were located at this site. Three participants's reported moderate or severe sacral pain over the study period. Two of the three participant's who reported moderate and severe pain levels demonstrated visible signs of pressure ulcer development.

4.7.3. S.E.M. Readings

Elevated S.E.M. readings were recorded at each of the anatomical sites. The recorded S.E.M. readings indicated a pressure ulcer prevalence rate of 51.4% as sixteen participant's demonstrated elevated readings. Elevated S.E.M. readings would imply that the participant was experiencing pressure damage at some point during their hospital admission. The most common location for elevated S.E.M. readings was the left heel. Seven (22.5%) of the thirty-one participant's demonstrated elevated S.E.M. at this site. As with the visible pressure ulcers, the two participant's (6.4%) also illustrated elevated S.E.M. readings at the sacrum.

Table eight fully illustrates the number of participant's who experienced elevated S.E.M. readings and at which anatomical sites these elevated readings occurred.

Table 8: Patients with elevated SEM readings

Anatomical Location	No. of patients with elevated S.E.M.
Left Shoulder	1
Right Shoulder	3
Sacrum	2
Left Heel	7
Right Heel	3

4.8. Investigations of Relationships

In order to further explore the data, correlational statistics were used to investigate the relationships that existing between the variables. A particular focus was placed on determining relationships between the development of pressure damage and the recorded value for recognised risk factors. Correlation is a statistical measure that demonstrates if two or more variables (i.e. S.E.M and immobility) fluctuate together.

Pearson Correlation (r) 2-tailed analysis was used to determine which factors (EPUAP, pain or S.E.M.) most accurately indicated the risk of pressure ulcer development. Statistical significance was determined by *p* values which were <0.01 and <0.05 respectively. The correlation co-efficient (r values) measured the strength of the relationship between two variables in question. Those that fell in to the 0-1 range illustrated a positive relationship (Parahoo 1997, Polit & Beck 2008).

4.8.1. S.E.M. and Risk Factors

Correlations were carried out between all measured risk factors and S.E.M. readings. The only significant relationships found were between S.E.M. and mobility scores.

Over the three-day period, mobility and S.E.M. readings demonstrated significant statistical correlations. On day one, mobility and S.E.M. correlated at $r=.420$, $p=.046$, on day two mobility and S.E.M. correlated at $r=.527$, $p=.010$ and finally on

day three mobility and S.E.M. correlated at $r=.420$, $p=.046$. Table nine demonstrates the statistical correlations found between S.E.M. and mobility throughout the study.

4.8.2. EPUAP Scores and S.E.M. Readings

Correlation was carried out on all EPUAP scores and S.E.M. readings. Of these correlations only the sacral EPUAP score and S.E.M. demonstrated significant statistical correlation ($r=.762$, $p=.000$). Table ten demonstrates the statistical correlations found between EPUAP scores and S.E.M. readings at the sacrum.

As previously discussed, two visual pressure ulcers were recorded during this study. Therefore, these findings highlight the positive relationship between visual skin inspection/detection and S.E.M. readings.

4.8.3. Pain and S.E.M. and EPUAP

Pain did not correlate with EPUAP scores or S.E.M. readings, indicating that pain may not be an accurate indicator of early ulcer development as measured by visual inspection

4.8.4. Other Relationships

Pain readings located at the left and right heels statistically correlated ($r=.432$, $p=.044$). Participant's age and S.E.M. readings statistically correlated ($r=.427$, $p=.042$). There was a positive statistical correlation between pain of the bilateral shoulders and age. The left shoulder and age correlated at ($r=.515$, $p=.007$). The right shoulder and age correlated at ($r=.474$, $p=.014$). There was also statistical significance noted between sacral pain and age ($r=.555$, $p=.003$) There was nil significant correlation between pain levels and S.E.M. readings ($p = .133$).

4.8.5. Summary of Correlations

It is evident that from the above findings that S.E.M readings correlated with sacral EPAUP scores. The sacral area is the only anatomical site where there was visual pressure ulceration. This in return reinforces this correlation. Pain proved not to be a precursor to pressure damage. The risk factors associated with pressure ulcer development were then examined. If one looks at the most popular pressure ulcer risk assessment tools the Braden, Norton and Waterlow scores it is evident that emphasis is placed on a number of risk factors for pressure ulcer development such as immobility, incontinence and impaired nutritional status. The only risk factor to positively correlate with elevated S.E.M. readings was immobility. Incontinence and impaired nutritional status did not correlate with S.E.M or EPUAP scores. Interestingly age positively correlated with the SEM readings. Therefore, what we saw was, that there was a relationship between pressure ulcer development and aging. In other words, as age goes up so should S.E.M. readings confirming that you are more likely to develop a pressure ulcer as you age. This finding echoes the findings of Wright *et al.* (2014) who also found that increasing age predisposed their participant's to developing a pressure ulcer. Age also correlated with sacral and bilateral shoulder pain, yet as previously discussed pain did not correlate with elevated SEM or EPUAP scores. Therefore, pain was not considered a risk factor for pressure ulcer development.

Table 9: Correlations

Relationships	P Values
Mobility & S.E.M. (Day 1)	.046
Mobility & S.E.M. (Day 2)	.010
Mobility & S.E.M. (Day 3)	.046
Sacral EPUAP Score & S.E.M. (Days1-3)	.000
Age & S.E.M.	.042
Pain at Bilateral Heels	.044
Left Shoulder Pain & Age	.007
Right Shoulder Pain & Age	.014
Sacral Pain & Age	.003

4.9. Summary of Findings

The strict inclusion and exclusion criteria were highlighted at the beginning of the chapter. Thirty-one participants were deemed suitable for inclusion. Of the thirty-one participant's 64.5% were elective surgical patients. Surgeries performed at the study site are deemed 'minor' as there is no twenty-four hour anaesthetic cover or an intensive care unit (ICU). The surgical participants were admitted for a variety of procedures. An average estimated length of surgery was 1.2 hours with an additional thirty minutes spent in the PACU, which as discussed is subject to change. It was noted that the included surgical patients were responsible for fluctuating mobility scores leading to fluctuating overall Waterlow scores. This is a result of the participant's mobility status being impaired due to the general or spinal anaesthesia. No other fluctuations were noted on the Waterlow scale, for either medical or surgical participants.

Only two participants were noted to have visible pressure ulcers (grade one) on their sacral areas. No other visible pressure ulcers were detected on any other on the anatomical sites. Therefore, the prevalence rate of visible pressure ulcers was 6.4%. Participant's only reported mild pain at the bilateral shoulder and heel sites. It was the sacral area that participant's reported all three pain descriptors (mild, moderate and severe). S.E.M readings of ≥ 5 were considered an indicator of early pressure damage. S.E.M readings indicated a pressure ulcer prevalence rate of 51.4%.

Twenty correlations were examined using different combinations of variables. From the twenty correlations, seven were found to be statistically significant. Mobility and S.E.M readings were found statistically significant. In this study 64.5% of participants were found to have a fluctuating mobility status secondary to general anaesthesia. S.E.M readings were noted to be elevated for these participant's also. Previous research which has focused on risk factors associated with pressure ulcer development, have stressed the importance of nutritional status and incontinence. Interestingly, neither of these risk factors correlated with the SEM readings. This is discussed in chapter five.

As discussed the two visible pressure ulcers were located on the sacrum. S.E.M readings did indeed correlate with the EPUAP pressure ulcer grading of the sacral area. However, elevated S.E.M readings were also located on participant's heels which did not show any visible signs of pressure ulcer development. Age also correlated with multiple other factors. Age positively correlated with the S.E.M readings, bilateral shoulder pain and sacral pain Age and mobility status also correlated, which again is interesting as 64.5% of the participants were surgical and demonstrated fluctuating mobility scores. Only one of the thirty-one included participants was a medical patient that was under the age of fifty. Therefore, twenty-one participants had impaired mobility status at some time during their admission and all of these participant's were <65 years old. Age finally correlated with bilateral shoulder pain. Yet it is already evident that pain may not be a precursor to pressure ulcer development. One cannot deny that the development of pressure ulcers does of course cause great pain for the individual. However, the writer cannot conclude from their findings that pain is an indicator of pressure ulcer development.

4.10. Conclusion

This chapter presented the findings from the completed data collection. It was the aim of this study to challenge the methodologies of currently published prevalence studies, as they utilise visual risk assessment and pressure ulcer grading tools to gather data only. For the purpose of this study, not only was the use of visual risk assessment and grading tools incorporated, but also the universal pain scale and S.E.M. scanning. The prevalence rate of pressure ulcers was 6.4% using visual assessment in comparison to S.E.M. scanning which reported a pressure ulcer prevalence rate of 51.4%. Pain did not prove to be an indicator for pressure ulcer development. Chapter 5 will discuss these findings in detail and consider the implications for practice, particularly the tenfold difference between prevalence determined by S.E.M and prevalence determined by visual inspection.

Chapter Five - Discussion

5.0. Introduction

This chapter has provided a summary of the study's findings. The current national and international pressure ulcer prevalence rates have been discussed and how they compare to the results of this study. From there the reader has been reminded of the current methods of risk assessing for pressure ulcers, that the previous researchers employed. The data collection tools used in this research study have been discussed and justified. These findings are compared to existing research that has been carried out. To conclude, the limitations and recommendations of this study have been discussed.

The aim of this study was to determine the prevalence rate of pressure ulcers in an acute hospital setting and investigate the value of using three different methods of pressure ulcer prevalence measurement. To implement effective prevention strategies, we must know the number of people at risk of pressure ulcer development. To do this we perform a prevalence study. However previous pressure ulcer prevalence studies, have only used the traditional of method visual risk assessment scoring tools to gather their data. One must question if this is the most appropriate method of collecting data, if the number of deep tissue pressure ulcers being identified is increasing. It is important to remember that visual risk assessment tools were devised to determine those at risk of pressure ulcer development. Their purpose is not to measure prevalence. It is the type of data that they gather (age, gender, mobility status) which makes them attractive to researchers performing prevalence studies.

With this in mind, a pressure ulcer prevalence study was performed. Instead of using the visual risk assessment tool alone, it was decided upon to also include the use of the universal pain scale and S.E.M. scanner to see if using these tools would give a greater insight into the area of pressure ulcer prevalence. Armed with these three components gave a clearer insight into pressure ulcer prevalence

and questioned the methods previously used to calculate pressure ulcer prevalence.

5.1. Summary of Findings

Thirty-one participants were assessed for pressure ulcers throughout this study. To determine pressure ulcer prevalence, the participants were assessed in the following ways, the use of the Waterlow score, universal pain scale and S.E.M. scanning. Throughout the study period, two participant's demonstrated visible signs of pressure ulcer development, yielding a pressure ulcer prevalence rate of 6.4%. Using EPUAP's grading tool these pressure ulcers were categorised as grade one. Both visible pressure ulcers were located on the sacrum. According to S.E.M. scanning, sixteen participant's demonstrated elevated S.E.M. readings which indicated pressure damage prevalence rate of 51.6%. Anatomical locations for elevated S.E.M. were not restricted to the sacrum. The most common anatomical site for elevated S.E.M. readings was recorded at the left heel. Seven (22.5%) of the thirty-one participant's demonstrated elevated S.E.M. at this site.

Surgical patient's accounted for 64.5% (n=20) of the total sample. All surgical patients were admitted for elective surgeries which on average lasted 1.2 hours with an additional minimum time of thirty minutes spent in P.A.C.U. The results of this study showed that fourteen surgical patient's demonstrated elevated S.E.M. readings, which indicated that these participants' were at risk of pressure damage at some point during their hospital admission. The surgical participants were exposed to periods of complete immobility secondary to being in receipt of general or spinal anaesthesia. It was noted that the included surgical patients were responsible for fluctuating mobility scores on the Waterlow scoring tool which lead to fluctuating overall Waterlow scores. Waterlow scores were elevated for the two participants' who demonstrated visual pressure ulcers. However, for those who illustrated elevated S.E.M. readings, their Waterlow scores did not fluctuate significantly to deem them at risk of pressure ulcer development. Immobility positively correlated with S.E.M. readings throughout the study, but especially on day two ($p=0.010$). This is a direct result of, that on day two immobility was at its most prominent for the surgical patient's. Pain levels were

then explored to determine if pain was a precursor to pressure ulcer development. Pain did not correlate with EPUAP scores or S.E.M. readings, pointing to pain being a poor predictor of pressure ulcer development. S.E.M. readings only correlated with sacral EPAUP scores, as it was the sacral site that demonstrated visible signs of pressure ulceration. According to the most widely used pressure ulcer risk assessment tools the Braden, Norton and Waterlow scores the most common risk factors that leads to pressure ulcer development are immobility, incontinence and impaired nutritional status. With this in mind, these risk factors were correlated with the S.E.M. readings. As discussed only mobility measures positively correlated with S.E.M. readings. S.E.M readings did not correlate with either incontinence or impaired nutritional status. However, a risk factor that did correlate with the S.E.M. readings was age. The majority of participant's (67.7%) in this prevalence study were under the age of sixty-five.

5.2. Prevalence Rates

This pressure ulcer prevalence study yielded a visible pressure ulcer prevalence rate of 6.4%. According to the use of the S.E.M. scanner, pressure ulcer prevalence was 51.6%. Throughout chapters one and two, national and international pressure ulcer rates were discussed. In Ireland pressure ulcer prevalence rates range between 12-38% (H.S.E. 2009). According the wound care guidelines published by the H.S.E. (2009), Ireland's pressure ulcer prevalence rates are in line with international figures.

Table 10: International Pressure Ulcer Prevalence Rates of Included Studies

Authors (Country)	Prevalence Rates
Gethin <i>et al.</i> (2005) (Ireland)	12.5%
Vanderwee <i>et al.</i> (2007) (Europe)	18.1%
Gallagher <i>et al.</i> (2009)(Ireland)	18.5%
Schluer <i>et al.</i> (2009) (Switzerland)	27.7%
Moore & Cowman (2012) (Ireland)	9%
Primiano <i>et al.</i> (2011) (U.S.A)	8.1%
Tubaishat <i>et al.</i> (2011) (Jordan)	12%
Briggs <i>et al.</i> (2013) (U.K.)	14.8%
Webster <i>et al.</i> (2015) (U.S.A.)	1.3%
This Study (Visual/S.E.M.) (Ireland)	6.4%/51.4%

5.3. Baseline Demographic Data

With the exception of Schluer *et al.* (2009), and Moore and Cowman (2012), the baseline demographic data in this study is comparable with seven of the included prevalence studies (Gethin *et al.* 2005., Gallagher *et al.* 2009., Vanderwee *et al.* 2007, Primiano *et al.* 2011., Tubaishat *et al.* 2011., Briggs *et al.* 2013 and Webster *et al.* 2015). The majority of participant's in this study were in the 14-49 age group (41.9%) with 67.7% of participant's under the age of 65. Of the thirty-one included patient's, fourteen (45.2%) were male and seventeen (54.8%) were female.

The visual prevalence rate of pressure ulcers in this study (6.4%) was most similar to the work of Primiano *et al.* 2011 (8.1%). Similar to this study, Primiano *et al.* (2011) included the surgical patient to determine pressure ulcer prevalence. Also similar to this study is that the participant's had to stay twenty-four in hospital

post procedure (Primiano *et al.* 2011). Unlike this research study and the study by Primiano *et al.* (2011) was the study by Webster *et al.* (2015). These researchers primarily focused their data collection to include the surgical patient only. Unlike this research study, data were collected in the PACU only (Webster *et al.* 2015).

The results of this study make it stand apart from the previously conducted pressure ulcer prevalence studies. Visually the prevalence rate of pressure ulcers was 6.4%. This is remarkably low in comparison to the prevalence of pressure damage using the S.E.M. scanner. The S.E.M. scanner yielded a high pressure reading which might be predictive of pressure ulcers in 51.6% of the participants at the sites indicated. Twenty of the thirty-one participant's were elective surgical patient's. Of these twenty patient's eleven experienced elevated S.E.M readings. This study illustrated that the recorded elevated S.E.M scores correlated with immobility. Yet it is important to remember that, S.E.M readings decreased again once the patient's mobility status increased. Therefore, it is not possible to conclude that there was actual pressure ulcer damage. This study showed that the participant's experienced an inflammatory response secondary to immobility, as a direct result of general and spinal anaesthesia. Therefore, it is possible to conclude that if the patient was to remain immobile for a longer period of time, then a visible pressure ulcer would have been detected.

5.4. Data Collection Methods

This study used the Waterlow score to determine those at risk of pressure ulcer development. Visible pressure ulcers were graded using the EPUAP's pressure ulcer classification system. Five of the included studies did not highlight which risk assessment tool was employed (Gethin *et al.* 2005, Vanderwee *et al.* 2007, Tubaishat *et al.* 2011, Briggs *et al.* 2013 and Webster *et al.* 2015). The Braden scale was used in four of the included studies. Like Gallagher *et al.* (2009), Schluer *et al.* (2009), Moore & Cowman (2012) and Briggs *et al.* (2013) the EPUAP grading tool was also used to grade detected pressure ulcers in this study. Primiano *et al.* (2011) utilised the NPUAP grading tool. It is unclear if a

grading tool was used in the studies by Gethin *et al.* (2005), Vanderwee *et al.* (2007), Tubaishat *et al.* (2011) and Webster *et al.* (2015).

5.4.1. The Waterlow Score

In this study Waterlow scores were recorded and were elevated for visually detectable pressure ulcers. The most commonly used risk assessment tools are the Braden, Norton and Waterlow scores. This study used the Waterlow score as it is used daily by the researcher in their place of employment. In chapter two the reliability and validity of the Waterlow was discussed at great length. Despite scoring low in both reliability and validity status, the Waterlow score is still the most commonly used tool across the U.K. and Ireland to determine those at risk of pressure ulcer development. The included pressure ulcer prevalence studies all utilised a version of a visual risk assessment tool to gather their data, arriving at results/prevalence rates that are in line with other research studies carried out in this area. Taking the findings of this research study into consideration, it calls to question if the use of a visual risk assessment tool alone will suffice in the effective detection of early pressure damage. The results of this research study would suggest that effective detection strategies would rely on a combination of risk assessment tools. Fourteen participants were elective surgical patients who scored 'low risk' of pressure ulcer development according to the Waterlow score. This would indicate the using the Waterlow score or any other visual risk assessment tool alone, will not detect all who are vulnerable of early pressure damage (as the prevalence of pressure damage was 51.6% according to the S.E.M. scanner). Therefore, such tools are not effective in the early detection, of those at risk of pressure ulcer development. If effective detection methods are not implemented, or indeed patients who are at risk of pressure ulcer development go undetected, then this poses a significant problem across all health care settings. Prior to the study commencement the reliability and validity of the Waterlow score was explored. Researchers such as Webster *et al.* (2010) state that it is the general consensus that the Waterlow score tends to over predict those at risk of pressure ulcer development and it should not replace clinical judgement. Perhaps the Waterlow score does over predict those at risk of pressure ulcer development,

but what this study has discovered is that it excludes people who are actually displaying signs of early pressure damage. Therefore, in this study (based on S.E.M. scores), the Waterlow score under predicted those at risk of experiencing pressure damage. This demonstrated a point of difference with researcher Webster *et al.* (2010). Further research focusing on this may prove beneficial. Though not the case in this study, pressure damage if not detected could develop into serious pressure ulcers.

The mean (\pm SD) of the Waterlow score was 6.8 (\pm 4.0). The lowest score was two while the highest score was sixteen. Yet 51.6% of participant's demonstrated elevated S.E.M. readings, indicating that they were at risk of pressure damage at some point during their hospital admission.

In this study the majority of patient's (93.5%) were deemed low risk of pressure ulcer development. This may be because twenty (64.5%) of the thirty-one participants, were elective surgical patients. These patients were deemed fit for surgery, admitted from their primary residence and experienced no underlying conditions that would alter their Waterlow score status. However, as discussed in chapter four, the participant's mobility status fluctuated over the three-day study period. Fluctuating mobility scores were evident for the surgical patient only. However, the increase in mobility scores, did not increase the Waterlow score significantly for the participant to be considered at risk of pressure ulcer development. Yet according to the S.E.M. scanner, the prevalence rate of pressure damage was 51.6%. Taking this into consideration would make one question if assessing the patient with a visual risk assessment tool alone, is sufficient to determine those at risk of pressure ulcer development (Kelly 2005 & Webster *et al.* 2010).

5.4.2. Pressure Ulcer Grading Tools

In the reviewed pressure ulcer prevalence studies, pressure ulcers were graded using either EPUAP's or NPUAP's grading tool. It has been proven to be a useful tool in the pressure ulcer classification process (Schluer *et al.* 2009, Primiano *et al.* 2011 and Briggs *et al.* 2013). However, it can be argued that despite the availability of this diagnostic aid, one will always encounter a discrepancy of opinion, when it comes to pressure ulcer diagnosing and grading. Perhaps this is result of healthcare professionals believing that, the development of pressure ulcers is a direct result of neglect of the patient on their part (O'Tuathail & Taqi 2011). Or indeed because grade one pressure ulcers have been misdiagnosed as incontinence dermatitis, maceration and excoriation. Therefore, prevention methods are not put in place until the pressure ulcer has progressed. Another factor which would question EPUAP/NPUAP's effectiveness, is that patients with darker skin tones prove more difficult to assess in relation to skin health. In chapter two, Bates-Jensen *et al.* (2009) also discussed the problems that assessing those with darker skin tones may present, therefore they examined the effectiveness of measuring S.E.M. in this case. Bates-Jensen *et al.* (2009) has documented the benefits of measuring S.E.M. for these patient's.

5.4.3. Pain

It is well documented that there is a strong relationship between pain and existing pressure ulcers (Gunes 2008 & McGinnis *et al.* 2014). This has been discussed in chapters one and two. Previous researcher's who have examined pressure ulcer pain, have focused their research on the effects of pressure ulcer pain on ones' quality of life and the prevalence of pain for those with existing pressure ulcers (Briggs *et al.* 2013 and McGinnis *et al.* 2014). It does not appear that pain has been explored as a precursor to pressure ulcer development. Pieper *et al.* (2009) stated that, the use of established reporting instruments (such as the universal pain scale), which allows the patient to self report their pain, is the most accurate form of identifying and treating pain. The universal pain scale was utilised throughout this study.

In this research study pain did not prove to be an indicator of pressure ulcer development. The sacral area was the only anatomical site to score for moderate and severe pain which is where the visible pressure ulcers were located in the two subjects mentioned. The bilateral shoulders and heels demonstrated mild or no pain. Yet it was the left heel that illustrated the majority of the elevated S.E.M. readings. Seven (22.5%) of the thirty-one participants demonstrated elevated S.E.M. at this site. This finding is similar to the included literature (Briggs *et al.* 2013). Although considered 'mild', in this research study pain was described by those with no visible signs of pressure ulceration. However, where this study differs is that the researcher could examine the participant for pressure damage by using the S.E.M. scanner, unlike the study by Briggs *et al.* (2013). Briggs *et al.* (2013) did not state if those who experienced pain at the pressure sites did indeed go on to develop pressure ulcers at a later stage. Therefore, it is unclear if the pain that they were experiencing was indeed an indicator of pressure ulcer development. A positive correlation between pain and S.E.M. readings may have indicated that pain was indeed a precursor to pressure ulcer development. However, pain and S.E.M. readings did not positively correlate. Therefore, pain was not deemed an indicator to pressure ulcer development. It could be argued that the surgical participants did not experience true pain in the immediate post operative phase, as a direct result of analgesia administered intra-operatively. Therefore, further research exploring the concept of pain being a precursor to early pressure damage may be warranted. Like McGinnis *et al.* (2014) those with existing pressure ulcers (n=2) did report pain where their pressure ulcer developed. What also appears similar between this research study and the study by McGinnis *et al.* (2014) is that those who reported pain with pressure ulcers had developed grade one pressure ulcers yet described moderate and severe pain. This finding echoes that of McGinnis *et al.* (2014), that pressure ulcer severity does not impact the level of pain being described by the patient. These findings are significant as an increase in pain levels may result decreased movement, which will increase the risk of further pressure damage (McGinnis *et al.* 2014).

5.4.4. S.E.M.

The four studies performed to date have all validated the usefulness of measuring S.E.M (Bates Jensen *et al.* 2007, 2008, 2009 and Guihan *et al.* 2012). Designed for the identification of pressure damage, S.E.M scanning has detected pressure ulceration at an early stage of development. Such detection leads to the early implementation of prevention strategies, which contributes to a reduced length of stay in hospital and reduces cost to the patient and healthcare institution (EPUAP/NPUAP/PPPIA 2014). All four studies concluded that those who did show signs of elevated S.E.M readings, were indeed more likely to develop pressure ulcers than those who did not demonstrate elevated S.E.M. readings (Bates-Jensen *et al.* 2007, 2008, 2009 and Guihan *et al.* 2012). Taking place across two nursing homes, the study by Bates-Jensen *et al.* (2007) included a total number of thirty-five participants'. Unlike this research study, Bates-Jensen *et al.* (2007) followed the participant's over a fifty-two-week period. This research study took place over three days. Also the study by Bates-Jensen *et al.* (2007) was conducted in a nursing home whereas this study took place in an acute hospital setting. Where the study takes place will have an effect on the study outcomes. For instance, twenty of the participants in this study were elective surgical admissions, where their mobility status was affected by the use of anaesthetics, but returned to their baseline readings in a matter of hours. In 2008, Bates-Jensen *et al.* revisited the idea that elevated S.E.M. readings resulted in visible pressure damage. The results of the study conducted by Bates-Jensen *et al.* (2007) is echoed in their later work (Bates-Jensen *et al.* 2008), as it concluded that the higher S.E.M. readings, predicted the greater chance of pressure ulcer development. The study conducted in 2009 by Bates-Jensen *et al.* examined the effectiveness of determining those at risk with darker skin tones of pressure ulcer development. Again the higher the S.E.M. readings indicated the likelihood of pressure ulcer development when the patients were reassessed.

In this study, elevated S.E.M. readings were recorded for each of the anatomical sites. The recorded S.E.M. readings indicated a pressure ulcer prevalence rate of 51.6% (n=16). Visible pressure ulcers were only noted at the sacrum. Elevated

S.E.M. readings would imply that the participant was at risk of pressure damage at some point during their hospital admission. This success is in line with the previous studies by Bates-Jensen *et al.* (2007, 2008, 2009) & Guihan *et al.* (2012). What is different about this study in comparison to the studies by Bates-Jensen *et al.* (2007, 2008 & 2009) is that fourteen of the sixteen participants who illustrated elevated S.E.M. readings were elective admissions. They were admitted from their home environment and did not show any signs of pressure damage pre-operatively. It was in the immediate post-operative phase that S.E.M. levels increased. On the day of the participant's discharge S.E.M. levels had returned to normal limits. If the participants were admitted to the I.C.U., or needed prolonged bed rest post-operatively, then one could argue that over time, such pressure damage may have become visible to the naked eye. However, this will never be fully known. The included elective patient's who did demonstrate elevated S.E.M. readings, were fully mobile within a number of hours and discharged home when deemed fit by their consultant. The participant's who took part in the studies by Bates-Jensen *et al.* (2007, 2008 & 2009) were nursing home residents. Their mobility status pre and post assessment is not highlighted throughout the studies.

The illustrated signs of increased S.E.M. levels should indicate to the healthcare professional, that there is high risk that the patient is experiencing pressure damage. Measuring S.E.M. is of huge importance in healthcare if it means that effective prevention strategies can be implemented, before the ulcer becomes so severe that it is near impossible to treat. Pressure ulcers are known to cause complications such as pain, depression, infection in skin, soft tissue and bone and can result in death (O'Tuathail & Taqi 2011). Yet by measuring S.E.M., healthcare professionals may be able to plan preventative strategies most appropriate for their patient's, in advance of the development of visual signs. Such prevention strategies would decrease the incidence and complications associated with pressure ulcer development.

As previously discussed the use of visual risk assessment tools and pressure ulcer grading tools alone can lead to a discrepancy of opinion between healthcare professionals. Measuring S.E.M. levels could avoid such discrepancies, allowing the patient to receive the care they need to avoid the development of severe pressure ulcers. This is not to say that using visual risk assessment tools should be abolished, but as found in this study, used in combination with measuring S.E.M. could make a huge difference in how we assess our patient's for pressure ulcer development in the future.

Measuring S.E.M. levels is still a relatively new concept. However, it appears from the available literature and indeed the findings of this study, that S.E.M. readings could be of enormous benefit in early pressure ulcer detection and the implementation of effective prevention strategies. The results of this study showed that measuring S.E.M. is an effective method to determine pressure ulcer prevalence. By assessing S.E.M. a total of sixteen participants (51.6%) were found to have signs of pressure damage in comparison to using a visual risk assessment tool alone, which showed a pressure ulcer prevalence rate of just 6.4% (n=2). According to NPUAP (2007) there has been an increase in the number of suspected deep tissue pressure ulcers being reported. Such ulcers are not visible until they reach an advanced stage, when they prove difficult to treat. It should be the aim of healthcare professionals to detect such pressure damage very early. Therefore, effective prevention strategies could be implemented in to the patient's care plan. These prevention strategies would benefit the patient and health organisation alike. Such benefits have been touched upon previously in this chapter. Assessing S.E.M. levels detected pressure damage for those patients's who would not have been assessed again if using the Waterlow score alone. The Waterlow score would have deemed them not at risk of pressure damage. However, the findings of this study confirm pressure damage was evident for these patients'. As previously stated if the participant's who did demonstrate elevated S.E.M. needed prolonged bed rest or experienced a surgical complication requiring further intervention, one could argue that it is not impossible that their pressure damage may have progressed to a grade one or worse pressure ulcer.

The purpose of this research study was to determine pressure ulcer prevalence incorporating the use of the S.E.M. scanner. This is where this research study hugely differed from the studies by Bates-Jensen *et al.* (2007, 2008 & 2009). Those studies set out to examine if high S.E.M. readings would result in visible pressure ulcer development over a certain number of weeks (Bates-Jensen *et al.* 2007, 2008 & 2009). This research study set out to determine pressure ulcer prevalence. Early pressure damage was evident after a matter of hours in this study. However, it cannot be concluded from this research study if the participants would have developed visible pressure ulcers if reassessed at a later date.

5.4.5. Objectivity

To ensure objectivity throughout this study, the researcher gathered the data independently. By gathering the data independently also meant that there was no under reporting of pressure ulcers in this study, as the researcher was not involved in the direct care of the participant's. This research study is similar to some of the included prevalence studies in this way also, as they too employed external data collectors (Gethin *et al.* 2005., Schluer *et al.* 2009., Moore and Cowman 2012 and Primiano *et al.* 2011). To guarantee objectivity, Schluer *et al.* (2011) went as far as employing ten rater pairs to collect their data and when a difference of opinion occurred a third party's opinion was sought. Pre-study training was available by some researchers (Briggs *et al.* 2013 and Webster *et al.* 2015). This researcher attended training in relation to measuring S.E.M. prior to study commencement, as this was a new concept for the researcher. Mandatory training is indeed essential for the successful completion of research. It allows the opportunity for those conducting the study to brief data collectors on effective data collection and study objectives.

5.5. Potential Effects of Underestimating Prevalence

In this study, the prevalence rate of visible pressure ulcers was confirmed at 6.4% (n=2) in comparison to the S.E.M. readings, which indicated a high pressure prevalence rate of 51.6% (n=16). With such a discrepancy of these findings, one must question then the reliability of using visual skin assessment alone to

determine pressure ulcer prevalence, or indeed correctly identify those at risk of possible pressure ulcer development. This calls into question if a percentage of pressure ulcers in the included prevalence studies went undetected. Therefore, these findings are not giving us a true insight in to the magnitude of the problem of pressure ulcer development. An oversight such as this can lead to patient's not receiving the correct preventative measures/treatment to reduce the risk of pressure damage. Failure to prevent such damage becoming severe may be too late for the patient (O'Tuathail & Taqi 2011). As previously discussed, severe pressure ulcers cause pain, loss of earnings for the patient, prolonged hospital stay which places financial burden on the healthcare setting, sepsis and can even result in death (O'Tuathail & Taqi 2011). Gethin *et al.* (2005) explored pressure ulcer prevalence so that an estimation of the cost to treat a pressure ulcer may be calculated. Gethin *et al.* (2005) estimated that it would cost 119,000 Euro to successfully treat one patient with a grade four pressure ulcer. The study is concluded by stating that it is estimated that it costs 250,000 Euro per year to treat pressure ulcers across all Irish healthcare settings (Gethin *et al.* 2005). Yet looking at the findings of this dissertation (a prevalence rate of 6.4% versus 51.6%), this estimated cost of treating pressure ulcer could be grossly under estimated. With the early detection of pressure damage, healthcare budgets could be allocated more effectively which in return decreases the financial burden on the health services. Pressure ulcers are one hundred percent avoidable (O'Tuathail & Taqi 2011). The implementation of effective preventative strategies is vital. Understanding pressure ulcer prevalence rates assists healthcare professionals to fully realise the burden that pressure ulcer development causes our health services. Therefore, by measuring S.E.M. and assessing the patient's pain levels, along with visually risk assessing, could allow healthcare budgets and allocation of time to be used more efficiently, as we would fully understand who is at risk of pressure ulcer development. However further research is warranted in this area to decide if the S.E.M scanner will positively impact nursing care and patient outcomes.

5.6. Surgical Patients and Pressure Ulcers

The most common risk factors associated with pressure ulcer development are immobility, incontinence and impaired nutritional status. Incontinence or nutritional did not correlate with S.E.M. readings in this study. Mobility status did correlate with S.E.M. readings. Twenty (64.5%) of participant's in this prevalence study were surgical patients. General or spinal anaesthesia induces periods of complete immobility. With this in mind, other studies examining the development of pressure ulcers in the surgical patient were re-examined. These studies were first explored in chapter two's literature review. This process was carried out to determine if the surgical patient, like in this study, can be deemed high risk of pressure ulcer development.

Schoonhoven *et al.* (2002) examined the incidence of pressure ulcers as a result of surgery. They found that forty-four (21.2%) of the 208 participant's developed seventy pressure ulcers in the first two days' post operatively. The most common location for pressure ulcer development was the heel with more than half (52.9%) developing here (Schoonhoven *et al.* 2002). The left heel was the most common anatomical location for elevated S.E.M. readings in this study.

As discussed in chapter two, Baumgarten *et al.* (2003) conducted a study to estimate the incidence of hospital acquired pressure ulcers among elderly patients who were admitted to hospital secondary to a hip fracture (Baumgarten *et al.* 2003). Data were collected by chart review, from admission to the 30th day post-surgery or until discharged (Baumgarten *et al.* 2003). The data were collected by trained study personnel using a standardised data extraction form. Baumgarten *et al.* (2003) used conditional logistic regression to estimate the association between pressure ulcers and the extrinsic risk factors collected. The presence of a pressure ulcer at discharge was the outcome variable in this multivariable analysis (Baumgarten *et al.* 2003). Each extrinsic risk factor was entered as independent variables. Also entered was a comprehensive set of confounding variables which represented known or suspected risk factors for pressure ulcer development.

These included age; sex, diabetes and activity of daily living (ADL) score (Baumgarten *et al.* 2003).

Lindquist *et al.* (2003) examined the relationship between sedation use and pressure ulcer development, noting that 45.5% of participants with existing pressure ulcers had been in receipt of sedation prior to admission. This led to a decrease in mobility which led to an increased risk of pressure ulcer development (Lindquist *et al.* 2003). Cherry & Moss (2011) also explored pressure ulcer development in the surgical patient. Their findings suggested that a surgical procedure that lasts 2.5 hours or more increases the risk of pressure ulcer development. These findings are similar to those of Jackson *et al.* (2011). These participants had undergone lengthy surgical procedures, have periods of paralysis and may be heavily sedated. The authors also highlighted that, when admitted to the ICU, patients tend to be quite ill, therefore regular repositioning of the patient is difficult to achieve. (Jackson *et al.* 2011). Primiano *et al.* (2011) looked at the prevalence rate of pressure ulcers and the associated risk factors for the surgical patient. Similar to this prevalence study carried out for the purposes of this dissertation, participants were aged eighteen or older and were scheduled for same day surgery. Like Cherry and Moss (2011), Primiano *et al.* (2011) only included lengthy procedures. For Primiano *et al.* (2011) that surgery would last a minimum of three hours. Similarly, to this research study, to be included the participant's also had to stay twenty-four in hospital post procedure (Primiano *et al.* 2011). 8.1% developed a pressure ulcer (Primiano *et al.* 2011). Webster *et al.* (2015) found that surgery which lasted a minimum of thirty minutes did not contribute to pressure ulcer development. Perhaps this was a result of the researchers not following the participant's progress post discharge from the P.A.C.U. As the participant's were not assessed again, it appears impossible to conclude that pressure damage did not continue to develop as a direct result of the surgery performed. Unlike Primiano *et al.* (2011), the time the participant's spent as an inpatient post surgery was not specified. In this study surgery lasted on average 1.2 hours with an additional minimum time of thirty minutes spent in PACU. Although the surgeries were not as long as those in the studies by Schoonhoven *et al.* (2002), Baumgarten *et al.* (2003), Cherry & Moss (2011) or

Primiano *et al.* (2011), they did contribute to elevated S.E.M. readings. Surgery of any length does induce periods of immobility, which has proved to positively correlate with elevated S.E.M. readings. While the results of Webster *et al.* (2015) stated that surgery does not lead to pressure ulcer development, the reader must remember two things. Firstly, the participant's skin was inspected in the PACU only. The participants were not followed up again on the ward prior to discharge. Secondly, the staff assessed the participants for pressure ulcers with the use of a visual skin assessment tool only. If S.E.M. was measured in the study by Webster *et al.* (2015), it may have yielded completely different results as it did in this study.

5.7. Immobility

This study found that that patient's who experienced periods of complete immobility demonstrated signs of elevated S.E.M. readings. This could potentially mean that if they were to remain immobile for a longer duration of time, it may have resulted with the development of a visible pressure ulcer. S.E.M. readings positively correlated with immobility. S.E.M. readings did not correlate with other risk factors mainly associated with pressure ulcer development (incontinence and impaired nutritional status). This calls to question if it is the risk factor of immobility alone, that results in pressure ulcer development. Taking the surgical patient's in to consideration, it was only their mobility status that was impaired and fluctuated on the Waterlow score. They did not experience incontinence or malnutrition, yet their S.E.M. readings were elevated. Once their mobility had returned to their baseline, their S.E.M readings decreased. Remembering pressure ulcer aetiology, especially the in vivo studies (Husain 1953 and Kosiak 1959), it is adequate to presume that neither the rats nor dogs were incontinent or nutritionally impaired. Pressure damage was a direct result of induced periods of immobility. This reinforces the idea that immobility could be the sole cause of pressure ulcer development. However further research is essential to determine this idea.

5.8. Study Limitations

Like all research studies, study limitations must be taken into consideration. The major limitation of this research study was the small sample size. There were thirty-one participants'. This is a reality of collecting clinical data. Also the study site is considered small with 130 beds. A small sample size may prove difficult to find significant relationships from the data; as statistical tests normally require a larger sample size (University of Southern California 2016).

Also the surgeries included in this study are considered minor. It would be of great interest to repeat this study and include surgical patients who would require longer periods of time in hospital post-operatively, secondary to lengthier surgical procedures. It would be interesting to determine if S.E.M. levels would return to normal limits as they did in this research study. The inter-rater, inter-device and reliability of the S.E.M. scanner has been previously discussed in chapter two (Clendenin *et al.* 2015). Proving high reliability and good agreement between operators, the researcher cannot see how using the S.E.M. scanner could limit the outcomes of this study.

Another limitation of this study was the follow up times. As this study took place over a three-day period, it could be argued that data were limited. Ideally the researcher would follow the participant's up for longer period of time to gather more data.

5.9. Summary

This study took place in an adult acute hospital setting. There were thirty-one participants' and 64.5% of these participant's were elective surgical patient's. 41.9% were aged between 14-49 with 67.7% aged less than sixty-five years. 64.5% of participants were surgical patients. There have been numerous studies conducted examining the relationship between pressure ulcer development and the surgical patient (Baumgarten *et al.* 2003., Lindgren *et al.* 2004., Schluer *et al.*

2009., Cherry & Moss 2011, Jackson *et al.* 2011 and Primiano *et al.* 2011). The surgeries included in these studies all lasted > 2.5 hours whereas the surgeries in this study lasted on average only 1.2 hours and yet elevated S.E.M. readings were still documented. Immobility and S.E.M. readings positively correlated in this study, especially on day two when immobility status was at its highest. In this study pain and S.E.M. only correlated at the bilateral heel site. Yet moderate and severe pain was reported at the sacral area only. Pain did not correlate with S.E.M. readings at the other anatomical sites indicating that pain is not a precursor to pressure ulcer development. The use of visual risk assessment tools has been used to determine those at risk of pressure ulcer development. Two (6.4%) visual pressure ulcers were detected. Using EPUAP's pressure ulcer grading tool, these pressure ulcers were classified as grade one.

It may be argued that the findings of this research study were limited due to the small sample size. However, the purpose of the study was to determine the prevalence of pressure ulcers in an acute hospital setting and investigate the value of using three different methods of pressure ulcer prevalence measurement. Two (6.4%) participant's developed visible pressure ulcers in comparison to 16 (51.6%) participant's who demonstrated elevated S.E.M. readings. This indicated that previous pressure ulcer prevalence rates have been grossly underestimated. This could have enormous repercussion on our health service. As healthcare professionals know, pressure ulcers are one hundred percent avoidable with the implementation of effective prevention strategies. However, perhaps we are overlooking some of our most vulnerable by not thinking they are experiencing pressure damage, simply because we cannot see it.

5.10. Conclusion

The aim of this study was to determine the prevalence of pressure ulcers in an acute hospital setting and investigate the value of using three different methods of pressure ulcer prevalence measurement. This was decided upon as there has been an increase in the number of deep tissue injuries being reported

(EPUAP/NPUAP 2014). Until now, pressure ulcer prevalence has been measured using visual risk assessment tools and pressure ulcer grading tools alone. As visual risk assessment tools are not a suitable tool for detecting pressure damage, prevalence was measured assessing the skin visually, assessing pain levels and measuring S.E.M. readings. A huge discrepancy was noted between visual skin assessment and S.E.M measuring (6.4% versus 51.6%). This led the researcher to consider the consequences of underestimating such a problem that is pressure ulcer development. The next chapter concluded this research study. How this study may influence nursing practice, education and its effects for future research has been discussed.

Chapter Six – Conclusions and Recommendations

6.0 Introduction

In chapter six the researcher will once again have reflected on the findings of this research study. The strengths and limitations of the data that was collected and analysed was discussed. It has highlighted how the researcher intends to share their findings of this study with the wider nursing community. The researcher has discussed the implications of the findings of this study for future nursing practice, education and management. Finally, in this chapter, the researcher has included their reflections on the performed study, which will include what they have discovered about the research process and how they think how their nursing practice may change in the future.

6.1. Overall Conclusions

A greater focus on pressure ulcer prevention has been a main priority across all healthcare settings in Ireland. The aim of this study was to determine the prevalence of pressure ulcers in an acute hospital setting and investigate the value of using three different methods of pressure ulcer prevalence measurement. Throughout the study period, two participant's demonstrated visible signs of pressure ulcer development, yielding a pressure ulcer prevalence rate of 6.4%. According to S.E.M scanning, sixteen participant's demonstrated elevated S.E.M readings which indicated pressure damage prevalence rate of 51.6%. The

findings of this study provide an insight into the reality that pressure damage can develop for anybody of any age. To date in Ireland, pressure ulcer prevalence rates range between 12-38% which is in adherence with international figures. (H.S.E 2009).

It is discussed at great length in chapter five that previous pressure ulcer prevalence studies relied solely on the use of visual skin assessment tools and pressure ulcer grading tools to arrive at their findings (Gethin *et al.* 2005., Vanderwee *et al.* 2007., Gallagher *et al.* 2009., Schluer *et al.* 2009., Moore & Cowman 2012., Primiano *et al.* 2011., Tubaishat *et al.* 2011., Briggs *et al.* 2013 and Webster *et al.* 2015). It has also been highlighted that risk assessment tools or pressure ulcer grading tools were not devised to measure prevalence rates, rather the sole purpose is to determine those at risk of pressure ulcer development or aid in the pressure ulcer classification process. Pressure ulcer prevalence in this research study was measured in three ways, visual risk assessment (Waterlow score), pain assessment (universal pain scale) and S.E.M scanning. The two visible pressure ulcers were located on the sacrum whereas the most popular anatomical site for elevated S.E.M. readings was in fact the left heel. Seven (22.5%) of the thirty-one participant's demonstrated elevated S.E.M. at this site. S.E.M readings were elevated at the sacrum where the visible pressure ulcers were located.

Participants in this study were in the 14-49 age group (41.9%) with 67.7% of participants under the age of 65. Fourteen participant's (45.2%) were male and seventeen (54.8%) were female. The majority of participant's (n=20) were elective surgical patient's, where surgeries lasted on average 1.2 hours. Although considered 'minor' surgery, participants were in receipt of general or spinal anaesthesia affecting their mobility status. As discussed in previous chapters, mobility status and S.E.M. readings positively correlated indicating that impaired mobility is a pressure damage indicator. Pain did not correlate with EPUAP scores or S.E.M readings, pointing to pain being a poor predictor of pressure damage/pressure ulcer development. S.E.M readings only correlated with sacral

EPAUP scores, as it was the sacral site that demonstrated visible signs of pressure ulceration.

The findings of this study suggest that it is possible that previously conducted prevalence studies may have under estimated pressure ulcer prevalence rates. The researcher has arrived at this conclusion as the participants in this study illustrated signs of early pressure damage using the S.E.M scanner, yet according to the Waterlow score were not deemed at risk of pressure ulcer development. Fourteen participants with elevated S.E.M readings did not show visible signs of pressure ulcer development what so ever. This indicated to the researcher that relying on the use visual risk assessment alone is no longer sufficient. The remaining two participants with elevated S.E.M. readings were in fact the two patients's with visible pressure ulcers. This study also demonstrated that the short stay surgical patient was at risk of pressure damage. Leading to the discussion that, it was these patients who were immobile that demonstrated elevated S.E.M readings. Therefore, it begs to question if immobility alone is responsible for pressure ulcer development. The researcher has briefly mentioned the relationship found between immobility and elevated S.E.M readings in this study. However, further research in this area may prove very beneficial, so that the sole cause of pressure ulcer development can be fully understood.

6.2 Distinctive Contributions of this Study

6.2.1. Three Methods of Measuring Prevalence

Four main strengths emerged from this study. Firstly, prevalence in this study was measured in three ways using the Waterlow score, universal pain scale and by S.E.M scanning. Previous pressure ulcer prevalence studies relied solely on the use of the visual risk assessment tool and pressure ulcer grading tools to determine prevalence (Gethin *et al.* 2005., Vanderwee *et al.* 2007., Gallagher *et al.* 2009., Schluer *et al.* 2009., Moore & Cowman 2012., Primiano *et al.* 2011., Tubaishat *et al.* 2011., Briggs *et al.* 2013 and Webster *et al.* 2015). It was the intention of the researcher to discover if there was a significant discrepancy in the

prevalence rate of pressure ulcers between using the visual risk assessment tool alone or using it alongside the universal pain scale and S.E.M scanning. The findings of this research study varied hugely with the prevalence rate of visual pressure ulcers being 6.4% in comparison to pressure damage prevalence reading 51.6% using the S.E.M scanner.

A visual risk assessment tool such as the Waterlow score does not measure pressure ulcer prevalence. Rather, it helps the healthcare professional to determine those at risk of pressure ulcer development. However, it is the type of data that the risk assessment tool gathers that proves useful when conducting pressure ulcer prevalence studies. Therefore, it is essential to question if the use of a visual risk assessment tool alone is appropriate for early pressure ulcer/damage detection. It has been already discussed in chapters two and five that the Waterlow tool's reliability and validity scores poorly. We know from this study that 93.5% of participants were deemed low risk of pressure ulcer development yet 51.6% demonstrated signs of early pressure damage. This study illustrates how pressure ulcers/pressure damage may not be recognised by using the current diagnostic aids. With this in mind, one could also question the reliability of EPUAP/NPUAP's pressure ulcer grading tool. The reliability of EPUAP's grading tool has been previously discussed (Pedley 2004). As seen in this study, early pressure damage that was detected by S.E.M scanning, was not visible to the naked eye. Using the pressure ulcer grading tool, it indicated that the fourteen participant's who did in fact demonstrate elevated S.E.M readings were deemed as having a grade zero pressure ulcer. This in return can lead to the underestimation of pressure ulcers across all healthcare settings. Therefore, the participant's pain was also examined to determine if it was a precursor to pressure damage. Those who have examined pain in relation to pressure ulcers focused their research on the effects of pressure ulcer pain on one's quality of life and the prevalence of pain for those with existing pressure ulcers (Briggs *et al.* 2013 & McGinnis *et al.* 2014). Reviewing the existing literature, it did not appear evident to the researcher that pain had been examined as an indicator to pressure ulcer development. Lastly to determine pressure ulcer prevalence, the S.E.M. scanner was used. This rationale for utilising the S.E.M. scanner was to discover if patients

were experiencing early pressure damage, that would go unnoticed if using visual risk assessment tools alone. It was important to include the detection of pressure damage due to the increase of deep tissue injury being recorded.

6.2.2. Inclusion of the Surgical Patient

Secondly this research study included elective surgical patients. Twenty of the thirty-one participants were admitted for surgery over the study period. Of these twenty patients, fourteen demonstrated elevated S.E.M. readings indicating that they were at risk of pressure damage at some point throughout their admission. The researcher did recognise that surgical patients have been included in other prevalence studies (Primiano *et al.* 2011). However, what makes this research study different, is that the surgeries in this study were indeed a lot shorter in length in comparison to the surgeries included by Cherry & Moss (2011) and Primiano *et al.* (2011) (1.2 hours versus >2.5 hours). Those who undergo surgery at this study site are usually expected to be discharged twenty-four hours post operatively. If the patient is not deemed fit for discharge, their mobility status has returned to their baseline as was the case in this study. As discussed in chapters four and five each participant was assessed using the Waterlow score. It was the surgical participants only, whose mobility status fluctuated from the pre operative to the post operatively phase. However, this fluctuation did not affect their overall Waterlow score, deeming them not at risk of pressure damage. Yet 51.6% of participant's demonstrated elevated S.E.M. readings, indicating that they were experiencing early pressure damage. This pressure damage/elevated S.E.M was recorded in the immediate post operative phase, returning to within normal limits prior to the participant's discharge. Mobility positively correlated with S.E.M readings, reinforcing that even short term impaired mobility status may indeed induce pressure damage.

6.2.3. Challenging Traditional Tools

The third strength of this research study is that it challenges the traditional tools used to determine prevalence and those at risk of pressure ulcer development. To

begin with pain proved not to be a precursor to pressure ulcer development. Therefore, incorporating the universal pain scale into pressure ulcer early detection strategies, may not prove useful. The Waterlow score significantly underestimated the prevalence rate of pressure ulcers at 6.4%. The S.E.M. readings illustrated the prevalence rate of pressure ulcers at 51.6%. This study found that the use of the S.E.M. scanner exposed those experiencing pressure damage, especially short stay surgical patient's. As illustrated in the studies by Bates-Jensen *et al.* (2007, 2008 & 2009), those with elevated S.E.M. readings could be eight times more likely to develop a grade one pressure ulcer. While the researcher set out to complete a pressure ulcer prevalence study, the usefulness of the S.E.M. scanner was also highlighted throughout.

An underestimation such as the one found in this research study, can lead to patient's not receiving the correct preventative measures/treatment, to reduce the risk of further pressure damage. Failure to prevent such damage becoming severe may prove difficult and lengthy to treat. Also the underestimating of pressure ulcers, could mean that resources such as nursing time and financial resources may be distributed unevenly. As stated in chapter one, in the U.K., 90% of the financial budget allocated to wound care is spent on nursing time in comparison to just 3.3% which is spent on necessary equipment such as dressings (Dealey *et al.* 2012).

6.2.4. Ensuring Objectivity

The fourth strength of this study is that, the data were collected and analysed solely by the researcher. This ensured objectivity throughout the study which again is a further strength of this study. To achieve objectivity, the researcher and those under investigation were independent of each other. In other words, the researcher was not involved in the provision or delivery of nursing care to these patients/subjects. The researcher had full control over the context of the study and all data were analysed statistically. This is where we see the positivist paradigm in

play, as the aim of positivism is to measure and analyse relationships between variables within a 'value-free' environment (Farrelly 2012 p. 508).

6.3. Limitations of Collected and Analysed Data

The major limitation of this research study was the small sample size. There were thirty-one participants. Unfortunately, this could not be avoided as the study site is considered small with a 130 bed capacity, the strict inclusion/exclusion criteria, bed closures and restrictions outlined by the ethics committee. A small sample size may prove difficult to find significant relationships from the data; as statistical tests normally require a larger sample size. A larger sample size ensures a representative distribution of the population and is considered to be representative of groups of people to whom results will be generalized or transferred (University of Southern California 2016).

The surgeries included in this study are considered minor. It would be of great interest performing this study including surgical patients who would require longer periods of time in hospital post-operatively secondary to lengthy surgical procedures. It would be interesting to determine if S.E.M. levels would return to normal limits as they did in this research study. However, this was a prevalence study which set out to determine if the current method of measuring prevalence is the most efficient.

It was established that pain was not an indicator of pressure damage in this study. However, it could be argued that the tool which was used to collect the data were not the most appropriate. Perhaps the use of a different data collection tool would have yielded different results. To answer this question would require further research being performed.

To resolve the limitations highlighted above, further research is warranted.

6.4. Dissemination of Findings

The dissemination of key findings upon study completion is a crucial step in nursing based research. It is vital that researchers share their findings with the greater nursing population, as sharing such results will allow health practitioners to reflect upon their own practice. Sharing the results of one's study raises awareness into the problem which in this instance is the prevalence rate of pressure damage. By completing research and sharing results allows evidence based practice to be implemented into the workplace, which allows us to provide the gold standard of care. Delivering such care is what every healthcare practitioner should strive for. Sharing research findings also leads to new collaborations, as other researchers with similar interests may share or oppose your opinions outlined in your study. Also by sharing the results of the study increases the impact and visibility of the study, which can minimise replication of work performed in the future. It allows for the advancement of healthcare practice in new ways (National M.S. Society 2016) (online).

To share the findings of this study the researcher will begin locally. Firstly, they will inform their workplace colleagues of the results of this study. It is essential that personnel such as the Director of Nursing, practice development, clinical facilitators and those in the tissue viability department are presented with these findings. Illustrating these results to such personnel could lead to change in policy and protocol within the healthcare organisation. Of course, informing frontline staff of the study's results is also essential, as it will be the frontline staff who will implement any change of practice that may occur as a result of this study. Even if changes to policy and practice are not made, the findings of this study should be of interest to all healthcare professionals. The results of this study may indeed influence staff members to re-evaluate who they consider at risk of pressure damage and pressure ulcer development. Education sessions like this can be carried out at ward level to facilitate nursing staff and healthcare assistants who directly provides patient care.

It is the intention of the researcher that their research study will be peer reviewed. Having ones' study peer reviewed means that the paper is studied by other

researchers. They evaluate the methods used and identify any potential flaws in the methodology that might shed doubt on the findings. Also the researcher would like to publish the results of this research study. Ideally this prevalence study will be published in peer-reviewed journals, which will allow the medical community to evaluate the findings themselves. It also outlines how the study was conducted so that other researchers can repeat the experiment. Repeating the study verifies and confirms the results (National M.S. Society 2016) (online).

It is also the intention of the researcher to share the results of this study at national and international conferences in the areas of nursing, tissue viability and wound management. This is vital to building collaborations and the sharing of ideas and methods.

6.5. Implications of the Findings of this Study for Future Nursing Practice, Education, Management and Further Research

In chapter one the term prevalence was defined. Understanding prevalence around a certain phenomenon (i.e. pressure ulcers) is essential especially in healthcare. Understanding prevalence rates allows us to implement certain strategies, policies and protocols. Comparing the results of this study to previous prevalence studies, it was evident that we have been underestimating pressure ulcer prevalence rates over the years. Therefore, the findings of this study should have huge implications for nursing practice, education and management.

6.5.1. Nursing Practice

It is a known fact that throughout the years, nurses have tended to carry out nursing procedures and provide nursing care, “the way it has always been done.” While the researcher is aware that it is difficult to introduce change, research findings have no value if they are not implemented. After evaluating research

findings, nurses should incorporate these relevant findings in to their daily practice. The aim of nursing research is to provide healthcare professionals with evidence based practice guidelines, which improves the care of patient's (Prenhall 2005) (online).

The major implication that the findings of this study will have on nursing practice, is that it will question the methods in which nurses assess all patients to determine who is at risk of pressure ulcer development. This study highlights that using a visual risk assessment tool alone is not sufficient in the early detection of pressure damage. According to the manufacturers of the S.E.M. scanner Bruin Biometrics (2014), S.E.M. should be considered the 6th vital sign. Looking at this study's findings, perhaps this should be the reality

The results of this study show that the surgical patient proved 'at risk' of pressure ulcer development during their admission. This has an implication on future nursing practice because this study demonstrates that, those admitted for 'minor' surgery are also at risk of pressure damage. More interesting is that the Waterlow tool when used in this study, found that those surgical patients were deemed 'low risk', however did indeed experience elevated S.E.M. readings. Despite the patients' S.E.M. readings returning to normal this cannot be ignored. Prevention strategies should be implemented for these patient's also. This implicates nursing practice greatly, as nurses will now be more aware that 'low risk' patient's, according to the Waterlow tool are in fact susceptible to pressure damage.

Currently nursing practice believes that the most common risk factors associated with pressure ulcer development are immobility, impaired nutritional status and incontinence. According to the results of this study, mobility status was the only risk factor to positively correlate with elevated S.E.M. readings. Again the findings of this study will allow the nursing profession to concentrate on their patients' mobility status, therefore reducing the risk of pressure ulcer development.

6.5.2. Education

As discussed earlier in this chapter, it is the researcher's intention that this study will be published in peer reviewed journals and presented at international conferences. Doing this allows the findings of this study to be validated throughout the nursing research community. Such validation could lead to the findings of this study being introduced to nursing students of undergraduate and postgraduate programmes. If we are to believe S.E.M. results, it will change the way we teach student nurses about pressure ulcers. It is the intention of this researcher that the findings of this study are incorporated in to the teaching plans delivered to our upcoming nurses. Education is essential for the successful implementation of effective prevention strategies in to our daily routine. And the inclusion of all members of the multi-disciplinary team, such as healthcare assistants, occupational therapists and physiotherapists will be essential. It is important to realise that pressure ulcer development is not a condition specifically designed for the elderly population and that anyone of any age is predisposed to pressure damage. Such misunderstandings on the causes of pressure damage and pressure ulcer development have been detrimental to the care of our patient's.

It is the intention of the researcher with the approval of the Nursing and Midwifery Board of Ireland, to integrate the findings of this research in to their category 1 approved study days. This will allow the researcher to share the findings of this study amongst all registered nurses, who have completed their full time education. It is the aim of the researcher that such study days will allow those in attendance to take away the findings of this study and share with their colleagues in their place of employment (i.e. rehabilitation centres, public health nurses and nursing homes). In this way, the findings of this study will be dispersed across all healthcare settings, perhaps changing the way nurses will assess for pressure ulcer development forever.

6.5.3. Further Research

It is the hope of this researcher that this study provides a foundation, that other researcher's may be able to build on with future work. While this study may have demonstrated that, the use of visual risk assessment tools alone is no longer sufficient. It is important to note that this study used one version of each risk assessment tool (Waterlow and universal pain scale). Perhaps the use of other tools may yield varied results. Therefore, further research is indeed needed. Also clarity surrounding the idea that impaired mobility status is the sole cause of pressure ulcer development would be beneficial. Clarity like this could result in significant changes in wound care guidelines and alter the way patients are managed in any healthcare setting. Measuring S.E.M. is still a relatively new concept. While the positive outcomes from assessing S.E.M. levels have been found in the studies by Bates-Jensen *et al.* (2007, 2008, 2009), Guihan *et al.* (2012) and indeed this study, further investigation is still needed

6.5.4. Management

'Professional nursing organizations and individual nurse leaders are united in identifying the need for research that will help build a scientific knowledge base for nursing practice' (Prenhall 2005 p. 23) (online).

The findings of this study have suggested that the prevalence rate of pressure ulcers has been grossly underestimated (6.4% versus 51.6%). This has major implications for all nursing managers. It concluded by stating that the use of the visual risk assessment tool alone is insufficient. Therefore, another method of risk assessing is necessary. This study utilised the S.E.M. scanner to determine prevalence. Somewhat new to nursing practice, the S.E.M. scanner is not in use in all healthcare settings. Therefore, nursing managers will have to ensure that full training is provided, if S.E.M. scanning was to be implemented in to nursing practice. It will also be the responsibility of the nurse managers that their staff nurses receive follow on training in the area of skin scanning, which will allow them to adequately assess their patient's. Also if a skin scanning device is incorporated in to nursing care full time, it will be the responsibility of the nurse

manager that the device be correctly calibrated and in perfect working order. Therefore, an open line of communication between nurse managers and the medical equipment maintenance team will be essential.

Another implication of the findings of this study for nursing management will be auditing the success of the S.E.M. Auditing allows the healthcare setting to determine if an intervention is positively or negatively impacting patient care (Bjorvell *et al.* 2000). The nurse manager will have to keep up to date files that will validate if trends of pressure ulcer development are increasing or decreasing. Such audits are essential to perform and keep a strict record of, as agencies such as the Health Information and Quality Authority (HIQA) require these to ensure high quality patient care is being delivered at all times.

6.5.5. Study Recommendations

Further research is needed in this area as this study was performed at a small study site. Firstly, the findings of this study have indicated that S.E.M. scanning does detect early pressure damage. Therefore, the researcher recommends the wider use of the S.E.M. scanner in the area of early pressure damage detection. Secondly, taking these findings into consideration could lead to policy change within the healthcare organisation. A change in policy would change the way we assess our patient's for pressure ulcer development. This in return could reduce the number of pressure ulcers developing, which prolongs the patient's length of stay in hospital and puts financial strain both on the patient and on the health organisation. For the success of a change in policy, the researcher would recommend mandatory education sessions for all healthcare personnel. Providing education would allow successful implementation of policy change, encouraging staff to utilise the new policy and co-ordinate it into the care they deliver on a daily basis. Education should be used to empower and encourage staff to utilise these policies, so that the patient receives the gold standard of care. This gold standard of care is what all healthcare professionals should strive to deliver.

6.6. Reflections on the Performed Study

Over the past sixteen months a lot has been discovered regarding the fundamentals of the research process. To begin with, a huge amount of background work was carried out prior to study commencement. It was necessary for the researcher to learn as much as possible about the subject in question (pressure ulcer prevalence) and discover gaps in the current literature. Such gaps were the foundation of this study. Also the researcher needed to receive ethical approval prior to study commencement. Seeking ethical approval had not been carried out by the researcher before. Although a lengthy process, the researcher fully appreciates that the ethics committee is a vital component of any research project that ensures patient safety and confidentiality at all times.

Now that this study has been completed, the researcher has seen firsthand how study findings could actually influence nursing practice. This prospect is very exciting for the researcher, as this is the first research study that they have completed. The successful completion of this research study will also enable the researcher to be critical of the nursing care that they deliver and question if indeed they are delivering care that is evidence based.

6.7. Conclusion

Pressure ulcer development is highly regarded as a quality of care indicator (O'Tuathail & Taqi 2011). Therefore, it is of great importance that we implement pressure ulcer prevention strategies early. The findings of this study have indicated that it may be necessary to reconsider how patients are assessed for pressure ulcer development. It will be very exciting to see the dissemination of these findings over the coming months and to witness the reactions of my fellow academic colleagues in the area of pressure ulceration.

The findings of this research study led the researcher to believe that, while the use of the visual risk assessment tools have assisted previous researchers to

determine pressure ulcer prevalence, they may no longer prove to be the most efficient tool to be used in this manner. It appears that visual risk assessment tools may under estimate those at risk of pressure ulcer development. In return this could lead to the uneven distribution of resources. With this in mind, the researcher believes that this research study will contribute to health and social gain as it has demonstrated the direction for further research in this important clinical subject.

References

Arber A. (2004) Is pain what the patient says it is? Interpreting an account of pain. *International Journal of Palliative Nursing* 10(10), 491-496.

Babbie E. (2010) *Nursing Research: An Introduction. The Practice of Social Research*. 12th edn. Belmont, California, U.S.A. Wadsworth Cengage Learning.

Bates-Jensen B.M., McCreath H.E., Kono A., Apeles N.C. & Alessi C. (2007) Sub-epidermal moisture predicts erythema and stage 1 pressure ulcers in nursing home residents: a pilot study. *Journal of American Geriatric Society* 58(8), 1199-1205.

Bates-Jensen B.M., McCreath H.E., Pongquan V. & Apeles N.C. (2008) Sub-epidermal moisture differentiates erythema and stage I pressure ulcers in nursing home residents. *Wound Care Regeneration* 16(2), 189-197.

Bates-Jensen B.M., McCreath H.E., & Pongquan V. (2009) Sub-epidermal moisture is associated with early pressure ulcer damage in nursing home residents with dark skin tones: pilot findings. *Journal of Wound, Ostomy & Continence Nursing* 36(3), 277-284.

Baumgarten M., Margolis D., Berlin J.A., Strom B.L., Garino J., Kagan S.H., Kavesh W. & Carson J.L. (2003) Risk factors for pressure ulcers among elderly hip fracture patients. *Wound Repair and Regeneration* (11) 2, 96-103.

Benbow M. (2009) Quality of life and pressure ulcers. *Journal of Community Nursing* 23 (12), 14-18.

Bergstrom N., Braden B., Kemp M., Champagne M. & Ruby E. (1998) Predicting pressure ulcer risk: a multisite study of the predictive validity of the Braden Scale. *Nursing Research*, 47(5), 261-9.

Bjorvell C., Thorell-Ekstrand I. & Wredling R. (2000) Development of an audit instrument for nursing care plans in the patient record. *Quality Health Care* 9, 6-13.

Briggs M., Collinson M., Wilson L., Rivers C., McGinnis E., Dealey C., Brown J., Coleman S., Stubbs., Stevenson., Nelson E.A. & Nixon J. (2013) The prevalence of pain at pressure areas and pressure ulcers in hospitalised patients. *BioMed Central Journal* 12(19), 1-5.

Boston University School of Public Health. Advantages & Disadvantages of Cohort Studies. Available at:
http://sphweb.bumc.bu.edu/otlt/MPHModules/EP/EP713_CohortStudies/EP713_CohortStudies5.html. Accessed:16th April 2015

Bouten C.V., Oomens C.W., Baaijens F.P., & Bader D.L. (2003) The Etiology of Pressure Ulcers: Skin Deep or Muscle Bound? *Archives Physical Medicine & Rehabilitation* 84, 616-619.

Bowling A. (2009) *Nursing in Research* 2nd edn. Sage Publications, New York, U.S.A.

Briun Biometrics. (2014) S.E.M Scanner Overview. Available at:
<http://www.bruinbiometrics.com/en/sem/sem-scanner-overview>. Accessed:2nd
February 2015.

Burns G. & Grove S.K. (2001) *The Practice of Nursing Research, Conduct, Critique and Utilisation*.4th edn. Saunders, Philadelphia

Ceelen K.K. (2003) Aetiology of pressure ulcers: A literature review. Published MSc-thesis. Faculty of Biomedical Engineering, Eindhoven University of Technology.

Chamanga E.T. (2009) A Critical review of the Waterlow Tool. *Journal of Community* 24(3), 45-49.

Chen H.L., Chen X.Y. & Wu J. (2012) The Incidence of Pressure Ulcers in Surgical Patients of the last 5 years. A systematic review. *Wounds: A compendium of Clinical Research & Practice* 24(9).

Cherry C. & Moss J. (2011) Best Practices for Preventing Hospital-acquired Pressure Injuries in Surgical Patients. *The Journal of Peri-operative Nursing in Australia* 24 (2), 16-21.

Clendenin M., Jaradeh K., Shamirian A. & Rhodes S.L. (2015) The inter-operator and inter-device agreement and reliability of the S.E.M. scanner. *Journal of Tissue Viability* 24 (1), 17-23.

Dealey C., Posnett J. & Walker A. (2012) The cost of pressure ulcers in the United Kingdom. *Journal of Wound Care* 21 (6), 261-266.

Defloor T. & Schoonhoven L. (2004) Inter-rater reliability of the EPUAP pressure ulcer classification system using photographs. *Journal of Clinical Nursing* 13(8), 952-959.

Dodd T. (2008) Quantitative and qualitative research data and their relevance to policy and practice. *Nursing Research* 15(4):7-14.

Eng J. & Chan C (2013) Stirling's Pressure Ulcer Severity Scale-Clinical Summary. Spinal Cord Injury Research Evidence. Available at:
<http://www.scireproject.com/outcome-measures-new/stirling-s-pressure-ulcer-severity-scale>. Accessed: 16th January 2016.

Eng J. & Christie C. (2013) Norton Measure Clinical Measure. Spinal Cord Injury Research Evidence. Available at: <http://www.scireproject.com/outcome-measures-new/norton-measure>. Accessed: 16th January 2016.

EPUAP/NPUAP (2009) *Prevention of Pressure Ulcers: Quick Reference Guide* (Online) Available at:
<http://www.npuap.org/?s=prevention+of+pressure+ulcers%3A+quick+reference+guide>. Accessed 30th November 2014.

EPUAP/NPUAP/PPIA (2014) Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline. Available at:
<http://www.npuap.org/resources/educational-and-clinical-resources/prevention-and-treatment-of-pressure-ulcers-clinical-practice-guideline/>. Accessed 23rd June 2015.

Farrelly, P. (2012) Understanding the research process in school nursing. *British Journal of School Nursing* 7, 457–459.

Fox C. (2002) Living with a pressure ulcer: a descriptive study of patients' experiences. *British Journal of Community Nursing* 7(6), 10-22.

Gallagher P., Barry P., Hartigan I., McCluskey P. & O'Connor M. (2009) Prevalence of pressure ulcers in three university teaching hospitals in Ireland. *Journal of Tissue Viability* 17(4), 103-109.

Gethin G., Jordan-O'Brien J. & Moore Z. (2005) Estimating costs of pressure area management based on a survey of ulcer care in one Irish hospital. *Journal of Wound Care* 14(4), 162-165.

Gregoire G., Derderian F. & Le Lorier J. (1995) Selecting the language of the publications included in meta-analysis: is there a Tower of Babel bias? *Journal of Clinical Epidemiology* 48, 159-163.

Guihan M., Bates-Jenson B.M., Chun S., Parachuri R., Chin A.S. & McCreath H. (2012) Assessing the feasibility of sub-epidermal moisture to predict erythema and stage 1 pressure ulcers in persons with spinal cord injury: a pilot study. *Journal of Spinal Cord Medicine* 35(1), 46-52.

Gunes U.Y. (2008) A descriptive study of pressure ulcer pain. *Ostomy Wound Management* 54(2), 56-61.

Hayes R.M., Spear M.E., Lee S.I., Krauser-Lupear B.E., Benoit R.A., Valerio R. & Dmochowski R.R. (2014) Relationship between time in the operating room and incident pressure ulcers: a matched case-control study. *American Journal of Medical Quality* 30(6), 591-597.

Health Service Executive (2009) National best practice and evidence based guidelines for wound management. Stationery Office, Dublin.

Husain T. (1953) An experimental study of some pressure effects on tissues, with reference to the bed-sore problem. *The World's Knowledge* 347-358.

International Association of the Study of Pain (2002) Classification of Chronic Pain. Available at: <http://www.iasp-pain.org/files/Content/ContentFolders/Publications2/FreeBooks/Classification-of-Chronic-Pain.pdf>. Accessed: 26th January 2016

Ingham-Broomfield R. (2015) A nurses' guide to the critical reading of research. *Australian Journal of Advanced Nursing* 32(1).

Jackson M., McKenney T., Drumm J., Merrick B., LeMaster T. & VanGilder C. (2011) Pressure Ulcer Prevention in High-Risk Postoperative Cardiovascular Patients. *Critical Care Nurse* 31(4), 44-53.

Jones S. (2014) Embracing research in nursing practice. *British Journal of Nursing* 23(18), 994-997.

Kandola D., Banner D., O'Keefe-McCarthy S. & Jassal D. (2014) Sampling Methods in Cardiovascular Nursing Research: An Overview. *Canadian Journal of Cardiovascular Nursing* 24 (3), 15-18.

Kelly J. (2005) Inter-rater reliability and Waterlow's pressure ulcer risk assessment tool. *Nursing Standard* 19(32), 86-92.

Kosiak M. (1959) Etiology and Pathology of Ischemic Ulcers. *Archives of Physical Medicine & Rehabilitation*, 62-69.

Krebs E.E., Carey T.S. & Weinberger M.M. (2007) Accuracy of Pain Numeric Rating Scale as a Screening Test in Primary Care. *Journal of General Internal Medicine*. 22(10), 1453–1458.

Leaf Healthcare (2014) The Financial Impact of Pressure Ulcers. A review of the direct and indirect costs associated with pressure ulcers. White Paper.

Available at:

http://www.leafhealthcare.com/pdfs/LH_WP_FinancialOverview_1563AA_PD F_100514.pdf. Accessed: 18th January 2015.

Lindquist L.A., Feinglass J. & Martin G.J. (2003) How sedative medication in older people affects patients risk factors for developing pressure ulcers. *Journal of Wound Care* (12) 7, 272-275.

LoBiondo-Wood G. & Haber J. (2013) *Nursing Research*. 8th edn. Elsevier Inc, U.S.A.

Lourenco L. & Blanes L. (2014) Quality of life and self-esteem in patients with paraplegia and pressure ulcers: A controlled cross-sectional study. *Journal of Wound Care* 23(6), 331-337.

McGinnis E., Briggs M., Collinson M., Wilson, L., Dealey Carol., Brown, J., Coleman S., Stubbs, N., Stevenson R., Nelson E. A. & Nixon J. (2014). Pressure ulcer related pain in community populations: a prevalence survey. *BioMed Central Nursing* 13(1) 16-35.

Moore Z. (2005) Pressure ulcer grading. *Nursing Standard*. 19 (52), 56-64.

Moore Z. & Cowman S. (2009) Quality of life and pressure ulcers: a literature review. *Wounds* 5 (1), 58-65.

Moore Z. & Cowman S. (2012) Pressure ulcer prevalence and prevention practices in care of the older person in the Republic of Ireland. *Journal of Clinical Nursing* 21(3-4), 362-371.

Moore Z., Cowman S. & Posnett J. (2013) An economical analysis of repositioning for the prevention of pressure ulcers. *Journal of Clinical Nursing* 22(15) 2354-2360.

Moore Z. & Cowman S. (2014) Risk assessment tools used for preventing pressure ulcers. *Cochrane Wounds Group* 10(3).

Moseley G.L. (2004) Reconceptualising pain according to modern pain science. *International Journal of Palliative Nursing*.10(10), 491-6.

National Multiple Sclerosis Society (2016) How and Why do Scientists share Results? Available at: <http://www.nationalmssociety.org/Research/Research-News-Progress/How-and-Why-Do-Scientists-Share-Results>. Accessed: 20th January 2016.

National Pressure Ulcer Advisory Panel (2007) NPUAP Pressure Ulcer Stages/Categories. Available at : <http://www.npuap.org/resources/educational-and-clinical-resources/npuap-pressure-ulcer-stagescategories/>. Accessed 10th March 2016.

Nay R. & Fetherstonhaugh D. (2012) What is pain? A phenomenological approach to understanding. *International Journal of Older People Nursing* 7(3), 233-239.

O'Connor R. (2014). *What is the relationship between cell deformation and the common risk factors associated with pressure ulcer development?* Unpublished Thesis, School of Nursing & Midwifery, Royal College of Surgeons Ireland

O'Tuathail C. & Taqi R. (2011) Evaluation of three commonly used pressure ulcer risk assessment scales. *British Journal of Nursing* 20 (6), S27-S34.

Oxford (2015) *Dictionary* (Online) Available at: <http://www.oxforddictionaries.com>. Accessed 15th April 2015.

Pancorbo-Hidalgo P.L., Garcia-Fernandez F.P., Lopez-Medina I.M. & Alvarez-Nieto C. (2006) Risk assessment scales for pressure ulcer prevention: a systematic review. *Journal of Advanced Nursing* 54(1), 94–110.

Parahoo K. (1997) *Nursing Research: Principles, Process and Issues*. 1st edn. Palgrave MacMillan, United Kingdom.

Pedley G.E. (2004) Comparison of pressure ulcer grading scales: A study of clinical utility and inter-rater reliability. *International Journal of Nursing Studies* 41(2), 129-140.

Pieper B., Langemo D. & Cuddigan J. (2009) Pressure ulcer pain: a systematic literature review and national pressure ulcer advisory panel white paper. *Ostomy Wound Management* 55(2), 16-31.

Polit D.F. & Beck C.T. (2008) *Nursing Research: Generating and Assessing Evidence for Nursing Practice*. 8th edn. Lippincott, Williams & Wilkins, Philadelphia.

Prenhall E. (2005) *Research Designs*. Prentice Hall, New Jersey, U.S.A.

Primiano M., Friend M., McClure C., Nardi S., Schaffer M., Savochka K. & McNett M. (2011) Pressure Ulcer Prevalence and Risk Factors During Prolonged Surgical Procedures. *Association of peri-Operative Registered Nursing Journal* 94(6), 555-566.

Reddy N.P (1990) Effects of mechanical stress on lymph and interstitial fluid flows. In: Bader D.L. (eds) *Pressure sores, clinical practice and scientific approach*. Macmillan Press, 203-219.

Rutherford-Hemming T. & Feliciano M. (2014) The research process and simulation in nursing: What it is and what it is not? *Journal for nurses in professional development* 30(3), 127-33.

Saleh M., Anthony D. & Parboteeah S. (2009) The impact of pressure ulcer risk assessment on patient outcomes among hospitalised patients. *Journal of Clinical Nursing* 18(3) 1923-1929.

Šáteková¹ L., Žiaková K., & Zeleníková¹ R. (2015) Predictive validity of the Braden Scale, Norton Scale and Waterlow Scale in Slovak Republic. *Central European Journal of Nursing & Midwifery* 6(3), 283–290.

Schluer A.B., Cignacco E., Muller M. & Halfens R.J. (2009) The prevalence of pressure ulcers in four paediatric institutions. *Journal of Clinical Nursing* 18, 3244-3252.

Schoonhoven L., Defloor T. & Grypdonck M.H.F. (2002) Incidence of pressure ulcers due to surgery. *Journal of Clinical Nursing* 11, 479-487.

Sisco M., Liu W.R., Kryger Z.B. & Mustoe T.A. (2007) Reduced up-regulation of cytoprotective genes in rat cutaneous tissue the second cycle of ischemia-reperfusion. *Wound Repair and Regeneration* 15, 203-212.

Spilsbury K., Nelson A., Cullum N., Iglesias C., Nixon J. & Mason S. (2007) Pressure ulcers and their treatment and effects on quality of life: hospital inpatient perspectives. *Journal of Advanced Nursing*, 494-504.

Stekelenburg A., Gawlitta D., Bader D.L. & Oomens C.W. (2008) Deep Tissue Injury: How Deep is Our Understanding? *Archives Physical Medicine & Rehabilitation* 89, 1410-1413.

Stites M. (2013) Pain Scales in Critically ill Adults. *Critical Care Nurse* 33(3), 1-11.

Thompson B. (2005) Evaluating the Quality of Evidence from Correlational Research for Evidence-Based Practice. *Council for Exceptional Children* 71(2)181-194.

Tubaishat A., Anthony D. & Saleh M. (2011) Pressure ulcers in Jordan: a point prevalence study. *Journal of Tissue Viability* 20(1), 14-19.

van Dijk J.F.M., Wijck A.J.M., Kappen T.H., Peelen L.M., Kalkman C.J. & Schuurman M.J. (2012) Postoperative pain assessment based on numeric ratings is not the same for patients and professionals: A cross-sectional study. *International Journal of Nursing Studies* 49 (1), 65-71.

Vanderwee K., Clarke M., Dealey C., Gunningberg L. & Defloor T. (2007) Pressure ulcer prevalence in Europe: a pilot study. *Journal of Evaluation in Clinical Practice* 13(2), 227-235.

Webster J., Gavin N., Nicholas C., Coleman K. & Gardner, G. (2010) Validity of the Waterlow screening tool and risks for pressure injury in acute care. *British Journal of Nursing* 19(6), 14-22.

Webster J., Lister C., Corry J., Holland M., Coleman K. & Marquart L. (2015) Incidence and Risk Factors for Surgically Acquired Pressure Ulcers. *Journal of Wound, Ostomy and Incontinence Nursing* 42(2), 138-144.

World Health Organisation (1997) *Measuring Quality of Life* (Online) Available at: http://www.who.int/mental_health/media/68.pdf. Accessed 12th November 2014.

World Health Organisation (2009) WHO guidelines on Hand Hygiene in Health Care: First Global Patient Safety Challenge Clean Care Safer Care. Available at: <http://www.ncbi.nlm.nih.gov/books/NBK144027/>. Accessed: 24th January 2016.

Wright, K. M., Van Netten, Y., Dorrington, C.A. & Hoffman, G.R. (2014) Pressure injury can occur in patients undergoing prolonged head and neck surgery. *Journal of Oral & Maxillofacial Surgery* 72(10), 2060-2065.

University of Southern California Organizing Your Social Sciences Research Paper: Limitations of the Study. Available at: <http://libguides.usc.edu/writingguide/limitations>. Accessed 24th May 2015.

Appendices

Appendix 1: Braden Scale

Patient's Name _____		Evaluator's Name _____		Date of Assessment _____					
SENSORY PERCEPTION Ability to respond meaningfully to pressure-related discomfort	1. Completely Limited Unresponsive (does not moan, flinch, or grasp) to painful stimuli, owing to diminished level of consciousness or sedation OR Limited ability to feel pain over most of body.	2. Very Limited Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness. OR Has sensory impairment that limits the ability to feel pain or discomfort over half of body.	3. Slightly Limited Responds to verbal commands but cannot always communicate discomfort or the need to be turned. OR Has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.	4. No Impairment Responds to verbal commands. Has no sensory deficit that would limit ability to feel or voice pain or discomfort.					
MOISTURE Degree to which skin is exposed to moisture	1. Constantly Moist Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is moved or turned.	2. Very Moist Skin is often, but not always, moist. Linen must be changed at least once per shift.	3. Occasionally Moist Skin is occasionally moist, requiring an extra linen change approximately once daily.	4. Rarely Moist Skin is usually dry. Linen requires changing only at routine intervals.					
ACTIVITY Degree of physical activity	1. Bedfast Confined to bed.	2. Chairfast Ability to walk severely limited or nonexistent. Cannot bear own weight and/or must be assisted into chair or wheelchair.	3. Walks Occasionally Walks occasionally during day, but only for very short distances, with or without assistance. Spends majority of each shift in bed or chair.	4. Walks Frequently Walks outside room at least twice a day and inside room at least once every 2 hours during waking hours.					
MOBILITY Ability to change and control body position	1. Completely Immobile Does not make even slight changes in body or extremity position without assistance.	2. Very Limited Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.	3. Slightly Limited Makes frequent though slight changes in body or extremity position independently.	4. No Limitation Makes major and frequent changes in position without assistance.					
NUTRITION Usual food intake pattern	1. Very Poor Never eats a complete meal. Rarely eats more than ____ of any food offered. Eats 2 servings or less of protein (meat or dairy products) per day. Takes fluids poorly. Does not take a liquid dietary supplement. OR Has no oral intake and/or has been maintained on clear liquids or IV nutrition for more than 5 days.	2. Probably Inadequate Rarely eats a complete meal and generally eats only about half of any food offered. Protein intake includes only 3 servings of meat or dairy products per day. Occasionally will take a dietary supplement. OR Receives less than optimum amount of liquid diet or tube feeding.	3. Adequate Eats more than half of most meals. Eats 4 servings of protein (meat or dairy products) per day. Occasionally will refuse a meal, but will usually take a supplement when offered. OR Is receiving tube feeding or total parenteral nutrition that probably meets most of nutritional needs.	4. Excellent Eats most of every meal. Never refuses a meal. Usually eats 4 or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation.					
FRICTION AND SHEAR	1. Problem Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures, or agitation leads to almost constant friction.	2. Potential Problem Moves feebly or requires minimum assistance. During a move, skin probably slides to some extent against sheets, chair, restraints, or other devices. Maintains relatively good position in chair or bed most of the time, but occasionally slides down.	3. No Apparent Problem Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.						
Total Score									

Appendix 2: Norton Scale

The Norton Scale for Predicting Pressure Ulcer Risk*	
Criterion	Score
Physical condition	4 = Good 3 = Fair 2 = Poor 1 = Very bad
Mental condition	4 = Alert 3 = Apathetic 2 = Confused 1 = Stupor
Activity	4 = Ambulant 3 = Walk with help 2 = Chair bound 1 = Bed bound
Mobility	4 = Full 3 = Slightly impaired 2 = Very limited 1 = Immobile
Incontinent	4 = Not 3 = Occasionally 2 = Usually/Urine 1 = Doubly
*Calculated as the sum of the scores in all 5 areas. A score < 14 indicates a high risk of pressure ulcer development.	

Appendix 3: Waterlow Scale

WATERLOW PRESSURE ULCER PREVENTION/TREATMENT POLICY RING SCORES IN TABLE, ADD TOTAL. MORE THAN 1 SCORE/CATEGORY CAN BE USED

BUILD/WEIGHT FOR HEIGHT	♦	SKIN TYPE VISUAL RISK AREAS	♦	SEX AGE	♦	NUTRITION	
AVERAGE BMI (20 – 24.9)	0	HEALTHY	0	MALE	1	A - HAS PATIENT LOST WEIGHT RECENTLY	B - WEIGHT LOSS SCORE
ABOVE AVERAGE BMI (25 – 29.9)	1	DRY	1	FEMALE	2	YES – GO TO B	0.5 – 5kg - 1
OBESE BMI > 30	2	OEDEMATOUS	1	14 - 49	1	NO – GO TO C	5 - 10kg - 2
BELOW AVERAGE BMI > 20	3	CLAMMY, PYREXIA	1	50 - 64	2	UNSURE – GO TO C & SCORE 2	10 – 15kg - 3
BMI = WT(Kg)/ HT (m ²)		DISCOLOURED	2	65 – 74	3		> 15kg - 4
		STAGE 1		75 – 80	4		UNSURE - 2
		PRESSURE ULCER		81 +	5	C – PATIENT EATING POORLY/LACK OF APPETITE	
		STAGE 2 – 4	3			NO – SCORE 0	YES - SCORE 1
CONTINENCE	♦	MOBILITY	♦	SPECIAL RISKS			
COMPLETE/ CATHETERISED	0	FULLY	0	TISSUE MALNUTRITION	♦	NEUROLOGICAL DEFICIT	♦
URINE INCONT.	1	RESTLESS/FIDGETY	1	TERMINAL CACHEXIA	8	DIABETES, MS, CVA	4 - 6
FAECAL INCONT.	2	APATHETIC	2	MULTIPLE ORGAN FAILURE	8	MOTOR SENSORY	
URINARY + FAECAL INCONTINENCE	3	RESTRICTED	3	SINGLE ORGAN FAILURE	5	PARAPLEGIA (MAX OF 6)	
		BEDBOUND	4	(RESP, RENAL, CARDIAC,)		MAJOR SURGERY OR TRAUMA	
		E.G. TRACTION		PERIPHERAL VASCULAR	5		
		CHAIRBOUND	5	DISEASE			
		E.G. WHEELCHAIR		ANAEMIA (Hb < 8)	2	ORTHOPAEDIC/SPINAL	5
				SMOKING	1	ON TABLE > 2 HR*	5
						ON TABLE > 6 HR*	8
SCORE				MEDICATION			
10+ AT RISK				CYTOTOXICS, STEROIDS, ANTI-INFLAMMATORY MAX OF 4			
15+ HIGH RISK							
20+ VERY HIGH RISK							

Appendix 4: The LANSS Pain Scale

THE LANSS PAIN SCALE Leeds Assessment of Neuropathic Symptoms and Signs

NAME _____ DATE _____

This pain scale can help to determine whether the nerves that are carrying your pain signals are working normally or not. It is important to find this out in case different treatments are needed to control your pain.

A. PAIN QUESTIONNAIRE

- Think about how your pain has felt over the last week.
- Please say whether any of the descriptions match your pain exactly.

1) Does your pain feel like strange, unpleasant sensations in your skin? Words like pricking, tingling, pins and needles might describe these sensations.

- a) NO - My pain doesn't really feel like this..... (0)
- b) YES - I get these sensations quite a lot..... (5)

2) Does your pain make the skin in the painful area look different from normal? Words like mottled or looking more red or pink might describe the appearance.

- a) NO - My pain doesn't affect the colour of my skin..... (0)
- b) YES - I've noticed that the pain does make my skin look different from normal (5)

3) Does your pain make the affected skin abnormally sensitive to touch? Getting unpleasant sensations when lightly stroking the skin, or getting pain when wearing tight clothes might describe the abnormal sensitivity.

- a) NO - My pain doesn't make my skin abnormally sensitive in that area..... (0)
- b) YES - My skin seems abnormally sensitive to touch in that area..... (3)

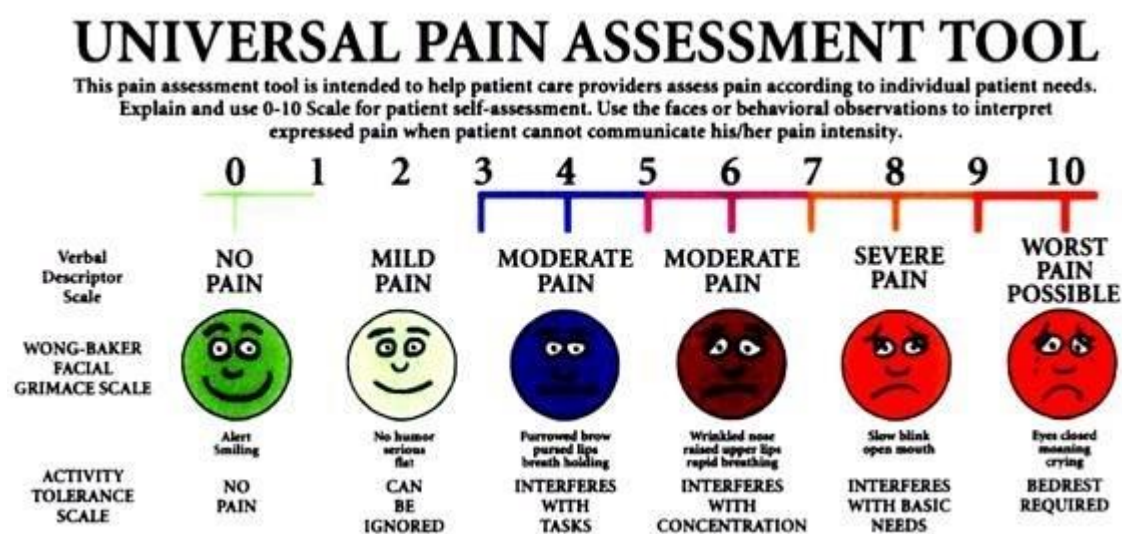
4) Does your pain come on suddenly and in bursts for no apparent reason when you're still. Words like electric shocks, jumping and bursting describe these sensations.

- a) NO - My pain doesn't really feel like this (0)
- b) YES - I get these sensations quite a lot (2)

5) Does your pain feel as if the skin temperature in the painful area has changed abnormally? Words like hot and burning describe these sensations

- a) NO - I don't really get these sensations..... (0)
- b) YES - I get these sensations quite a lot (1)

Appendix 5: Universal Pain Scale



Appendix 6: Quality Appraisal for Systematic Reviews

Steps for Conducting Systematic Reviews	Systematic Review		
	Yes (Y)	No (N)	Comment
Background			
Research Question			
Aim			
Objectives			
Criteria for selecting studies for review:			
Types of studies			
Types of participants			
Types of interventions			
Types of outcome measures			
Search methods for identification of studies			
Data collection			
Data analysis			
Results:			
Description of studies			
Risk of bias in included studies			
Effects of interventions			
Discussion			



ELM

PARK, DUBLIN 4

PARTICIPANT INFORMATION AND CONSENT FORM-

STUDY TITLE: What is the prevalence of pressure ulcers in the acute hospital setting?

NAME OF PRINCIPAL INVESTIGATOR: Director of Nursing

You are being invited to participate in a research study. Thank you for taking time to read this.

WHAT IS THE PURPOSE OF THIS STUDY?

The aim of the study is to determine the prevalence of pressure ulcers among patients in an acute hospital care setting in Ireland. A pressure ulcer is defined as the injury to a localised area of the skin. This injury is a direct result of pressure or shear (a force which acts in a opposite direction to the surface of your skin).

WHY HAVE I BEEN CHOSEN?

You are being asked to take part because your estimated length of stay in hospital is greater than 24 hours.

WHAT WILL HAPPEN IF I VOLUNTEER?

Your participation is entirely voluntary. If you initially decide to take part you can subsequently change your mind without difficulty. This will not affect your future treatment in any way.

If you decide to take part Rosalind (research nurse) will visit you a total of three times.

Day One:

1. She will carry out a visual skin inspection just like your nurse.
2. Your pain at your bony prominences (any point on the body where the bone is immediately below the skin surface) will be assessed using the universal pain scale.
3. Your skin will be assessed using a skin scanner (a hand held device that measures the moisture levels of the skin).

Day Two: The above steps are repeated.

Day Three: The above steps are repeated.

It is important to note, that all participants who partake in this study will remain anonymous.

ARE THERE ANY BENEFITS FROM MY PARTICIPATION?

You will not benefit directly from taking part in this study but the information we will obtain may provide further knowledge of this condition.

ARE THERE ANY RISKS INVOLVED IN PARTICIPATING?

There are no risks associated with this study.

WHAT HAPPENS IF I DO NOT AGREE TO PARTICIPATE?

If you decide not to participate in this study your treatment will not be affected in any way.

CONFIDENTIALITY

Your identity will remain confidential. A study number will identify you. Your name will not be published or disclosed to anyone.

COMPENSATION

N/A

WHO IS ORGANISING AND FUNDING THIS RESEARCH?

This study is organised by Rosalind O'Connor as part of her Masters Degree in nursing. No funding has been obtained in order to complete this study.

Will I be paid for taking part in this study? No

Will my expenses be covered for taking part in this study? N/A

HAS THIS STUDY BEEN REVIEWED BY AN ETHICS COMMITTEE?

The St. Vincent's Healthcare Group, Ethics and Medical Research Committee have reviewed and approved this study.

CONTACT DETAILS

If you require any further information regarding this study please contact:

Name: Rosalind O'Connor

Address: Royal College of Surgeons Ireland

Phone No:

Appendix 8: Consent Form

PLEASE TICK YOUR RESPONSE IN THE APPROPRIATE BOX

- I have read and understood the Participant Information YES ☐ NO ☐
- I have had the opportunity to ask questions and discuss the study YES ☐ NO ☐
- I have received satisfactory answers to all my questions YES ☐ NO ☐
- I have received enough information about this study YES ☐ NO ☐
- I understand that I am free to withdraw from the study at any time without giving a reason and without this affecting my future medical care YES ☐ NO ☐
- I agree to take part in the study YES ☐ NO ☐

Participant's Signature: _____ Date: _____

Participant's Name in print: _____

Investigator's Signature: _____ Date: _____

Investigator's Name in print: _____

Appendix 9: Consultants Letter



St. Vincent's Healthcare
GROUP LIMITED



Rosalind O'Connor
RCSI
St. Stephens Green
Dublin 2

30th March 2015

Dear Sir/Madam,

I am writing to you as a staff member in the chosen study site and as a MSc Research Nursing student in the Royal College of Surgeons Ireland. Currently I am conducting a pressure ulcer prevalence study within the chosen study site. As you are aware the development of pressure ulcers remain a growing concern for all healthcare professionals. The development of pressure ulcers can have a profound effect on the patient, as they can be a great source of pain and greatly delay the discharge process. I feel that performing a research study in this area would greatly benefit patient care.


This study will commence in the coming weeks. It will be carried out over three days. If your patients meet the study criteria they will be included. As this is a prevalence study, all nursing duties will continue to be performed on a daily basis. The results and outcomes of this study will be distributed upon completion. This study and all of the relevant documentation has been approved by the SVHG research and ethics committee. I would be delighted to answer any queries that you may have regarding this research study by email:

Yours Sincerely,

Rosalind O'Connor

Appendix 10: EPUAP Minimum Data Set

SUMMARY REPORT ON THE PREVALENCE OF PRESSURE ULCERS



30077

Hospital identification number

0 1 2 3 4 5 6 7 8 9

0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0

European Pressure Ulcer Prevalence Study Minimum Data Set

General Data

Setting

☐ University Hospital

☐ General Hospital

☐ Local Hospital

Number of Beds

☐ > 1000

☐ 500 - 1000

☐ < 500

Country

☐ Belgium

☐ Denmark

☐ Finland

☐ France

☐ Germany

☐ Greece

☐ Hungary

☐ Italy

☐ Netherlands


☐ Portugal

☐ Spain

☐ Sweden

☐ United Kingdom

☐ Other



Patient Data

Age

☐ < 12

☐ 12 - 18

☐ 19 - 39

☐ 40 - 59

☐ 60 - 69

☐ 70 - 79

☐ 80 - 89

☐ > 89

Gender

☐ Female

☐ Male

Broaden Scale

Sensory perception	Moisture	Activity
<input type="radio"/> Completely limited	<input type="radio"/> Constantly moist	<input type="radio"/> Bedfast
<input type="radio"/> Very limited	<input type="radio"/> Very moist	<input type="radio"/> Chairfast
<input type="radio"/> Slightly limited	<input type="radio"/> Occasionally moist	<input type="radio"/> Walks occasionally
<input type="radio"/> No impairment	<input type="radio"/> Rarely moist	<input type="radio"/> Walks frequently
Mobility	Nutrition	Friction and Shear
<input type="radio"/> Completely immobile	<input type="radio"/> Very poor	<input type="radio"/> Problem
<input type="radio"/> Very limited	<input type="radio"/> Probably inadequate	<input type="radio"/> Potential problem
<input type="radio"/> Slightly limited	<input type="radio"/> Adequate	<input type="radio"/> No apparent problem
<input type="radio"/> No limitations	<input type="radio"/> Excellent	

Incontinence

☐ Not

☐ Occasional

☐ Usually/Urine

☐ Double

Care Group

☐ Neurology / Rehabilitation

☐ Intensive

☐ Chronic Care

☐ Acute Care / High Dependency

Expected Length of Stay

☐ < 6 days

☐ 6 days - 1 month

☐ > 1 month

Skin observation

Most severe pressure ulcer

☐ None

☐ Non-blanchable erythema

☐ Blister / Abrasion

☐ Superficial ulcer

☐ Deep ulcer / Necrosis

Location(s) of most severe pressure ulcer(s)

☐ Sacrum

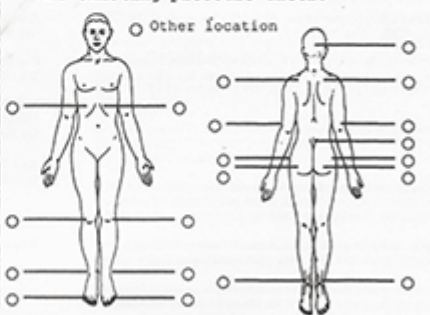
☐ Heel

☐ Hip

☐ Other

All existing pressure ulcers

☐ Other location



Prevention

Equipment

In bed

☐ No special equipment

☐ Non-powered device

☐ Powered device

Repositioning

In bed

☐ No planned/irregularly

☐ Every 2 hours

☐ Every 3 hours

☐ Every 4 hours

In chair

☐ No special equipment

☐ Non-powered device

☐ Powered device

In chair

☐ No planned/irregularly

☐ Every 2 hours

☐ Every 3 hours

☐ Every 4 hours

Appendix 11: S.E.M Scanner



SEM Scanner top view



SEM Scanner bottom view

Appendix 12: Illustration Skin Physiology

