

Norton, Waterlow and Braden scores: a review of the literature and a comparison between the scores and clinical judgement

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Aims and objectives. To consider the validity and reliability of risk assessment scales for pressure ulcers.

Background. Pressure ulcers are a major problem worldwide. They cause morbidity and lead to mortality. Risk assessment scales have been available for nearly 50 years, but there is insufficient evidence to state with any certainty that they are useful.

Design. A literature review and commentary.

Methods. Bibliographic databases were searched for relevant papers, a critical review was completed on relevant papers.

Results. There is contradictory evidence concerning the validity of risk assessment scales. The interaction of education, clinical judgement and use of risk assessment scales has not been fully explored. It is not known which of these is most important, nor whether combining them results in better patient care.

Conclusions. There is a need for further work. A study exploring the complex interaction of risk assessment scales, clinical judgement and education and training is introduced.

Relevance to clinical practice. Nurses may be wasting their time conducting risk assessment scoring if clinical judgement and/or education are sufficient to assess pressure ulcers risk.

Key words: clinical judgement, nurses, pressure ulcer, reliability, risk assessment, validity

Introduction

This paper is primarily concerned with answering the questions 'are risk assessment scales (RASs) valid and reliable?' and 'which of these clinical judgement and RASs are superior?' The path to answering these related questions commences with an introduction to the subject area, then describes the three most common RASs. Other reviews of RASs are then described to show the gap in knowledge which this review explores. To evaluate validity the items included in RASs are next identified and how these are used to compute an overall score. Reliability is next addressed as RASs are normally completed not only more than once, but by more than one clinician. Evaluation explores validity, reliability and outcomes and studies evaluating RASs are next examined. How RASs are actually used and whether they are better than clinical judgement is next considered. Finally problems in comparing clinical judgement and RASs are stated and suggestions for new work offered.

Search strategy

Cumulative index to nursing and allied health literature (CINAHL) was searched using medical subject headings (MeSH) keywords 'pressure ulcer'(PU) and 'risk assessment' for all papers 1960–May 2006 which gave 531 papers. Limiting to research or review papers gave 253. The earliest paper located was 1991 and there were further papers each subsequent year, with a trend of increasing numbers in later years. All available abstracts were read and assessed for relevance. Where no abstract was available the title was examined to determine the relevance. Full text papers that were evaluated to be relevant were obtained where possible. Additional papers that were known to the authors were also used.

Inclusion criteria

Papers that used quantitative methods to evaluate RASs. All papers that considered sensitivity, specificity, receiver operating characteristic, inter- and intra-observer reliability.

Exclusion criteria

Papers with no evaluation of RASs, for example papers employing a RAS within a trial where the validity, reliability or precision of the RAS was not evaluated. Editorials and journalistic articles with no primary data were also excluded.

Results

Pressure ulcers are not a new phenomenon. The first reference to PUs by a nurse that the authors can find was

in 1899 when Amy Hughes, a nursing sister, wrote a section in a medical book outlining PU prevention (Hughes 1899). She advocated vigorous massage of the buttocks, thought then to be appropriate, now thought to be a disastrous strategy. Dyson showed, in a sample of 200 patients, a 38% reduction in incidence of PUs in those who had not received massage (Dyson 1978). Doctors had discussed PUs earlier; a *BMJ* editorial in 1873 discussed PUs (Anonymous 1873), stating they should be left to dry out. This is also now thought to be the wrong approach, as Winter showed that sores heal much faster under an occlusive dressing (Winter 1962). The same year James Paget gave advice on how to treat them that was surprisingly similar to modern ideas, advocating diet as being crucial (Paget 1873), though his prescription of restricting meat and giving a little wine would be seen as suboptimal today. However, there are earlier references; PUs were described in the sixteenth century by Pare (Levine 1992) and Fabricus (Torrance 1983); Hildnaus used term decubitus in 1590 (Guggisberg *et al.* 1992); they have even been seen in Egyptian mummies (Torrance 1983).

There are many papers on prevention of PUs, and several clinical guidelines are available from reputable agencies that offer consistent and evidence based advice, e.g. the National Institute of Clinical Excellence (available from <http://www.nelh.nhs.uk>).

One might imagine, given the long history of PUs and the current availability of quality advice, nurses would be very familiar with prevention of PUs, and PU prevalence would be very low. However, the scale of the problem is huge; the European Pressure Ulcer Advisory Panel study found an overall prevalence of PUs in hospital patients in Europe of 18%, depending on patient group and care environment (Clark *et al.* 2004).

Why this remains the case is explicable for two related reasons:

- 1 Nurses are not always knowledgeable about PU prevention; for example, one audit showed deficiencies in knowledge of the staff and care given to prevent and manage PUs (Jones *et al.* 2003). Even in 2005, nurses in one Turkish study were still using massage and inflatable rings for PU prevention (Acaroglu & Sendir 2005), nearly 30 years after massage was generally considered dangerous and at least 20 after inflatable rings were similarly viewed. Inappropriate PU prevention advice was evident in the UK decades after it was widely discredited in the academic press (Anthony 1996).
- 2 PU prevalence and incidence are under-reported and thus nurses may not be aware of the true scale of the problem (Gunningberg & Ehrenberg 2004). If the true scale of the problem was evident nurses would presumably more

actively educate themselves on the appropriate prevention methods.

If nurses are to prevent PUs, clearly they need to be aware of what causes them and those risk factors that make them more likely to occur so preventative actions may be taken. Known risk factors have been used to create RASs which are described below.

Examples of RASs

Norton score

In the late 1950s and early 1960s a team working in London, including doctors and nurses were working on developing a RAS. Exton-Smith and Sherwin had shown that patients who move during sleep at least 20 times per night were less likely to develop PUs than those who moved less (Exton-Smith & Sherwin 1961). Mobility was clearly one factor, but in 1962 several other factors were added to mobility; incontinence, activity, mental state and physical condition to create the first RAS, the Norton score (Norton *et al.* 1962). The score was designed so that the lower the score the higher the risk of developing PUs.

Waterlow score

At the time of Norton's prominence in care units for older people in the 1980s (Spenceley 1988, Girvin & Griffiths-Jones 1989) a new tool, the Waterlow score was designed as a practical aid to the preventive aids and treatments available whilst at the same time promoting awareness of the causes of PUs and determined risk (Waterlow 1985, 1988, 1991). The Waterlow score is composed of the following risk areas; build/weight, continence, skin type, mobility, sex/age, appetite, tissue malnutrition, neurological deficit, surgery/trauma, specific medication and additional risk factors (such as smoking). The higher the score, the higher the risk of PU formation.

The Braden score

Around the same time as Waterlow devised her score, a further assessment tool, the Braden score, was being developed based upon the literature exploring the aetiology of PU formation. Braden and Bergstrom found the critical factors to be intensity and duration of pressure and tolerance to pressure (Braden & Bergstrom 1987). Other risk factors such as mobility, skin moisture and nutritional status were also incorporated. Each sub-scale has three to four levels all with an operational definition. Like the Norton score, low values are supposed to denote high risk of PU. Patients are deemed to be 'at risk' with a score of 16 or less.

Reviews of RASs

There are many reviews of RASs (Edwards 1994, Smith *et al.* 1995, Deeks 1996, Stotts 1999, Moore & Pitman 2000, Tarpey *et al.* 2000, Vap & Dunaye 2000, Defloor & Grypdonck 2004, Price *et al.* 2005, Thompson 2005, Maylor 2006). These reviews compare and contrast the various RASs, but there is no RAS that is clearly the best. As of 2005, there were over 40 different assessment tools (Thompson 2005). In part, the proliferation of RASs is because of the differing needs of different clinical areas; for example, neither the Waterlow nor Braden (both designed for hospital patients) seems to be suitable for wheelchair users in the community (Anthony *et al.* 1998). However, even in specific clinical areas, there is no agreed best RAS; for example, in paediatrics there are several competing RASs, and eight published risk assessment tools have been identified (Willock 2006). While some validation studies have been performed on the more common RASs, there are few studies that compare the RASs on the same population.

There has long been concern over the lack of conclusive data regarding the comparative merits of one tool over another (Flanagan 1995). However, Clark and Farrar found if threshold scores were set correctly, the choice of tool was relatively unimportant (Clark & Farrar 1991). Whilst difficulties still remain as to choice of instrument based on evaluations of their respective sensitivity, specificity and reliability scores, some have begun to question the application of the criteria with which judgements are made as to the efficacy and applicability of such a tool.

For example Waterlow has responded to some of the criticisms made regarding the validity and reliability of her tool (Waterlow 1996). She rejects the way validity is being used by 'trying to tie dubious measurements of specificity and sensitivity' and considers the definition of validity as being 'sound, well-grounded' more appropriate. Similarly, she argues how 'reliability' will be achieved by education and use over time, producing a reduction in pressure sores.' Furthermore, she is concerned over the use of the word 'predict' as 'at worst the word predict takes RASs out of their role of aids to prevention and puts them into the realm of prophesying pressure ulcer development' (Waterlow 1996, p. 58). This has been reiterated by Shakespeare who states that the risk score is not for the prediction of sore development, it is for the assessment and prediction of risk which can be influenced by many factors such as the quality of nursing care and medical advances (Shakespeare 1994).

If a high RAS score causes greater prevention measures, sensitivity will be lower, but what is happening is that, while the RAS appears to be poorer at prediction, it is in fact having

a beneficial effect on reducing PU incidence and is working well. For example, appropriate interventions and high quality nursing care could influence the incidence of PUs which in turn would show the RAS to be poorly performing with respect to sensitivity and specificity (Edwards 1996). To determine true sensitivity and specificity would mean withholding preventive intervention and allowing PUs to develop in vulnerable patients, which would be ethically unacceptable (Flanagan 1995).

Which risk factors should be included?

There are many factors other than those identified in the most common RASs (Norton, Waterlow and Braden) located in literature, including ethnicity (Zollo *et al.* 1996), low blood pressure (Van Marum *et al.* 2000) and many other factors have been proposed. Indeed over 200 risk factors have been reported for PUs (Salzberg *et al.* 1999), but these are not all relevant to all client groups, for example cigarette smoking (Salzberg *et al.* 1996) will not apply to neonates.

How are risk factors added to produce a score?

In the first RAS, Norton, the five risk factors were assigned a number from 1–4 where the lower the score the greater the risk. These were then summed to give a total score. The risk factors were assumed to be independent sub-scores of equal importance.

Waterlow has different score ranges for the 11 sub-scores. Thus the risk factors were assumed to be independent but not of equal importance, though these ranges of values were not derived via any validation studies. In Waterlow high scores are higher risk. Braden uses sub-scores 1–4 for sensory perception, moisture, activity, mobility, nutrition and 1–3 for friction/shear. Low scores are higher risk. All other RASs follow similar methods to compute a total score from sub-scores that are each measures of some risk factor. However, the weightings applied have rarely been subject to statistical analysis (for example regression analysis).

In all RASs the sub-scores are assumed to be linear, i.e. they are simply added to give a total score. However, non-linear models are possible; to compute a total score one might apply various functions to each sub-score. For example one could use trigonometric functions (sine, cosine, tangent etc), powers (square, cube etc.), logarithms, exponential transforms and many others. Common non-linear methods include artificial neural networks (ANNs). These consist of several layers of units that attempt to model (in a simple way) how a brain (that can deal with non-linear behaviour) functions. In ANNs, input values (here sub-scores) are fed into the model which is trained to associate inputs to outputs (here presence of not of PUs). Once trained the ANN should be able to state

how likely a patient will develop a PU given the sub-scores. In what the authors believe is the only study that considered non-linear modelling, linear modelling performed as well as ANNs, and so this may not be a serious limitation (Anthony *et al.* 2000).

How many factors are used and how these are added has been a subject of few studies. One large study evaluated the Walsall score and pain was taken out as a factor as it did not seem to increase risk (Chaloner & Franks 2000). Other studies have shown removing sub-scores from Waterlow allow similar or better prediction of incidence, but the sub-scores removed are different for various client groups (Anthony *et al.* 1998,2000). Thus, simply adding more factors is not necessarily going to improve a score, and the particular factors that are relevant vary across clinical areas. This does not mean the factors are not relevant to PU incidence in general, but this may not apply to some groups. For example in wheelchair users in the community, recent surgery (one sub-score of Waterlow) was not predictive of PUs, but none of the population had surgery recently, so it clearly would not distinguish between those with and those with no PU.

Are RASs reliable?

In some studies, they are shown to be so; for example, in a Spanish context the Braden and Norton both were reported to have good interobserver reliability (Caja *et al.* 1998), a clear requirement in any clinical area where more than one nurse may make assessments. Braden was also found to show good interobserver reliability in the Netherlands (Bours *et al.* 1999). The Waterlow score showed poor inter-observer reliability according to one study (Kelly 2005), though the statistical approach in that study was suboptimal (as exact agreement was measured and similarity would be preferred).

It is possible that the Waterlow score is inherently less reliable than Norton or Braden, but other factors such as training on use of the tool will affect the reliability. For example there may be confusion over how to assess risk items such as nutrition (Kelly 2005).

One particular problem that may appear to show a given RAS is unreliable is that the data collected may be inaccurate. For example almost half of Waterlow scores collected on a Hospital Information Support System were impossible given the patient's age and gender, and it is not known that even the remaining data are accurate (Anthony *et al.* 2003). Further independent risk assessment showed poor agreement with nursing staff assessments (Scott & Newens 1999).

Bridel found the Braden tool to be the most reliable and that the 'validity of the tool is generally good and compares favourably in comparison with Norton and Waterlow scores'

(Bridel 1993). However, Edwards is more cautious and argues that the reliability of the instrument might be influenced by differences in the nursing profession especially in primary care nursing in North America (Edwards 1994). Furthermore, Edwards points out how the assessments were not carried out on admission to acute medical or surgical settings and may also have affected the results.

Evaluation of RASs

The validity and reliability of the tool were not seen to have been fully addressed and Bridel further notes how information such as the number of patients 'at risk' and incidence of PUs was omitted. Moreover, the reliability of the tool was judged as poor based on lack of comparative scoring, operational definitions and problems associated with interpretation of items (Bridel 1993).

In terms of content validity, the Waterlow score has been found to be intuitively preferred by ward nurses as it contains more of the items associated with risk (Wardman 1991, Dealey 1994) although certain items have been criticised as being crude and ambiguous, especially in the assessment of neurological disorders.

The Waterlow score, it has been argued, will inevitably achieve high sensitivity as it contains a score for skin damage (Edwards 1996). The tendency of the Waterlow score to over-predict risk status (Bridel 1993) has caused some to challenge its usefulness in care settings such as care units for older people (Wardman 1991, Dealey 1994). For example, in a comparative study, Clarke and Farra demonstrated that 57% of patients who progressed from being risk-free to 'at risk' using the Waterlow score *did not* develop PUs (Clark & Farra 1991). Edwards ascribes this over-prediction in older populations to the high weighting given to age and high levels of chronic illness (Edwards 1996). Whilst Bridel dismisses the tool in its use for calculating risk of PU formation, Edwards suggests it should be used more as a diagnostic than predictive tool.

Evaluation can be a complex process; it involves deciding for whom the evaluation is for and then deciding the outcomes that are important for that group. Thus it is quite possible to evaluate a RAS to determine its acceptance among the health professionals (e.g. nurses) who will use it. However, typical evaluation of RASs considers how well the tool predicts the occurrence of a new ulcer (sensitivity) or the non-occurrence of an ulcer (specificity). But there are concerns using sensitivity and specificity. The point of using a RAS is to decide whether a patient is at high risk of developing a PU. If nothing happened once the score was known then collecting the data and computing a RAS score would be a meaningless paper exercise. One would hope that

patients found to be high risk would be given PU prevention measures such as regular turning, special mattresses, nutritional support, etc. This, as stated above, would (and of course should) reduce sensitivity.

Arguably, a more valid way to evaluate the RAS is to identify if using the RAS in practice reduces PU incidence. In one study (Bergstrom *et al.* 1995), albeit with methodological weaknesses (Deeks 1996), substantial improvements in PU incidence was found over a four year period after implementation of a RAS.

How are RASs used in clinical practice?

In a study of the Braden scale, patients identified as at-risk according to the RAS had more prevention strategies present than the not-at-risk group, though the percentage of patients placed on a PU prevention programme was low for both groups (Pieper *et al.* 1997). More preventive care was given in high risks groups as measured by a modified Norton score (Mazzocco & Zampieron 2000). A greater number of prevention methods were employed on high risk patients (Goodridge *et al.* 1998). Higher risk was associated with increased nursing interventions (Prevost 1992). However, there was no relationship between level of risk (facility risk tool score) and type of prevention used in recent study published one year later (Richardson *et al.* 1998). In addition, most patients identified at risk received no appropriate preventative measures (Gunningberg 2005).

Is clinical judgement better than a RAS?

Gould *et al.* (2002,2004) used expert opinion to rate several patient scenarios in terms of risk using clinical judgement and compared these to the risk levels of ward nurses using both RASs and their own clinical judgement. Nurses' clinical judgement was close to expert opinion but the risk levels identified by RASs were not. Using the expert opinion as a gold standard, this would imply nurses' clinical judgement is superior to the risk identified by the RASs (Waterlow, Braden and Norton). However, it is plausible that both expert opinion and nurses' evaluation are wrong, and a check needs to be made against outcomes. Using PU incidence as an outcome measure showed that while RASs were poor, clinical judgement was worse (Defloor & Grypdonck 2005) and the Waterlow score performed better than Norton and informal nurse assessment (Charlier 2001).

Confounding factors in RASs

Simply requiring nurses to complete a RAS on each admitted patient (say) would be a pointless exercise for the following reasons:

The scores would be unreliable as each nurse might have a different perception of the interpretation of the sub-scores. For example the Norton sub-score for physical condition can be good, fair, poor or bad. But what do these words mean in clinical practice?

Higher risk scores might not lead to PU prevention strategies. To get reliable scores training is needed to allow nurses to set the same or similar scores for given patient conditions. To link higher scores to risk reduction strategies, education is needed.

Education improves PU prevention measures (Cole & Nesbitt 2004, Gunningberg 2004). PU risk reduction programmes are, generally, not merely educational but multi-modal, employing education combined with utilisation of a RAS and adoption of clinical guidelines and other actions, and these do reduce PU incidence (Regan *et al.* 1995, Xakellis *et al.* 1998). Active strategies such as education programmes were found in a review of interventions to be more effective (Maklebust *et al.* 2005) than passive ones, such as merely providing information.

Training and education could lead to improved patient outcomes even if no RAS were to be employed. Therefore, in any programme of implementing a RAS, where education and training are given during the implementation process, positive outcomes could be because of the RAS itself, education and training, or all three.

Conclusion

If one RAS worked well in all clinical groups then there would be no pressing need for another. The mere existence of so many tools suggests that this is not the case. There are specialized RASs for given clinical areas [e.g. paediatrics (Willcock 2006)] but even here there are several such tools (and in some other areas e.g. care of the older people), which further suggest that none is working ideally.

RASs are not perfect, but may be helpful in identifying patients who need higher levels of support. Clinical judgement should also be useful, and an experienced nurse should be able to identify a high risk patient in the absence of a RAS score. It seems that clinical judgement is not the same as the output of RASs. It is not clear which is better in terms of patient outcome.

After nearly 50 years of using RASs it is still not known if their use improves patient outcomes. For while RAS scores are different in patients who develop PUs than those who do not, clinical judgement might be as, or more, effective. Implementation of RASs has been shown to reduce PU incidence, but it is not clear if this is because the RAS is effective or if the education and training that accompany it increase clinical judgment ability.

Further work

In Saudi Arabia, the Braden scale is being implemented in the Riyadh Military Hospital. This gives an ideal opportunity to evaluate this RAS.

To disentangle the effects of clinical judgement, education & training and the RAS a study is underway. Braden scale scores are calculated by a tissue viability nurse specialist (TVNS) prior to implementation. Nurses give a clinical judgement on each of the patients who are assessed by the TVNS, but do not know the Braden scale score. Subsequently, several wards will be given education and training as part of a programme implementing the Braden scale. A similar group of wards will have the same education and training, but not implementation of the Braden scale. Outcome in terms of PU incidence will be measured.

It should be possible to show whether the RAS (Braden in this case) with education and training is superior to education and training alone.

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