

Pressure ulcers risk assessment: Clinical practice in Spain and a meta-analysis of scales' effectiveness

By

Pedro L. Pancorbo-Hidalgo

Nursing Department. School of Health Sciences, University of Jaén. GNEAUPP Committee Director.

Francisco P. García-Fernández

Training, Research and Quality Unit, Jaén HospitalComplex. GNEAUPP Committee Director.

J. Javier Soldevilla-Agreda

Clinical Management Area, Infectious Disease and Preventive Medicine, Riojan Health Service. Professor of Geriatric Nursing, Nursing School of Logroño. GNEAUPP Director.

Fernando Martínez-Cuervo

Director of the Polyvalent Resource Centre for the Elderly "La Vega", Mieres, Principdom of Asturias. GNEAUPP Committee Director.

Correspondence:

Pedro L. Pancorbo

Hidalgo Departamento de Enfermería

University of Jaén.

23071-Jaén

E-mail: pancorbo@ujaen.es

SUMMARY

Objectives: 1) To update the knowledge about pressure ulcer risk assessment scales (EVRUPP): validation, efficacy and risk prevention. 2) Identify the methods used for assessing the risk of developing pressure ulcers in actual clinical practice in Spain.

Methods: For the first objective a systematic review has been carried out of the literature with meta-analysis of the validation studies. the search was made on 14 bibliographical data bases with the descriptors “pressure ulcers”, “decubital ulcers“, “risk assessment” and their combinations. A critical assessment of the studies found, was made using the CASP guide. Each scale’s validation data were extracted and a meta-analysis was made for scales with 2 or more published studies. For the second objective a survey was made among nurses in pressure ulcers’ committees.

Results: 44 studies with validation data of 17 UPP risk assessment scales, have been selected. Only 5 scales have 2 or more validation studies: Braden, Cubbin-Jackson, EMINA, Norton and Waterlow. The scales with the highest predictive capability are Braden (OR = 5,1) and EMINA (OR = 7,14). The nurses’ clinical judgement, by itself, do not have sufficient UPP risk prediction capability. In intensive care patients the scales with the best predictive capability are: Cubbin-Jackson (OR = 6,63) and Braden (OR = 3,02). A great majority (67,3%) of nurses surveyed stated that they always assessed the risk of UPP; the most frequent procedure was the use of an EVRUPP (46,2%). The EVRUPP most frequently used in Spain are, in this order: Braden, Norton, modified Norton, Cubbin-Jackson and EMINA. The number and type of preventive measures used is associated with the patients’ UPP risk level.

Conclusions: The EVRUPP with the best validation and capability indicators are Braden, EMINA and Norton (original). The use of one of these scales is greater than of clinical judgement only in the UPP risk prediction. In intensive care, the scales with a better behaviour are Braden and Cubbin-Jackson⁸⁵. Among the Spanish nurses surveyed, the UPP risk assessment is a habitual practice and the majority use the Braden and Norton scales

KEYWORDS

Pressure ulcers, risk assessment scales, systematic review, meta-analysis, clinical practice.

INTRODUCTION

The pressure ulcers (UPP) constitute an important health problem that affects all developed healthcare

systems (1). In Spain they have a considerable epidemiological impact by their prevalence – that data from 2005 estimate as 8,91% in hospitals and 9,11% in primary care centres (2)-, as well as their mortality (3).

The assessment of a patient's risk of developing UPP is a key aspect of prevention. The clinical practice guidelines recommend a risk assessment of all persons at their first contact with the healthcare system in hospitals, geriatric centres or patients cared for at their homes (4). The risk identification will permit the early application of prevention measures. Nevertheless, there is no clear consensus among experts and professionals about the best way to make this assessment of UPP. Some of the oldest clinical practice predictive guidelines consider as fundamental the nurses' clinical judgement and the use of assessment scales as a complement (5,6), while other recent investigations conclude that several validated scales can be a better alternative than clinical judgement, especially with novice nurses (7). A recent review finds five additional advantages in the use of risk assessment scales: ensures the efficient and effective allocation of limited preventive resources; serves as a support for clinical decisions; permits the adjustment of cases as a function of the risk in epidemiological studies; facilitates the development of risk assessment and can serve as a proof in cases of litigation (8).

The literature (9) describes up to 22 pressure ulcer risk assessment scales (EVRUPP), and the number keeps increasing since new scales are still being developed and proposed. Among this group of scales there are some for general use in any assistance context, and others are aimed at specific patients or contexts – critical care, paediatrics, home care --. Nevertheless, their majority have not been subjected to an adequate validation process, therefore there is no guarantee for their validity. These two factors – many scales and lack of validation – contribute to the existing confusion about their use in clinical practice ⁴¹. The problem is well illustrated by the case of the Norton scale since, besides the original version, there are many variants of this scale with significant variations among them, which creates great difficulties for understanding when reference is made to them.

The existing information on the degree of utilisation of the EVRUPP in clinical practice is limited. A recent study in the Autonomous Community of Andalusia states that 43,2% of nurses declare that they always use a scale for assessing risk, 40,3% do it sometimes and 10,1% never use one (10). Data from the Second National UPP Prevalence Study, of 2005, indicate that the use of scales among Spanish nurses is between 58,6% (in Primary Care centres) and 86% in hospitals, and the most used scales are Norton, Braden and Norton-INSALUD (2). In other countries the degree of usage of scales is very variable: between 72% in the UK (11) and 21% in Australia (12). About which scales are the most used by nurses, the information is almost nonexistent.

OBJECTIVES

This investigation deals with the following objectives:

- Update the knowledge of validation parameters and the efficacy of scales for assessing the risk of developing pressure ulcers.
- Identify the scales with published validation studies.
- Compare the capability for predicting the risk of the different scales and of the isolated clinical judgement.
- Identify the scales aimed at specific patients or contexts (critical and paediatric care).
- Identify the methods used for assessing the risk of developing pressure ulcers in actual clinical practice in Spain at the different assistance levels.

METHODS

Validation and Efficacy of the scales ⁴²

Using meta-analysis we updated a systematic review that included articles published until January 2004 (7), with articles published from that date until December 2007.

Search strategy

We made a bibliographical search throughout the entire scientific output related to the use of EVRUPP in the clinical practice. For the search we used 14 bibliographical data bases: *Database of Abstracts of Reviews of Effectiveness (DA-RE)*, *Cinahl*, *Medline*, *Currents Contents: Clinical Medicine, Social and Behavioural Sciences, Life Sciences*, *Spanish Medical Index (IME)*, *Cuiden Plus*, *Latin American and Caribbean Information Centre on Healthcare (LILACS)*, *Cochrane Library*, *EBS-CO*, *ScienceDirect*, *Springer*, *Inter-Sciencia*, *ProQuest* and *Pascal*. We used the following terms as descriptors: “pressure ulcers” o “decubital ulcers” and “risk assessment”; in some data bases we combined them with the term “clinical trial”. Additionally, we did an inverse search starting from the bibliographical references of the selected studies. For the localisation and retrieval of unpublished studies we assessed reports, national and international congress records, as well as consultations to experts in the subject.

Inclusion criteria

Controlled clinical trials and prospective cohort studies. In these, the patients included in the study do not present UPP at the beginning, in order to ensure the predictive validity of the scale.

Studies whose percentage of patients followed during the specified period is larger than 75%. That is, the loss of patients is not larger than 25% according to the habitually established criterion (13). Patients are systematically followed during the established period.

Studies that provide scale data with predictive validity (sensitivity and specificity) or the raw data

necessary to carry out their calculations. *Studies published in one of the following languages:* Spanish, English, French and Portuguese.

Exclusion Criteria

Studies in which the same data has been used for generating the scale and for establishing its validity. This is because in this case the sensitivity and specificity values are not reliable. Nor have we included retrospective studies due to the higher possibility of biases and their lower reliability.

Assessment of methodological quality

For the critical assessment of identified studies, we used the CASP guide (*Critical Appraisal Skills Programme*) for the bibliographical search. Each study was independently assessed by two investigators. In case of discrepancies in its consideration as valid, a third investigator examined the study and decided on its acceptance.

Data extraction

The data from each study accepted as valid were recorded on a data extraction sheet. Two investigators independently extracted the data from each valid study. To minimise biases, we prepared a list with operational definitions of the variables considered.

Validity indicators

- *Sensitivity*. It measures the proportion of true positives among the cases. Or the percentage of patients with UPP identified by the EVRUPP, among all UPP patients.
- *Specificity*. It measures the proportion of true negatives among the controls, i.e. the percentage of patients that the EVRUPP classifies as risk-free and that finally do not present UPP.
- *Positive predictive value*. It measures the proportion of true positives among those exposed. i.e. the percentage of patients who develop UPP among all classified as risk prone.

- *Negative predictive value*. It measures the proportion of true negatives among those not exposed, i.e. the percentage of patients who do not present UPP among all classified as risk-free ⁸⁶.
- *Efficacy or correct percentage*. It measures the proportion of true positives and true negatives among the total number of patients, i.e. the sum of correctly classified patients.
- *Area under the curve (AUC)*.

These were calculated for verification from raw data provided by the authors of each study, in all cases where this was possible. When one of these indicators in the original study or the efficacy indicator were missing, the value calculated from the data by the reviewers was used.

For their joint analysis we have calculated the weighted mean values according to the model of random effects that takes into account diverse elements as sample size, distribution, etc., in a way that the more homogeneous and larger studies weigh more than those studies with smaller and more heterogeneous samples (14).

Effect indicators

The indicator of the magnitude of effect used has been the odds ratio or ratio of advantages (OR), understood as the quotient of the number of persons in a group with a characteristic, divided by the number of persons without that characteristic. An odds ratio of 1, or its confidence interval, indicate that there is no difference among the comparison groups. This risk indicator, odds ratio, was calculated from the data provided in the original studies.

In those EVRUPP that involved two or more valid original studies, a joint analysis of the indicators considered was made. Concretely, a meta-analysis has been made using also the random effect model (DerSimonian-Laird model), for the same cause previously expressed.

Use in clinical practice

We made a survey of use by professional nurses in their practice. 87 The professionals were those who attended the III National Meeting of Pressure Ulcer Committees held in November 2007 in Arnedillo (La Rioja). Thus, they are experts with a specific profile (members of committees that deal with ulcers, quality or care, depending on the centre, knowledgeable on the subject and all assistance contexts).

The survey was anonymous and performed voluntarily. It included items about generic issues (age, gender, community, years of experience, or work centre) and specific risk assessment issues (clinical judgement or scales, parameters referring to one or others, etc.), motives for selection, ease of use and clinical practice motivated by its use.

RESULTS

Scale Validation

We found 111 articles on pressure ulcer risk assessment scales (Fig. 1). Of those, 26 were review studies or other methodology that did not meet inclusion criteria (8, 15-39). Of the remaining 85, 13 were eliminated for being transversal studies (40-51); 24 because they lacked validation data and it was not

possible to find them (41, 52-74), and 5 had a high loss rate, limited sample or other biases (75-79).

Therefore, we have included for the final analysis 43 studies. Table 1 presents the main characteristics of the selected studies (author and year, scale and cut-off point, type of centre where it was made, participants, sample size, etc.).

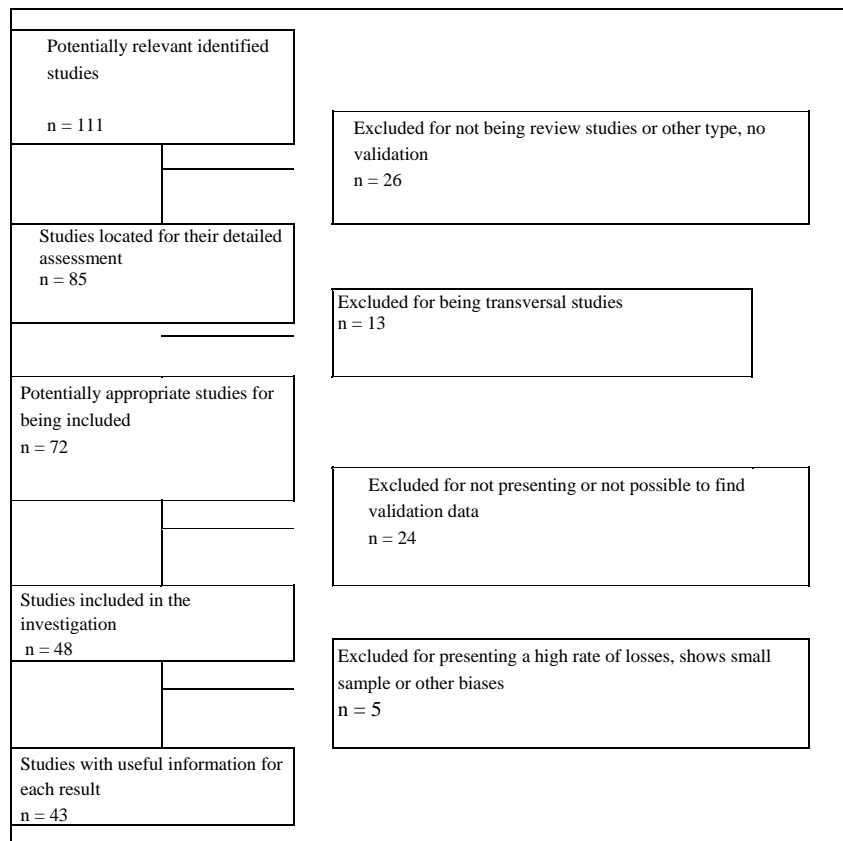


Fig. 1: Flow diagram of included and excluded studies.

Table 1

Validation and Efficacy parameters of scales for the risk assessment of developing UPP

The 43 included studies (80-122) analyse a total of 17 scales, although only 5 of them have 2 or more validation studies and, therefore, can be considered validated (Braden, Cubbin-Jackson, EMINA, Norton and Waterlow). From them, the Cubbin-Jackson scale is designed for intensive care patients, for which it will be analysed in the section of specific contexts' scale.

Table 2 shows the analysis of validity weighted by means of the random effect model. The Braden with 24 studies (82-105) – although two of them with double populations (92, 93), reason for which actually are considered 26 studies – is the best validated scale, with almost 8.500 patients included. It is followed by Waterlow with 9 publications (103-111) and almost 3.000 patients; Norton with 8 studies (38, 102-105, 110-112) and almost 400 patients, and finally EMINA with only two validation studies (81, 117) and 861 patients. Nevertheless, the scale that presents the most efficacy is EMINA, although followed by Braden and Norton. The Waterlow scale has a very low efficacy, mainly due to a poor specificity.

The risk predictive capability⁴³ of the scales measured by means of the *odds ratio* and its confidence interval is presented in Table 3. The situation is similar to the validation parameters. The scale that presents the highest OR is EMINA, followed by Braden and Norton, the Waterlow scale being below the former.

Scale	n (number of studies) ^a	N (number of patients)	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negat. predictive value (%)	Efficacy (%)
Braden	26	8.423	68,6	62	34,5	87,8	65,2
EMINA	2	861	77,4	67,1	15,9	97,4	67,9
Norton	8	3.839	60,6	63,2	27,1	87,6	62,5
Waterlow	9	2.882	79,8	37,6	25,4	88,1	42,3
Clinical judgement	4	1.474	47,7	69,7	35,9	80,3	65,8

Scale	n (Number of studies) ^a	N (Number of patients)	OR	IC 95%
Braden	26	8.423	5,10	3,37 - 7,72
EMINA	2	861	7,14	3,86 - 13,19
Norton	8	3.839	4	1,77 - 9,03
Waterlow	9	2.882	2,84	1,46 - 5,53
Clinical judgement	4	1.474	2,45	0,94 - 6,37 NS

^aOnly have been included studies where it was possible to calculate the *odds ratio*. NS: Not significant.

Effectiveness of scales compared to nurses' clinical judgment

In the same tables 2 and 3 the validity and effectiveness of the different scales is compared to the clinical judgement. Although as we can see in Table 2, the nurses' clinical judgement has an efficacy very similar to that of the Braden scale, its sensitivity is very low, identifying as true positives at least half of the patients who really develop pressure ulcers. As for its effectiveness, the OR of 2,45 has no significance, since its confidence interval includes 1.

Specific context scales (critical and paediatric care) 92 In intensive care we can find three scales that have been validated in this environment: Braden with 5 specific studies (93-97) for patients admitted in ICU, Waterlow with three studies (106-108) and Cubbin-Jackson with 2 publications (95, 107). The latter scale is specific for these units and has been developed by professionals who work in them.

Table 4 shows the validation parameters. As we can see, the Braden and Cubbin-Jackson scales have very similar values, much higher than the Waterlow scale's efficacy, again. This fact is repeated in the effectiveness table (Table 5), where this scale is not efficacious (its interval includes 1). In this case, the Cubbin-Jackson scale has a better OR than Braden's, but its confidence interval is very wide due to the heterogeneity of both studies that validate it.

Insofar as paediatric care, there are two specific scales. The first one is an adaptation of the Braden scale called Braden Q; the second one has been labelled Glamorgan scale. Both scales have only one validation study, therefore they cannot be considered formally validated.

Use of scales in clinical practice in Spain at all assistance levels.

The total amount of questionnaires validly fulfilled was 106, belonging to 16 autonomous communities (all except Murcia and the autonomous cities of Ceuta and Melilla). The profile of the surveyed professional is, by a majority, a woman (78,6%) with an average age of 43,4 years, (range between 24 and 57 years) with 20 years of professional experience. They work in practically equal numbers in health centres and hospitals at 41%. In elderly care residences, the work proportion is 14%, and in other centres – mostly universities – 4%.

67,3% always assess the risk of developing pressure ulcers, 27,9% assesses generally, and only 5% never or rarely assesses. As to when they make the assessment, 61,4% does it at admission, 25,7 %

regularly, 11,9% when the patient’s situation changes, and only 1% when the caretaker’s situation changes. In Fig. 2 we can see how the surveyed professionals assess risk. Fundamentally, it is made by means of a scale, followed by the combination of the scale with the clinical judgement with almost 19%. The same percentage uses only clinical judgement.

Professionals who use clinical judgement assess an average of three risk factors. The most used factors are nutrition, mobility and overall state, together with a sample of different values, among which are the patient’s age, characteristics of the caretaker, etc. If clinical judgement and scale differ, the majority of professionals – 33% - are inclined to favour the scale, 30,2% to his clinical judgement, 5,73% prefers his colleague to make the assessment, and 31,1% does not know or does not answer the question.

Table 4. Accumulated analysis of scale validity in intensive care. Average values weighted by random effects model.

Scale	n (number of studies) ^a	N (number of patients)	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)	Efficacy (%)
Braden (ICU)	5	429	79,2	39,8	45,1	74,9	56,3
Cubbin-Jackson	2	426	85,6	52	30,3	94,8	57,6
Waterlow (ICU)	3	1.001	83,1	26,4	9,1	95,2	31,2

Table 5. Meta-analysis of predictive capability of scales in Intensive Care. Random effects model

Scale	n (number of studies) ^a	N (number of patients)	OR	IC 95%
Braden	5	429	3,02	1,28 - 7,09
Cubbin-Jackson	2	426	6,63	1,9 - 23,09
Waterlow (UCI)	3	1.001	1,87	0,93 - 3,79 NS

^a Only included studies in which it was possible to calculate the *odds ratio*.
NS: Not significant.

Table 6 shows the most used assessment scales. As can be seen, Braden and Norton are the most used scales, while the modified Norton scales, Cubbin-Jackson and EMINA are very far behind from the former ones in their use. 71% of surveyed professionals say that they use this scale because it the one established in the protocol in their centre, 7,5% say they use it because of consensus in their unit, and 21,5% due to personal choice. 68,1% of professionals say that it is not difficult at all to apply the scale, 29,8% that it is somewhat difficult, and only 2,1% say its application is very difficult.

When professionals were asked if they use preventive measures as a function of the risk they identify with the scale, 36,2% said that they generally do, and 63,8% that they always do. No professional replied that he does not apply preventive measures.

As for applied measures, the surveyed professionals say they make one assignment as a function of risk. Thus, they apply, as an average, two preventive measures when the patient has a low risk (generally, the use of hyper-oxygenated fatty acids –AGHO- and postural changes). When the patient has a medium risk another preventive measure is added, mainly the use of a special pressure management surface, and when the patient has a high risk, 4 preventive measures are usually applied, mainly the three previous ones plus other local measures (skin care, local protection, dressings, etc.).

Table 6. Use of risk scales

Scale	Frequency	Percentage
Braden	41	44,1
Norton	38	40,9
Modified Norton	5	5,4
Cubbin-Jackson	5	5,4
EMINA	4	4,3
Total	93	100

DISCUSSION

First, we would like to emphasise that, although a high number of EVRUPP are described and published, only five of them can be considered formally validated (Braden, EMINA, Norton, Waterlow and Cubbin-Jackson).

Since the 2004 review and until December 2007, we have found 34 new studies, 12 of them have been added to the study and 22 have been excluded for different causes. This high number of articles about scales (almost 12 per year) justifies updating the review after 3 years of having made the previous one and not having waited 5 years, as usual.

The results of this meta-analysis confirm the efficacy of the Braden and Norton EVRUPP, according to data of the previous studies (7, 9), but it adds the new position of the EMINA scale in the high efficacy group. An important point to take into account is that the Norton scale presents lower reliability

in its original version and that there are numerous modified versions; but these have not been subjected to an adequate validation process.

As for the predictive capability of the scales, and like with the validation data, the EMINA scale presents the best values, followed by the Braden scale, then the Norton scale and, very far behind, by Waterlow. These data suggest that the EMINA scale could be considered as valid as the Braden scale. Nevertheless, more validation studies would be required, especially within the context of home care, where it has not been validated yet, but the data indicate that it could be a very useful scale, with the advantage that it has been developed in our midst and with clinical validity 95 within our sanitary context although, curiously as we will later point out, it is one of the least used scales in clinical practice.

Table 7. Preventive measures used as a function of risk			
Measure	Low risk	Middle risk	High risk
Hyper-oxygenated fatty acids	41,5%	50,9%	55,6%
Posture changes	39,6%	55,6%	65,1%
Special pressure management surfaces	22,6%	62,2%	75,5%
Dressings	4,7%	11,3%	15,1%
Local protection	16,0%	28,3%	31,1%
Skin care	28,3%	30,2%	31,1%
Other measures (nutrition, education)	17,9%	22,6%	30,2%
Number of preventive measures applied (Mean ± standard deviation)	1,71 ± 1,03	2,61 ± 1,36	3,04 ± 1,58

About clinical judgement we can say that it is not superior to assessment scales, since these emerged precisely to prevent the variability among observers and the judgement of trained nurses with less training. As we have seen, clinical judgement by itself is not effective in the prediction of risk of developing pressure ulcer, according to the currently published studies. These data confirm the results produced by the previous systematic review made by this investigative team and that differs from what was published by other authors (123, 124), having already four studies and almost 1.500 patients, that compare clinical judgement to scales, which appears to be an endorsement of sufficient strength for recommending professionals and sanitary centres to include a risk assessment scale to prevent the onset of pressure ulcers and not to leave it to the professionals' clinical judgement.

For intensive care, the validity and effectiveness studies show how the Cubbin-Jackson scale has

better values than Braden and Waterlow scales for patients admitted in critical care units. However, more validation studies should be made, especially in our midst with this scale. In any case, the Braden scale appears also as an effective one for ICU patients, being easier to apply than the Cubbin-Jackson scale.

For paediatric care, more studies are required for being able to recommend any scale. However, the specific Braden Q (114) and Glamorgan (116) scales seem to be valid but, as we say, we still cannot recommend them yet with the current data.

For clinical use of scales, for the first time in Spain a specific analysis is carried out about the degree of usage of scales in daily practice. It is true that in the two national prevalence studies professionals have been asked about their use but, in this case, the specific questionnaire about the use of scales – that besides has been complimented by leaders in pressure ulcer management over the whole national territory – permits us to have a snapshot, we think it is very precise, of the reality of its use at the different healthcare levels.

As we have seen in the results, two out of every 3 professionals always assess the risk, albeit in a still high percentage tends to use them generally but not always, and only 5% say that they never assess this risk, with the legal consequences that may derived from that. The nurses who do not assess because of that if the patient later develops an ulcer.

It is also surprising that, by a majority of professionals only assess the risk at admission time and only one of four assesses it regularly. We understand that the patients' situation is not static and therefore periodic assessment guidelines should be established or, at least, when the patient's or the caregiver's situation changes, as some clinical practice guides recommend (4).

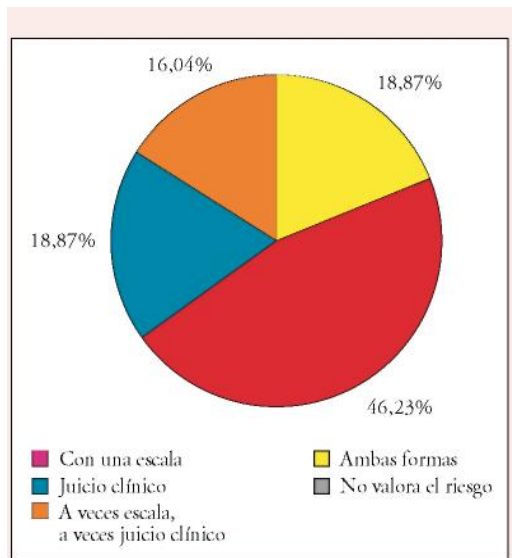


Fig. 2. How do you assess the risk of developing pressure ulcers?

Although the majority of surveyed professionals recognise that they use a risk assessment scale, still a high percentage states that they use the clinical judgement exclusively when, as we have seen, it is less efficacious than the use of scales. Therefore, and as it has been commented, we recommend the systematic use of a validated tool, as the risk scales are.

Curiously, when we ask professionals who only use clinical judgement what parameters they assess (nutrition, mobility, patient's state, etc.) they are parameters included by the majority of scales, for which we could suspect that they are making a mental adaptation of the risk assessment scales, but are not conscious about it.

The Braden and Norton scales are the most used by surveyed professionals, which coincides with data published in the national prevalence studies. It is striking to see how the EMINA scale, despite being a valid scale and developed in our country, has an almost marginal usage, even lower than a specific and more novel scale, developed in the Saxon environment, as Cubbin-Jackson is. Probably, the cause for this was that the majority of centres bets on these two scales, Braden y Norton, when evidence shows that the EMINA scale has similar parameters in validity and efficacy, or even superior, if we consider Norton. Nevertheless, the fact that it had been developed more recently it can influence by being less known or being already established in old protocols and records, which are not updated with the latest evidences.

Practically all surveyed professionals recognise that prevention measures always or generally apply as a function of the risk identified by the scale. Besides, the number of preventive measures increases

with risk, the fatty acids, posture changes and the use of special pressure management surfaces, being the basic triad of prevention measures used by almost all professionals for patients identified as risk prone. By using more measures as a function of risk, nurses are showing that they adapt and optimise to the maximum extent the available resources, which is another advantage of the assessment scales, since they permit the allocation of resources in a rational way in a system where they are limited.

CONCLUSIONS

The EMINA, Braden and Norton scales are valid and effective for assessing the risk of developing pressure ulcers. Besides, these scales are superior to clinical judgement in the prediction of that risk.

We recommend the healthcare institutions to include one of these scales (EMINA or Braden) in their prevention protocols. The original Norton scale can be an alternative, but it offers lower inter-observer reliability.

Braden and Cubbin-Jackson are valid scales for measuring the risk in patients admitted to intensive care units.

We cannot recommend any scale for their use on paediatric patients.

The majority of professionals assess the risk of developing pressure ulcers and they do, fundamentally, using a scale, mainly Braden or Norton 96.

Nurses who state that they use clinical judgement to determine the risk, assess parameters gathered by the principal assessment scales, thereby adapting such scales in an unconscious way.

Almost all professionals use preventive measures as a function of risk, which entails an optimisation of resources and adaptation of available means.

BIBLIOGRAPHY

1. Panagiotopoulou K, Kerr SM. Pressure area care: an exploration of graduate nurses' knowledge and practice. *J Adv Nurs* 2002; 40 (3):285-96.
2. Soldevilla Agreda JJ, Torra i Bou J, Verdú Soriano J *et al.* 2nd National Study on Prevalence of Pressure Ulcers in Spain, 2005. *Epidemiology and Defining Variables of Lesions and Patients*. *Gerokomos* 2006; 17 (3): 154-72.
3. Verdú Soriano J, Nolasco A, García C. Analysis of Mortality by Pressure Ulcers in Spain. Period 1987 - 1999. *Gerokomos* 2003; 14 (4): 212-26.
4. García Fernández F, Montalvo Cabrerizo M, García Guerrero A *et al.* Guide to Clinical Practice for the Prevention and Treatment of Pressure Ulcers. Sevilla: Andalusian Health Care Service, 2007.
5. Panel for the Prediction and Prevention of Pressure Ulcers in Adults. Pressure ulcers in adults: prediction and prevention. Clinical Practice Guideline 3. Rockville, MD. US: Department of Health and Human Services. Public Health Service. Agency for Health Care Policy and Research, 1992.
6. National Institute for Clinical Excellence. NICE. Pressure Ulcer risk and prevention. National Institute for Clinical Excellence. NICE. NHS., 2001.
7. Pancorbo Hidalgo PL, García Fernández F P, López Medina IM, Álvarez Nieto C. Risk assessment scales for pressure ulcer prevention: a systematic review. *J Adv Nurs* 2006; 54 (1): 94-110.
8. Papanikolaou P, Lyne P, Anthony D. Risk assessment scales for pressure ulcers: a methodological review. *Int J Nurs Stud* 2007; 44 (2): 285-96.
9. Moreno Pina J P, Richart Martínez M, Guirao Goris JA, Duarte Climents G. Analysis of Assessment Scales for the Risk of developing pressure ulcers. *Clinical Nursing* 2007; 17 (4): 186-97.
10. Pancorbo Hidalgo PL, García Fernández F P, López Medina IM, López Ortega J. Pressure ulcer care in Spain: nurses' knowledge and clinical practice. *J Adv Nurs* 2007; 58 (4): 327-38.
11. Hallett A. Managing pressure sores in the community. *J Wound Care* 1996; 5 (3): 105-7.

12. Sharp C, Burr G, Broadbent M, Cumminis M, Casey H, Merriaman A. Pressure ulcer prevention and care: a survey of current practice. *J Qual Clin Practice* 2000; 20: 150-7.
13. Sackett DL, Richardson WS, Rosenberg W, Haynes RB. Evidence-based medicine: How to practice and teach EBM. London. Churchill Li-vingstone, 1997.
14. García Fernández F P, Pancorbo Hidalgo PL, Gálvez Toro A. Assessment of quality of investigation designs (III). Systematic review and meta-analysis. Gálvez Toro A. Evidence-based Nursing: how to incorporate investigation to health care practice. 2 Ed. Granada: Fundación Index, 2007.
15. Buhner R, Mitchell P. Peer-identified expert nurses' approaches to risk assessment for pressure ulcers. *Adv Wound Care* 1996; 9 (1): 41-6.
16. Edwards M. The rationale for the use of risk calculators in pressure so-re prevention, and the evidence of the reliability and validity of publis-hed scales. *J Adv Nurs* 1994; 20: 288-96.
17. Deeks JJ. Pressure sore prevention: using and evaluating risk assessment tools. *Br J Nurs* 1996; 5 (5): 313-20.
18. Flanagan M. Choosing pressure sore risk assessment tools. *Prof Nurse* 1997; 12 (6 Suppl): S3-S7.
19. MacDonald K. The reliability of pressure sore risk-assessment tools. *Prof Nurse* 1995; 11 (3): 169-71.
20. Hamilton F. An analysis of the literature pertaining to pressure sore risk-assessment scales. *J Clin Nurs* 1992; 1: 185-93.
21. Bergstrom N, Braden B, Boynton P, Bruch S. Using a research-based assessment scale in clinical practice. *Nurs Clin North Am* 1995; 30 (3): 539-51.
22. Wellard S, Kai Lo S. Comparing Norton, Braden and Waterlow risk assessment scales for pressure ulcers in spinal cord injuries. *Contemp Nur-se* 2000; 9 (2): 155-60.
23. Haalboom JRE, den Boer J, Buskens E. Risk assessment tools in the prevention of pressure ulcers. *Ostomy Wound Manage.* 1999; 45 (2): 20-34.
24. Lyne PA, Papanikolaou P, Lycett E. Pressure-sore risk assessment: preliminary report of a study using multivariate methods to define and weigh risk factors. *Clin Effec Nurs* 1999; 3: 136-8.
25. Waterlow J. Reliability of the Waterlow score. *J. Wound Care* 1995; 4 (10): 474.
26. Rutledge DN, Donaldson NE, Pravikoff DS. Protection of skin integrity: progress in pressure ulcer prevention since the AHCPR 1992 guideline. *The Online Journal of Clinical Innovations* 2000; 3 (5): 1-67.
27. Bergstrom N, Braden BJ. Predictive validity of the Braden Scale among Black and White subjects. *Nurs Res* 2002; 51 (6): 398-403.
28. Lyder CH. Pressure ulcer prevention and management. *Annu Rev Nurs Res* 2002; 20: 35-61.
29. Papanikolaou P, Clark M, Lyne PA. Improving the accuracy of pressure ulcer risk calculators: some preliminary evidence. *Int J Nurs Stud* 2002; 39: 187-94.
30. Cooper P, Gray D. Pressure ulcer prevention. *Nurs Times* 2002; 98 (27): 34-6.
31. Llabata P, Carmona J V, Royo F, Escrivá R. Assessment of nursing knowledge on pressure ulcer scales. *Integral Nursing* 2005; (72): 28-33.
32. Thompson D. An evaluation of the Waterlow pressure ulcer risk-assessment tool. *Br J Nurs* 2005; 14 (8): 455-9.
33. Jackson P. Commentary on Defloor T & Grypdonck MFH (2005) Pressure ulcers: validation of two assessment scales. *J Clin Nur* 14, 373-382. *J Clin Nurs* 2006; 15 (2): 240-1.
34. Maylor ME. Complications of adapting pressure ulcer risk assessment scales. *Br J Nurs* 2006; 15 (6): S26-31.
35. Sharp CA, McLaws ML. Estimating the risk of pressure ulcer development: is it truly evidence based? *Int Wound J* 2006; 3 (4): 344-53.
36. Salcido R. Pressure ulcer risk: Gazing into a crystal ball? *Adv Skin Wound Care* 2006; 19 (6): 288, 290.
37. De Laat EH, Schoonhoven L, Pickkers P, Verbeek A, Van Achterberg T. Epidemiology, risk and prevention of pressure ulcers in critically ill patients: a literature review. *L Wound Care* 2006; 15 (6): 240-1.
38. Defloor T, Grypdonck M F. Validation of pressure ulcer risk assessment scales: a critique. *J Adv Nurs* 2004; 48 (6): 613-21.
39. Gray M. Which pressure ulcer risk scales are valid and reliable in a paediatric population? *J Wound Ostomy Continence Nurs* 2004; 31 (4): 157-60.
40. Ferrell BA, Josephson K, Norvid P, Alcorn H. Pressure ulcers among patients admitted to home care. *J Am Geriatr Soc* 2000; 48: 1042-7.
41. Perneger TV, Héliot C, Raë A-C, Borst F, Gaspoz J-M. Hospital-acquired pressure ulcers. Risk factors and use of preventive devices. *Arch Intern Med* 1998; 158: 1940-5.
42. Xakellis GC, Frantz RA, Arteaga M, Nguyen M, Lewis A. A comparison of patients risk for pressure ulcer development with nursing use of preventive interventions. *J Am Geriatr Soc* 1992; 40: 1250-4.
43. Vap PW, Dunaye T. Pressure ulcer risk assessment in long-term care nursing. *J Gerontol Nurs* 2000; 26 (6): 37-45.
44. Anthony D, Barnes D, Unsworth J. An evaluation of current risk assessment scales for decubitus ulcer in general inpatients and wheel-chair users. *Clin Rehabil* 1998; 12: 136-42.
45. Papanikolaou P, Lyne PA, Lycett E. Pressure ulcer risk assessment: application of logistic analysis. *J Adv Nurs* 2003; 44 (2): 128-36.
46. García AM, de la Rosa G, Garrido G, Rodríguez P. Norton scale. Is it valid as a predictive method for the development of pressure ulcers? *Medicina Preventiva* 1999; 5 (3): 24-7.
47. Soto Pino I, Zavala Gutiérrez M. Assessment of the risk of formation of pressure ulcers in the hospitalised elderly. *Gerokomos* 2003; 14 (3): 157-64.
48. Valls C, Sánchez A, Subirana M, Cadena R, Gich I. Validity of Norton scales for assessment of the risk of presenting pressure ulcers in a tertiary hospital. Comparison with the EMINA scale. *Enfer Clín* 2004; 14 (6): 313-7.
49. Esperón Güimil JA , Vázquez Vizoso FL. Nurses' knowledge on pressure ulcers and its determiners. *Geroko-mos* 2004; 15 (2): 107-16.
50. Tannen A, Bours G, Halfens R, Dassen T. A comparison of pressure ulcer prevalence rates in nursing homes in the Netherlands and Germany, adjusted for population characteristics. *Res Nurs Health* 2006; 29 (6): 588-96.
51. Balzer K, Pohl C, Dassen T, Halfens R. The Norton, Waterlow, Braden, and Care Dependency Scales: comparing their validity when identifying patients' pressure sore risk. *J Wound Ostomy Continence Nurs* 2007; 34 (4): 389-98.
52. Hodge J, Mounter J, Gardner G, Rowley C. Clinical trial of the Norton scale in acute care settings. *Aust J Adv Nurs* 1990; 8(1): 39-46.

53. Gould D, Goldstone L, Gammon J, Kelly D, Maidwell A. Establishing the validity of pressure ulcer risk assessment scales: a novel approach using illustrated patient scenarios. *Int J Nurs Stud* 2002; 39: 215-28.
54. Van Marum RJ, Ooms ME, Ribbe MW, Van Eijk JT. The Dutch pressure sore assessment score or the Norton scale for identifying at-risk nursing home patients? *Age Ageing* 2000; 29: 63-8.
55. Allman RM, Goode PS, Patrick MM, Brust N, Bartolucci AA. Pressure ulcer risk factors among hospitalised patients with activity limitation. *JAMA* 1995; 273 (11): 865-70.
56. Bergstrom N, Braden B, Kemp M, Champagne M, Ruby E. Multi-site study of incidence of pressure ulcers and the relationship between risk level, demographic characteristics, diagnoses, and prescription of preventive interventions. *J Am Geriatr Soc* 1996; 44: 22-30.
57. Berglund B, Nordström G. The use of the modified Norton scale in nursing-home patients. *Scand J Caring Sci* 1995; 9: 165-9.
58. Chaplin J. Pressure sore risk assessment in palliative care. *Journal of Tissue Viability* 2000; 10 (1): 27-31.
59. Waterlow J. Pressure sores in children: risk assessment. *Paediatr Nurs* 1998; 10 (4): 22-3.
60. Carlson EV, Kemp MG, Shott S. Predicting the risk of pressure ulcers in critically ill patients. *Am J Crit Care* 1999; 8 (4): 262-9.
61. Gunningberg L, Lindholm C, Carlsson M, Sjöden P-O. Reduced incidence of pressure ulcers in patients with hip fractures: a 2-year follow-up of quality indicators. *Int J Quality in Health Care* 2000; 13 (5): 399-407.
62. Goldstone LA, Goldstone J. The Norton score: an early warning of pressure sores? *J Adv Nurs* 1982; 7: 419-26.
63. Cook M, Hale C, Watson B. Interrater reliability and the assessment of pressure-sore risk using an adapted Waterlow Scale. *Clinical Effectiveness in Nursing* 1999; 3: 66-74.
64. Edwards M. Pressure sore risk: validating an assessment tool. *British Journal of Community Health Nursing* 1996; 1 (5): 282-8.
65. Chaloner DM, Franks PJ. Validity of the Walsall Community Pressure Sore Risk Calculator. *British Journal of Community Health Nursing* 2000; 5 (6): 266-76.
66. Bermejo Caja CJ, Beamud Lagos M, de la Puerta Catalayud M, Ayu-so Gil ME, Martín Iglesias S, Martín-Cocinas Fernández MC. Inter-observer reliability of two detection scales of the risk of formation of pressure ulcers in patients 65 years old or older. *Enferm Clín* 1998; 8 (6): 242-7.
67. Quirarte C, Martínez RM, Fernández C. Validity criteria studies of the modified Norton scale at the San Carlos Clinical Hospital. *Enferm Clín* 1998; 8 (4): 151-5.
68. Barbero Juárez FJ, Villar Dávila R. Continuous improvement of the quality of pressure lesions through the assessment of the risk of onset. *Enferm Clín* 1998; 8 (4): 141-50.
69. Leblebici B, Turhan N, Adam M, Akman MN. Clinical and epidemiologic evaluation of pressure ulcers in patients at a university hospital in Turkey. *J Wound Ostomy Continence Nurs* 2007; 34 (4): 407-11.
70. Kim TY, Lang N. Predictive modelling for the prevention of hospital-acquired pressure ulcers. *AMIA Annu Symp Proc* 2006; 434-8.
71. Kelly J. Inter-rater reliability and Waterlow's pressure ulcer risk assessment tool. *Nurs Stand* 2005; 19 (32): 86-7, 90-2.
72. Okuwa M, Sanada H, Sugama J *et al.* A prospective cohort study of lower-extremity pressure ulcer risk among bedfast older adults. *Adv Skin Wound Care* 2006; 19 (7): 391-7.
73. Lepisto M, Eriksson E, Hietanen H, Lepisto J, Lauri S. Developing a pressure ulcer risk assessment scale for patients in long-term care. *Ostomy Wound Manage* 2006; 52 (2): 34-46.
74. Machado S, De Castilho S, Oliveira BGR. Evaluation of risk assessment scales for decubitus ulcer in intensive care patients. *Online Brazilian Journal of Nursing* 2006; 5 (2): 3.
75. García Fernández FP, Bermejo Cobo J, Pérez Catalán MJ *et al.* Validation of two assessment scales for the risk of pressure ulcers: Gosnell and Nova-4. *ROL Enf* 1999; 22 (10): 685-7.
76. Gosnell DJ. An assessment tool to identify pressure sores. *Nurs Res* 1973; 22 (1): 53-9.
77. Lincoln R, Roberts R, Maddox A, Levine S, Patterson C. Use of the Norton pressure sore risk assessment scoring system with elderly patients in acute care. *J Enterostom Ther* 1986; 13: 132-8.
78. Harrison MB, Wells G, Fisher A, Prince M. Practice guidelines for the prediction and prevention of pressure ulcers: evaluating the evidence. *Appl Nurs Res* 1996; 9 (1): 9-17.
79. Cubbin B, Jackson C. Trial of a pressure area risk calculator for intensive therapy patients. *Intensive Care Nurs* 1991; 7: 40-4.
80. Gunningberg L, Lindholm C, Carlsson M, Sjöden P-O. Implementation of risk assessment and classification of pressure ulcers as quality indicators for patients with hip fractures. *J Clin Nurs* 1999; 8: 396-406.
81. Fuentelsaz Gallego C. Validation of the EMINA scale: an assessment instrument for the risk of developing pressure ulcers in hospitalised patients. *Enferm Clín* 2001; 11 (3): 97-103.
82. Ramundo JM. Reliability and validity of the Braden scale in the home care setting. *J Wound Ostomy Continence Nurs* 1995; 22 (3): 128-34.
83. Capobianco ML, McDonald DD. Factors affecting the predictive validity of the Braden scale. *Adv Wound Care* 1996; 9 (6): 32-6.
84. Halfens RJG, Van Achterberg T, Bal RM. Validity and reliability of the Braden scale and the influence of other risk factors: a multi-centre prospective study. *Int J Nurs Stud* 2000; 37: 313-9.
85. Lyder CH, Yu C, Emerling J *et al.* The Braden scale for pressure ulcer risk: evaluating the predictive validity in black and latino/hispanic elders. *Appl Nurs Res* 1999; 12 (2): 60-8.
86. Bergquist S, Frantz RA. Braden scale: validity in community-based older adults receiving home health care. *Appl Nurs Res* 2001; 14 (1): 36-43.
87. Bergstrom N, Braden B, Kemp M, Champagne M, Ruby E. Predicting pressure ulcer risk. A multisite study of the predictive validity of the Braden scale. *Nurs Res* 1998; 47 (5): 261-9.
88. VandeBosch T, Montoye C, Satwiciz M, Durkee-Leonard K, Boylan-Lewis B. Predictive validity of the Braden scale and nurse perception in identifying pressure ulcer risk. *Appl Nurs Res* 1996; 9 (2): 80-6.
89. Barnes D, Payton RG. Clinical application of the Braden scale in the acute-care setting. *Dermatol Nurs* 1993; 5 (5): 386-8.
90. Bergstrom N, Demuth PJ, Braden B. A clinical trial of the Braden scale for predicting pressure sore risk. *Nurs Clin*

- North Am 1987; 22 (2): 417-28.
91. Braden B, Bergstrom N. Predictive validity of the Braden scale for pressure sore risk in a nursing home population. *Res Nurs Health* 1994; 17: 459-70.
 92. Langemo DK, Olson B, Hunter S, Hanson D, Burd C, Cathcart-Silberberg T. Incidence and prediction of pressure ulcers in five patient care settings. *Decubitus* 1991; 4 (3): 25-33.
 93. Bergstrom N, Braden B, Laguzza A, Holman V. The Braden scale for predicting pressure sore risk. *Nurs Res* 1987; 36 (4): 205-10.
 94. Salvadarena GD, Snyder ML, Brogdon KE. Clinical trial of the Braden scale on an acute care medical unit. *J ET Nurs* 1992; 19: 160-5.
 95. Seongsook J, Ihnsook J, Younghee L. Validity of pressure ulcer risk assessment scales; Cubbin and Jackson, Braden, and Douglas scale. *Int J Nurs Stud* 2004; 41 (2): 199-204.
 96. Suriadi, Sanada H, Sugama J *et al*. A new instrument for predicting pressure ulcer risk in an intensive care unit. *J Tissue Viability* 2006; 16 (3): 21-6.
 97. Feuchtinger J, Halfens R, Dassen T. Pressure ulcer risk assessment immediately after cardiac surgery-does it make a difference? A comparison of three pressure ulcer risk assessment instruments within a cardiac surgery population. *Nurs Crit Care* 2007; 12 (1): 42-9.
 98. Hagsawa S, Barbenel J. The limits of pressure sore prevention. *J R Soc Med* 1999; 92: 576-8.
 99. Lewicki LJ, Mion LC, Secic M. Sensitivity and specificity of the Braden scale in the cardiac surgical population. *J Wound Ostomy Continence Nurs* 2000; 27: 36-41.
 100. Goodridge DM, Sloan JA, LeDoyen YM, McKenzie J-A, Knight WE, Gayari M. Risk-Assessment scores, prevention strategies, and the incidence of pressure ulcers among the elderly in four Canadian health-care facilities. *Can J Nurs Res* 1998; 30 (2): 23-44.
 101. Defloor T, Grypdonck M F. Pressure ulcers: validation of two risk assessment scales. *J Clin Nurs* 2005; 14 (3): 373-82.
 102. Kwong E, Pang S, Wong T, Ho J, Shao-ling X, Li-jun T. Predicting pressure ulcer risk with the modified Braden, Braden, and Norton scales in acute care hospitals in Mainland China. *Appl Nurs Res* 2005; 18 (2): 122-8.
 103. Mei-che Pang S, Kwok-shing Wong T. Predicting pressure sore risk with the Norton, Braden, and Waterlow scales in a Hong-Kong rehabilitation hospital. *Nurs Res* 1998; 47 (3): 147-53.
 104. Schoonhoven L, Haalboom JRE, Bousema MT *et al*. Prospective cohort study for routine use of risk assessment scales for prediction of pressure ulcers. *Br Med J* 2002; 325: 797-801.
 105. Jalali R, Rezaie M. Predicting pressure ulcer risk: comparing the predictive validity of 4 scales. *Adv Skin Wound Care* 2005; 18 (2): 92-7.
 106. Weststrate JTM, Hop WCJ, Aalbers AGJ, Vreeling AWJ, Bruining HA. The clinical relevance of the Waterlow pressure sore risk scale in the ICU. *Intensive Care Med* 1998; 24: 815-20.
 107. Boyle M, Green M. Pressure sores in intensive care: defining their incidence and associated factors and assessing the utility of two pressure sore risk assessment tools. *Aust Crit Care* 2001; 14 (1): 24-30.
 108. Aizpitarte Pegenaute E, Galdiano Fernández A, Zugazagoitia Cia-rusta N, Margall Coscojuela M, Asian Erro MC. Pressure ulcers in intensive care: risk assessment and prevention measures. *Enferm Intens* 2005; 16 (4): 153-63.
 109. Edwards M. The levels of reliability and validity of the Waterlow pressure sore risk calculator. *J Wound Care* 1995; 4 (8): 373-8.
 110. Wai-Han C, Kit-Wai C, French P, Yin-Sheung L, Lai-Kwan T. Which pressure sore risk calculator? A study of the effectiveness of the Norton scale in Hong-Kong. *Int J Nurs Stud* 1997; 34 (2): 165-9.
 111. Smith I. Waterlow/Norton scoring system: a ward view. *CARE-Science and Practice* 1989; 7 (4): 93-5.
 112. Stotts NA. Predicting pressure ulcer development in surgical patients. *Heart & Lung* 1988; 17: 641-7.
 113. Perneger TV, Raë A-C, Gaspoz J-M, Borst F, Vitek O, Héliot C. Screening for pressure ulcer risk in an acute care hospital: development of a brief bedside scale. *J Clin Epidemiol* 2002; 55: 498-504.
 114. Curley MAQ, Razmus IS, Roberts KE, Wypij D. Predicting pressure ulcer risk in paediatric patients. The Braden Q scale. *Nurs Res* 2003; 52 (1): 22-33.
 115. Hensch I, Gustafsson M. Pressure ulcers in palliative care: development of a hospice pressure ulcer risk assessment scale. *Int J Palliat Nurs* 2003; 9 (11): 474-84.
 116. Willock J, Baharestani M, Anthony D. A risk assessment scale for pressure ulcers in children. *Nurs Times* 2007; 103 (13): 32-3.
 117. Rodríguez Torres M, García Fernández F, Plaza Jurado F *et al*. Validation of the EMINA scale. *Gerokomos* 2005; 16 (3): 174-82.
 118. Andersen KE, Jensen O, Kvorning SA, Bach E. Prevention of pressure sores by identifying patients at risk. *Br Med J* 1982; 284: 1370-1.
 119. Lothian P. Identifying and protecting patients who may get pressure sores. *Nurs Stand* 1989; 4 (4): 26-9.
 120. Towey A P, Erland SM. Validity and reliability of an assessment tool for pressure ulcer risk. *Decubitus* 1988; 1 (2): 40-8.
 121. Lindgren M, Unosson M, Krantz A-M, Ek A-C. A risk assessment scale for the prediction of pressure sore development: reliability and validity. *J Adv Nurs* 2002; 38 (2): 190-9.
 122. Schoonhoven L, Grobbee DE, Donders AR *et al*. Prediction of pressure ulcer development in hospitalized patients: a tool for risk assessment. *Qual Saf Health Care* 2006; 15 (1): 65-70.
 123. Cullum N, Deeks JJ, Fletcher A *et al*. The prevention and treatment of pressure sores: How useful are the measures for scoring people's risk of developing a pressure sore? *Eff Health Care* 1995; 2 (1): 1-18.
 124. McGough A. A systematic review of the effectiveness of risk assessment scales in the prevention and management of pressure sores. Rycroft-Malone J, McInnes E. Pressure ulcer risk assessment and prevention. Technical report. Royal College of Nursing, 2000.