proLékaře.cz | 17.11.2026

doi: 10.14735/amcsnn2017S25

The Relationship between Risk Factors, Risk Assessment, and the Pathology of Pressure Ulcer Development

Vztah mezi rizikovými faktory, hodnocením rizika a patologií vzniku dekubitální léze

Abstract

Although many individuals experience the prime causes of pressure ulcers, not all will develop permanent tissue damage. This arises due to the complexity and multifactorial nature of pressure ulcer pathology. The literature acknowledges a variety of risk factors, which play a role in pressure ulcer development. Indeed, it is known that any risk factor increases the probability of pressure ulcer development if combined with pressure/shear forces. However, impaired mobility is the most important attribute that exposes an individual to sustained unrelieved pressure and shear forces and is known as contributing factor. Risk assessment is a central component of clinical practice, but is a challenging process given the plethora of risk assessment tools currently in use, and the lack of validity and reliability of these tools. This article aims to discuss how the risk factors directly contribute to pressure ulcer development and to evaluate the current risk assessment methods and procedures.

Souhrn

Přesto, že mnoho jedinců má zkušenost s vlivy, které jsou primární příčinou vzniku dekubitů, ne u všech dekubitus vznikne. Toto je způsobeno s ohledem na komplexní a multifaktoriální příčinu a patofyziologii dekubitů. V literatuře jsou zdůrazňovány různé rizikové faktory, které sehrávají významnou roli při vzniku dekubitů. Je známým faktem, že jakýkoli rizikový faktor zvyšuje pravděpodobnost vzniku dekubitů, pokud je zároveň přítomen tlak a tření. Nicméně, omezená mobilita je nejdůležitějším atributem, který vystavuje jednotlivce trvalému tlaku a smykové síle a je znám jako významný přispívající faktor. Posouzení rizik je ústřední součástí klinické praxe, ale je to náročný proces vzhledem k množství používaných nástrojů pro hodnocení rizik, a jejich nedostatečné validity a reliability. Cílem příspěvku je diskutovat, jak přímo přispívají rizikové faktory k rozvoji dekubitů a vyhodnotit současné metody a postupy při hodnocení rizika jejich vzniku.

Acknowledgement

The author is supported by the "Conselho Nacional de Desenvolvimento Científico e Tecnológico" – CNPq/Brazil.

The authors declare they have no potential conflicts of interest concerning drugs, products, or services used in the study.
Autoři deklarují, že v souvislosti s předmětem studie nemají žádné komerční zájmy.
The Editorial Board declares that the manuscript met the ICMJE "uniform requirements" for biomedical papers.
Redakční rada potvrzuje, že rukopis práce splnil ICMJE kritéria pro publikace zasílané do biomedicínských časopisů.

A. M. Vitoriano, Z. Moore

School of Nursing and Midwifery, Royal College of Surgeons in Ireland, Dublin, Ireland

✉
Aglécia Moda Vitoriano
School of Nursing and Midwifery
Royal College of Surgeons in Ireland
123 St. Stephens Green
Dublin 2, Ireland
e-mail: agleciabudri@rcsi.ie

Accepted for review: 10. 6. 2017
Accepted for print: 30. 6. 2017

Key words

pressure ulcer – pressure injury – pressure sore – risk factors – risk assessment – aetiology – mobility

Klíčová slova

dekubitus – tlakové poranění – tlakový vřed – rizikové faktory – hodnocení rizika – etiologie – mobilita

Introduction

A pressure ulcer, or pressure injury, is a localised injury to the skin and/or underlying tissues, over a boney prominence. The prime cause of the damage is due to external mechanical loads such as pressure (perpendicular force to the tissue), shear (parallel force to the skin surface) or, a combination of those two forces. Whereas, pressure and shear are the primary cause of the tissue damage, some risk factors such as age, incontinence, increased moisture/temperature and malnutrition increase the probability of pressure ulcer development [1].

Pressure ulcers remain common in high-income countries and are also highly incident and prevalent in medium and low-income areas. In Europe, prevalence rates vary between 8.9 and 25%, and incidence rates vary from 1.8 to 20% [2,3]. Furthermore, pressure ulcers account for 4 and 5% of an-

proLékaře.cz | 17.11.2026

nual healthcare expenditure in Europe, with nursing/healthcare assistants' resource utilisation contributing to 90% of this spending [4]. Worryingly, there is a tremendously negative impact of a pressure ulcer on patients' quality of life. Patients express that pressure ulcers are a particularly negative experiences, which have a detrimental impact on their daily lives. This arises because of the physical suffering related to discomfort and pain as well as psychological distress due to the anxiety around the healing process [5].

Give the impact of pressure ulcers on the individual, on the health system and on society as a whole, healthcare professionals should be able to objectively assess those at risk and implement appropriate prevention strategies. This is essential in order to avoid the negative impact of pressure ulcers and also the adverse consequences from the high treatment costs. However, of concern is the fact that current risk assessment tools available have been shown not to be 100% accurate [6,7]. This means that nurses may often plan care based on non-reliable assessments, exposing patients to an increased risk of developing pressure ulcers. Thus, this paper aims to discuss how the risk factors directly contribute to pressure ulcer development and to evaluate the current risk assessment methods and procedures.

How risk factors contribute to pressure ulcer development

Pressure and shear forces cause tissue deterioration, which, if unrelieved, will lead to permanent local tissue damage. Although many individuals experience the prime causes of pressure ulcers, not all will develop permanent tissue damage. This arises due to the complexity and multifactorial nature of pressure ulcer pathology. Furthermore, there are other attributes that can influence the individual's tissue susceptibility to the damage process. Those characteristics influence the length of time that the individual and their tissues can tolerate pressure and shear forces. When an attribute prolongs the length of time for tissue damage to occur, it may be a potentially preventive attribute, such as immobility. Conversely, it may be a physiological specific characteristic of the patient, such as age, for which there is no prevention potential. When any attribute shortens the length of time tissue can tolerate pressure/shear forces, it is known as a risk factor [8].

According to the World Health Organization (WHO), a risk factor is an attribute or characteristic that increases the probability of an individual develops a disease [9]. A risk factor can also be defined as a variable that bears a significant statistical association with the outcome [9]. In terms of the pressure ulcer pathology, as discussed, risk factors decrease the length of time tissue can tolerate the prime causes of pressure ulcers. The literature acknowledges a variety of risk factors such as increased age, skin moisture, factors affecting tissue perfusion/oxygenation, nutritional status, body temperature and sensory perception [1]. Any of these risk factors increase the probability of pressure ulcer development if combined with pressure and shear forces. For example, a 90-year-old man presents no history of ever having a pressure ulcer, but his 82 years old wife had a fall, became bedridden and developed a pressure ulcer. Both of them had increased age as a risk factor, however, only the lady had the causal factor in place to develop the tissue damage, as she became confined to bed and had been exposed to prolonged unrelieved pressure and shear forces [8].

To sustain a pressure ulcer, what does a patient have to be exposed to?

Impaired mobility (be that immobility or atypical abnormally frequent movements), is the attribute that exposes an individual to sustained unrelieved pressure and shear forces and it is known as confounding or contributing factor [1,10,11]. Further, it is also a variable that correlates or connects the prime cause of pressure ulcer to the risk factors. If, for instance, a person has diabetes, in combination with impaired sensory perception as a risk factor, they would not be at risk of developing a pressure ulcer unless mobility status was affected (or if they wore ill-fitting foot wear). Currently, there are 422 million people living with diabetes globally [12] and clearly, they are not all at risk of developing a pressure ulcer. However, if mobility status modifies because of a trauma, a long surgery, a hip fracture, acute illness or a neurological disorder [1], for example, they will then have the combination of a risk factor and affected mobility, that can expose them to pressure and shear forces. Fundamentally, then, the risk of developing a pressure ulcer changes significantly.

The difference between being at risk of developing a pressure ulcer, to actually developing one, involves the causal factors setting up some pathological mechanisms responsible for soft tissue to breakdown. Based on laboratory experiments and animal studies, the literature acknowledges four mechanisms for pressure ulcer development [13]. The first is localised ischaemia, traditionally thought of as being the key factor related to pressure ulcer development. It is characterised by the blockage, or complete occlusion, of a vein, artery or capillary due to external loading. This results in a reduction of nutrients supplementation to the tissues and accumulation of toxic waste products that also induces harmful pH changes [14–17]. The second mechanism is known as reperfusion injury. This damaging process arises, when, after a long period of ischaemia, blood supply is restored, and in doing so there is a release of toxic oxygen derived free radicals. These free radicals are excessive in abundance and outweigh the body's own natural scavenging ability. As a result, the free radicals, due to their toxic effects, cause significant tissue destruction [18–20].

The tissue destructive mechanism is also induced when external mechanical loads occlude lymph vessels leading to an increase in the interstitial fluid. In addition there is accumulation of toxic metabolites leading to tissue damage [21,22]. Finally, cell deformation is the most recently discovered mechanism, and has been studied using animal models, engineered tissue, and finite element modelling. These experiments have shown that when external mechanical loads overburden the soft tissue, cells change shape, becoming deformed. If loading is persistent, cell death will occur because deformation strains reach the maximum threshold, after which cell rupture is inevitable [11,23,24]. This damaging process is much faster than seen with ischaemia, which needs an extended exposure time to lead to cell death [25].

Individual susceptibilities and tolerances, such as individual mechanical properties of the tissue, tissue/bone morphology, physiology and capacity of repair and transport and thermal properties are also acknowledged to play a role in influencing the damage threshold that triggers pressure ulcer mechanisms [1,26]. This means that when the known pathological mechanisms are in place while the individual is being exposed to external mechanical forces, these properties may also be the reason why tissue re-

proLékaře.cz | 17.11.2026

Tab. 1. Sensitivity, specificity, odds ratio and confidence intervals for the four most used risk assessment scales [7].

Assessment Tool	sensitivity(true positive)	specificity(true negative)	odds ratio	95% confidence intervals
Braden Scale	57.1%	67.5%	4.08	2.56–6.48
Norton Scale	46.8%	61.8%	2.16	1.03–4.54
Waterlow Scale	82.0%	27.4%	2.05	1.11–3.76
Clinical Judgment	50.6%	60.1%	1.69	0.76–3.75

sponds differently, leading some individuals to develop a pressure ulcer and others not.

Evaluating pressure ulcer risk assessment methods and procedures

Risk assessment is the systematic process of identifying patients for whom preventative interventions are necessary [26] and is a central component of clinical practice [1]. From an ethical point of view, this screening process and subsequent interventions employed to combat risk, cannot be harmful and as such must have a reasonable chance of benefiting the individual [27]. Thus, accuracy and reliability of screening is fundamental. Pressure ulcer risk assessment scales are tools, which are based on a scoring system, with the included parameters being the risk factors and other known variables correlated to pressure ulcer development [7].

To identify whether a risk assessment scale is valid or not, statistical tests can be performed. Sensitivity, or true positive, is used to determine the ability of the scale to correctly identify an individual at risk [28]. For example, if there were 100 patients at risk of developing a pressure ulcer in a hospital and Braden Scale sensitivity is 57.1%, only around 57 out of 100 patients would be correctly identified using this scale and 43 patients at risk of developing a pressure ulcer would be missed.

Specificity is another test that determines the ability of the tool to correctly identify an individual as being disease-free, in this instance the person being not at risk of pressure ulcer development [28]. A second example to illustrate sensitivity is, if there were 100 patients not at risk of developing a pressure ulcer and the Braden Scale specificity is 67.5%, then around 67 out of 100 patients would be correctly identified as not being at risk. Commonly, highly sensitive tests have low specificity, meaning that they will correctly identified many at risk, but will have many "false positives" [29]. This is a challenge because, in clinical practice, is extremely important to have the ability to correctly identify those truly at risk of developing a pressure ulcer as they need prevention measures in place. It is also crucial to correctly identify individuals not at risk in order not to spend valuable resources on staffing hours and prevention devices, such as pressure redistribution surfaces.

Another noted test is the odds ratio (OR) or risk prediction. OR is a measure of the association between an exposure and the outcome, which can also be used to compare the magnitude of various risk factors on the outcome [30]. Table 1 shows the validity performance, OR and the 95% confidence intervals for the four most used risk assessment scales according to a systematic review carried out by Pancorbo-Hidalgo et al. [7]. The Waterlow Scale has the highest sensitivity, but the lowest specificity and, in comparison with the three assessment tools displayed on the table below, also has the lowest OR. The Braden Scale has the highest OR, however, does not have perfect sensitivity or specificity. Overall, as can be seen in Tab. 1, there are challenges with all the current methods of risk assessment.

A robust randomized clinical trial found no statistical significant differences in pressure ulcer incidence when healthcare staff used either the Waterlow risk assessment tool, the Ramstadius risk assessment tool, or nursing clinical judgment alone [6]. Additionally, a systematic review by Moore and Cowman found that there is no reliable evidence that use of current risk assessment tools makes any difference to pressure ulcer incidence [6]. Therefore, in daily clinical practice, a combination of different evaluation approaches may increase the confidence of the diagnosis [28]. Indeed, the National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance [1] suggests that a comprehensive skin assessment and clinical judgment may be combined to achieve a more successful and holistic assessment.

To enhance the quality of risk assessment, the focus of this process should be on the prime causes of pressure ulcer development and on the factor, that predisposes an individual to pressure and shear forces; this factor is believed to be mobility [8,31]. Further factors that influence the length of time the tissue can tolerate impaired mobility may also be considered [8,25,32]. However, those factors should only be investigated if mobility issues are identified [8]. Moreover, the rise in technology for healthcare should be incorporated into the wound care field, such advanced tools for screening and early prediction of pressure ulcers, for example, ultrasound imaging and subepidermal moisture measurement [33].

Implications for practice

Pressure ulcer pathology is complex and has a multifactorial exposure-outcome relationship. From the managers regulating pressure ulcer prevention policies, to the bedside staff, a greater understanding of this topic would certainly benefit clinical judgement and give guidance for the prescription of higher quality prevention care. Therefore, healthcare professionals' education is the foundation of any prevention strategy for hospital or community settings.

Scientific evidence is a strong ally in the evidence-based decision making process. Systematic reviews and guidelines are examples of scientific literature with high-quality recommendations for clinical practice. Although further studies in the risk assessment field are needed, the validity rates for the current most used risk assessment scales point out that nurses are spending valuable resources among patients that are not always at risk. Further, they may be missing at risk individuals by failing to identify them correctly. To improve risk assessment, the screening process should primarily focus on mobility status and then move to including other risk factors as aggravating variables.

proLékaře.cz | 17.11.2026

In summary, risk assessment is essential to identify patients at risk of pressure ulcer occurrence and to guide the implementation of efficient prevention strategies. Risk assessment is a challenging process given the plethora of risk assessment tools currently in use, and the lack of validity and reliability of these tools. None the less, focussing on the prime cause of pressure ulcers, namely, pressure and shear, followed by giving consideration given to the factor that exposes an individual to pressure and shear is fundamental to success. As such, there is a hierarchy of risk factors with immobility being the prime risk factor and once impairment in this factor is identified, other factors such as perfusion, nutrition, moisture and others come into play. Adopting a pathological approach to risk assessment will serve to clarify the process, and hopefully help to reduce the burden of pressure ulcers for the individual, the health service and society as a whole.

References

1. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel, Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline. Perth, Australia: Cambridge Media 2014.

2. Moore Z, Webster J, Samuriwo R. Wound-care teams for preventing and treating pressure ulcers. Cochrane Database Syst Rev 2015;9(6):CD011011. doi: 10.1002/14651858.CD011011.pub2.

3. Pokorná A, Benešová K, Mužík J, et al. Sledování dekubitálních lézí u pacientů s neurologickým onemocněním – analýza Národního registru hospitalizovaných. Cesk Slov Neurol N 2016;79/111(Suppl 1):S8–14. doi: 10.14735/amcsnn2016S14.

4. Posnett J, Gottrup F, Lundgren H, et al. The resource impact of wounds on health-care providers in Europe. J Wound Care 2009;18(4):154–61.

5. Gorecki C, Brown JM, Nelson EA, et al. Impact of pressure ulcers on quality of life in older patients: a systematic review. J Am Geriatr Soc 2009;57(7):1175–83. doi: 10.1111/j.1532-5415.2009.02307.x.

6. Moore ZE, Cowman S. Risk assessment tools for the prevention of pressure ulcers. Cochrane Database Syst Rev 2014;2:CD006471. doi: 10.1002/14651858.CD006471.pub3.

7. Pancorbo-Hidalgo PL, Garcia-Fernandez FP, Lopez-Medina IM, et al. Risk assessment scales for pressure ulcer prevention: a systematic review. J Adv Nurs 2006;54(1):94–110.

8. Moore Z, Cowman S, Conroy RM. A randomised controlled clinical trial of repositioning, using the 30 degrees tilt, for the prevention of pressure ulcers. J Clin Nurs 2011;20(17–18):2633–44. doi: 10.1111/j.1365-2702.2011.03736.x.

9. Brotman DJ, Walker E, Lauer MS, et al. In search of fewer independent risk factors. Arch Intern Med 2005;165(2):138–45.

10. Skelly AC, Dettori JR, Brodt ED. Assessing bias: the importance of considering confounding. Evid Based Spine Care J 2012;3(1):9–12. doi: 10.1055/s-0031-1298595.

11. Gefen A, van Nierop B, Bader DL, et al. Strain-time cell-death threshold for skeletal muscle in a tissue-engineered model system for deep tissue injury. J Biomech 2008;41(9):2003–12. doi: 10.1016/j.jbiomech.2008.03.039.

12. World Health Organization. Global Report on Diabetes 2016. [online]. Available from URL: http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257_eng.pdf?ua=1.

13. Bouten CV, Oomens CW, Baaijens FP, et al. The etiology of pressure ulcers: skin deep or muscle bound? Arch Phys Med Rehabil 2003;84(4):616–9.

14. Kosiak M. Etiology of decubitus ulcers. Arch Phys Med Rehabil 1961;42:19–29.

15. Dinsdale SM. Decubitus ulcers: role of pressure and friction in causation. Arch Phys Med Rehabil 1974;55(4):147–52.

16. Bader DL, Barnhill RL, Ryan TJ. Effect of externally applied skin surface forces on tissue vasculature. Arch Phys Med Rehabil 1986;67(11):807–11.

17. Gawlitta D, Oomens CW, Bader DL, et al. Temporal differences in the influence of ischemic factors and deformation on the metabolism of engineered skeletal muscle. J Appl Physiol 2007;103(2):464–73.

18. Peirce SM, Skalak TC, Rodeheaver GT. Ischemia-reperfusion injury in chronic pressure ulcer formation: a skin model in the rat. Wound Repair Regen 2000;8(1):68–76.

19. Unal S, Ozmen S, Demlr Y, et al. The effect of gradually increased blood flow on ischemia-reperfusion injury. Ann Plast Surg 2001;47(4):412–6.

20. Tsuji S, Ichioka S, Sekiya N, et al. Analysis of ischemia-reperfusion injury in a microcirculatory model of pressure ulcers. Wound Repair Regen 2005;13(2):209–15.

21. Reddy NP, Cochran GV, Krouskop TA. Interstitial fluid flow as a factor in decubitus ulcer formation. J Biomechanics 1981;14(12):879–81.

22. Miller GE, Seale J. Lymphatic clearance during compressive loading. Lymphology 1981;14(4):161–6.

23. Ceelen KK, Stekelenburg A, Loerakker S, et al. Compression-induced damage and internal tissue strains are related. J Biomech 2008;41(16):339–404.

24. Loerakker S, Stekelenburg A, Strijkers GJ, et al. Temporal effects of mechanical loading on deformation-induced damage in skeletal muscle tissue. Ann Biomed Eng 2010;38(8):2577–87. doi: 10.1007/s10439-010-0002-x.

25. Loerakker S, Manders E, Strijkers GJ, et al. The effects of deformation, ischemia, and reperfusion on the development of muscle damage during prolonged loading. J Appl Physiol 2011;111(4):1168–77. doi: 10.1152/japplphysiol.00389.2011.

26. Coleman S, Nixon J, Keen J, et al. A new pressure ulcer conceptual framework. J Adv Nurs 2014;70(10):2222–34. doi: 10.1111/jan.12405.

27. Lester B. In: Rifkin E, Bouwer E, eds. The illusion of certainty health benefits and risks. New York: Springer 2007.

28. Parikh R, Mathai A, Parikh S, et al. Understanding and using sensitivity, specificity and predictive values. Indian J Ophthalmol 2008;56(1):45–50.

29. Beaglehole R, Bonita R, Kjellstrom T. In: Beaglehole R, Bonita R, Kjellstrom T, eds. Basic epidemiology. Geneva: World Health Organization 1993.

30. Szumilas M. Explaining odds ratios. J Can Acad Child Adolesc Psychiatry 2010;19(3):227–9.

31. Fisher AR, Wells G, Harrison MB. Factors associated with pressure ulcers in adults in acute care hospitals. Holist Nurs Pract 2004;18(5):242–53.

32. Oomens CW, Bader DL, Loerakker S, et al. Pressure induced deep tissue injury explained. Ann Biomed Eng 2015;43(2):297–305.

33. Oliveira AL, Moore Z, T. OC, Patton D. Accuracy of ultrasound, thermography and subepidermal moisture in predicting pressure ulcers: a systematic review. J Wound Care 2017;26(5):199–215. doi: 10.12968/jowc.2017. 26.5.199.