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GERIATRIC REHABILITATION (P KORTEBEIN, SECTION EDITOR)

# Management of Pressure Ulcers and Pressure-Related Injury

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## Abstract

**Purpose of Review** Pressure ulcers, or pressure-related injuries, result from localized injury to the skin and underlying tissues due to unrelieved pressure, usually over a bony prominence, resulting in ischemia, cell death, and tissue necrosis. Pressure injuries are increasing in incidence due to an aging population with increasing rates of obesity, diabetes, and cardiovascular disease. A rapidly expanding geriatric population with impaired mobility, diminished sensation, and poor nutrition—factors exacerbated by the end-stage effects of dementia, obesity, osteoarthritis, and diabetes as well as cardiovascular and cerebrovascular disease—have a greater propensity toward, and a higher prevalence of, pressure injury. Our aim in this paper is to determine through a review of the literature whether any new literature exists, indicating greater effectiveness in pressure ulcer prevention or treatment as compared to standard of care. We examined which studies of available support surfaces, new and currently utilized wound dressings or any other treatment modalities have provided evidence of any greater effectiveness than standard of care in the prevention of pressure injury and in promotion of pressure ulcer healing. Our objective is to provide healthcare providers with an assessment of the relative efficacy of the various interventions available to facilitate their decision-making in the healing of their patient's pressure ulcers. Goals for pressure injury prevention or treatment, especially in the geriatric population, address repositioning for pressure redistribution and accurate diagnosis of wound etiology, including comorbidities in aging, cognition, care of aging skin, and patient or family goals in care (healing versus palliation).

**Recent Findings** We performed a literature search of the Cochrane Database of Systematic Reviews, Ovid Medline, and PubMed for published studies, reviews, and meta-analyses using the keywords pressure ulcer, pressure injury, wound care, bedsore, decubitus ulcers, and support surfaces. We also examined the reference lists of included studies to identify additional trials, position statements, guidelines, and reviews. We limited our review to English language publications between January 2008 and November 2018. We identified 36 studies for review. Despite this relatively large number of studies, there remains a disturbing lack of good-quality evidence regarding the effectiveness of support surfaces or repositioning for pressure ulcer prevention or treatment, for any class of dressing or topical therapy for promotion of wound healing, or for nutritional supplementation to facilitate wound healing.

**Summary** These studies yielded little evidence to warrant an update to the current standard of care for pressure ulcer prevention or management. The prevention and management of pressure ulcers requires a varied approach including assessment of risk, institution of preventive measures, and interventions to promote wound healing. Several tools for pressure injury risk assessment have been developed; a comparative description of these scales is provided. Understanding comorbidities (e.g., cardiovascular disease, diabetes, and neurodegenerative disorders) as well as complicating issues common to the elderly population that can impact pressure injury treatment (e.g., malnutrition, polypharmacy, incontinence, frailty, and disability) helps tailor wound care to this population.

**Keywords** Pressure ulcer · Pressure injury · Decubitus ulcer · Bed sore · Wound care · Support surfaces

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## Introduction

Pressure ulcers, or pressure-related injuries, result from localized injury to the skin and underlying tissues due to pressure, shear, friction, or some combination thereof, usually over a bony prominence. Older adults in particular are at high risk secondary to reduced mobility, impaired cognition, frailty, and disability related to multiple comorbidities which may include

dementia, obesity, osteoarthritis, and diabetes, as well as cardiovascular and cerebrovascular disease.

## Epidemiology

An estimated 2.5 million people in the USA develop pressure ulcers annually according to the Agency for Healthcare Research and Quality with an estimated prevalence of 0.4 to 38% in acute care facilities, 2 to 24% in long-term care facilities, and up to 17% in home caresettings [1]. The Agency for Healthcare Research and Quality (AHRQ) reported that 705,000 of these pressure injuries occur during acute inpatient stays in its National Scorecard for hospital-acquired complications (HAC) for 2014–2016. Indeed, of the 10 HAC monitored by the Department of Health and Human Services with a goal of 20% reduction between 2014 and 2019, pressure injury occurrence is one of only two conditions (the second being catheter-associated urinary tract infection) that have not only not decreased but actually increased since 2014. According to the AHRQ, the estimated cost of treating each of these ulcers is $37,800 to $70,000 with up to $11 billion annually expended on pressure injury management. This represents a costly and resource-intensive (time, labor, space) challenge to healthcare providers and payers.

While progress in modern medicine improves life expectancy and systemic disorders, longer life also contributes to more advanced stages of disease and an increased potential for pressure injury development. Pressure injuries are increasing in incidence due to orthopedic and neurologic injuries and due to an aging population with increasing rates of obesity, diabetes, and cardiovascular, as well as cerebrovascular disease. In addition, higher rates of surgery (e.g., hip and knee replacement) can lead to more time in dependent positions. Prodigious numbers of patients with end-stage complications of these illnesses such as stroke and amputation result in a greater prevalence of predisposing factors for pressure injury such as decreased mobility, diminished sensation, poor nutrition, and incontinence (fecal and urinary). A retrospective study in 2015 of 174 patients in a skilled nursing facility by Jaul and Calderon-Margalit showed that patients with pressure injury died significantly sooner (94 days) than patients with the same comorbidities without pressure injury (414 days, $p = 0.005$) [2]. Another study demonstrated that decreased survival in an elderly population was associated with the number pressure ulcers combined with anemia, advanced dementia, or higher BMI (Jaul 2017) [3].

## Pathophysiology

Normal capillary pressure is approximately 25 to 32 mmHg, with occlusion of blood vessels if external pressure is greater than 33 mmHg [4]. As pressure exceeds this value, tissue anoxia ensues. Exceeding supracapillary pressure (70 mmHg) continuously for 2 h leads to microvessel occlusion in the dermis as first identified by Kosiak in rat models [4]. Ultimately, this process leads to cell death and ultimately soft tissue necrosis and ulceration.

There is an inverse relationship between the duration of pressure and the degree of pressure. How much pressure and the time needed to create injury is widely studied. Epidermal hyperemia can be seen in 30 min or less with pressures over 33 mmHg, while ischemia may occur after 2 to 6 h of this continuous pressure. Necrosis is observed after 6 h of continuous pressure [4].

Why some areas are more prone to pressure injury than others is multifaceted, and typically relates to the amount of pressure and bony prominences. Subcutaneous tissue and muscle are more metabolically active and thus more vulnerable to pressure injury than skin, with pressure greatest at the interface of a bony prominence and soft tissue. Tissue pressures can vary over different pressure points depending upon posture/body position: pressure can be 70 mmHg on the buttocks when supine and as high as 300 mmHg at the ischial tuberosities in sitting [5]. Many older adults develop loss of soft tissue cushion between skin and bony prominences as a consequence of aging; this can increase their risk of tissue injury. Given the wide variety of body habitus, positions of comfort, contractures, and comorbidities/self-care deficits (e.g., incontinence, mobility issues), it is difficult to give narrow recommendations on "safe" sit or lie times. General guidelines recommend weight-shifting every 15–20 min for 30 s or more if sitting, and repositioning every 2 h in bed. These guidelines need to be tailored for the unique needs of each patient.

It should be recognized that skin assessment must consider the skin color of the patient. Erythema in darker pigmented patients may look purple or appear as darkening. In these patients, thickened skin consistency and/or increased temperature may be better indicators than erythema or blanchability.

## Objective

The intent of this paper is to perform a review of the most current literature for relevant trends and/or significant advances in the prevention and management of pressure-related injury. Our goal is to provide a critical assessment of new approaches as well as comparisons of the efficacy of existing therapies to help inform healthcare providers' decisions in the prevention of pressure-related injury and in the management of pressure ulcers.

**Current Best Practice for Pressure Ulcer Prevention and Management** Current best practice for the prevention and management of pressure injury requires a comprehensive program as detailed in Table 1. Practices noted often need to be

**Table 1** Current best practice for the prevention and management of pressure injury

| Prevention and management of pressure-related injury |
|---|
| Assessment of risk |
| Pressure alleviation |
| Utilization of evidence-based prevention (if any) |
| Staging of wounds* |
| Debridement, if indicated |
| Topical wound therapies |
| Nutrition optimization |
| Comorbidity management |
| Ongoing surveillance for and management of complications |
| Referral to specialists as needed (i.e., infectious disease, vascular surgery, plastic surgery) |

These best practices are based on the 2009 joint guidelines from the European Pressure Ulcer Advisory Panel (EPUAP) and the National Pressure Ulcer Advisory Panel (NPUAP). These guidelines were the culmination of 4 years of collaborative research to identify evidence-based recommendations which could be used by healthcare professionals worldwide [6••]. They are available online at http://www.npuap.org

*See "Evaluation" section for staging of pressure injury

done concurrently, rather than in sequence. Approach is tailored to the goals and needs of each patient [7•].

## Methods

We completed a literature search of the Cochrane Database of Systematic Reviews, Ovid Medline, and PubMed for published studies, reviews, and meta-analyses of pressure injury prevention and management. We also examined the reference lists of included studies to identify additional trials, position statements, guidelines, and reviews. We limited our review to English language publications between January 2008 and November 2018.

We identified and reviewed 11 original studies, 19 reviews, 2 guidelines, and 4 meta-analyses which examined evidence of effectiveness of support surfaces, repositioning techniques, methods for risk assessment and staging, various dressings and topical wound therapies, advanced wound therapies, nutritional interventions, and other therapeutic interventions. We also reviewed recent updates to the EPUAP.

## Findings

### Risk Assessment

Risk assessment and preventive measures are undertaken to identify and mitigate or even eliminate factors predisposing to pressure ulcer development. Risk factors for pressure ulcers include impaired mobility, older age, cognitive impairment, poor nutrition, impaired sensation, hypoalbuminuria, microvascular disease, urinary or fecal incontinence, lower body weight, and black race or Hispanic ethnicity. Several tools for pressure injury risk assessment have been developed; the most widely used tools, including the tool components and scoring, are listed in Table 2.

We identified four comparative analyses of risk assessment tools with our literature search: one RCT, one Cochrane review, one narrative review, and one clinical practice guideline from the American College of Physicians [12–15]. The RCT compared the effectiveness of two tools, the Waterlow tool and the Ramstadius tool (a combination risk assessment and intervention tool), and clinical judgment of experienced wound care nurses in a good-quality randomized study with more than 1200 subjects; subjects were followed for the duration of their inpatient stay (minimum of 3 days, average 8.6 days). This study found no difference in pressure ulcer incidence between the three groups (Waterlow 8%, Ramstadius 5%, Nursing judgment 7%) [12]. Both the Cochrane review and the narrative review came to the same conclusion—there is no evidence to indicate greater effectiveness of any of these tools in reducing the incidence of pressure injury as compared to nursing clinical judgment [13, 14]. Finally, the clinical practice guideline published by ACP notes moderate-quality evidence of low specificity and sensitivity to identify patients at risk of pressure injury across the Braden, Norton, Cubbin and Jackson, and Waterlow tools as well as moderate-quality evidence showing

**Table 2** Risk assessment tools for pressure injury

| Tool | Scale components | Scoring |
|---|---|---|
| Braden [8] | Sensory perception, moisture, activity, mobility, nutrition, friction, and shear | 6–23 scale (lower score, higher risk) |
| Norton [9] | Physical condition, mental condition, activity, mobility, incontinence | 5–20 scale (lower score, higher risk) |
| Cubbin and Jackson [10] | Age, weight, medical history, skin condition, mental condition, mobility, hemodynamics, respiration, oxygen requirements, nutrition, incontinence, hygiene (developed for ICU patients) | 9–48 (lower score, higher risk) |
| Waterlow [11] | Build/weight for height, skin type, sex and age, continence, mobility, nutrition, neurological deficit, major surgery/trauma | 1–64 scale (higher score, higher risk) |

similar diagnostic accuracy across the four scales [15]. The result of these studies provide support for relying on the judgment of experienced nursing staff, or a wound care professional, when available, for the assessment of pressure ulcer risk, and utilizing any of the noted risk assessment tools if an appropriate professional is not available.

## Prevention

Once risk for pressure injury has been assessed and judged to be significant, preventive measures should be initiated. Preventive measures include pressure relief via mobilization when possible, support surfaces and repositioning, nutritional supplementation, dressings, and skin emollients.

A wide variety of support surfaces are available from a diverse group of manufacturers around the world. However, no high-quality studies of the relative effectiveness of these offerings have been conducted. Indeed, a dearth of head-to-head comparisons in controlled trials, randomized or not, exists. The small number of existing studies exhibit a heterogenous study population and a high risk of bias [16–18]. Further limitation in the ability to assess the relative effectiveness of different support surfaces lies in use of outdated classification systems by investigators. The NPUAP has recently instituted the Support Surface Standards Initiative (S3I) classification system with a goal of standardizing terms and definitions across the industry [18].

A high-quality Cochrane review by McInnes et al. in 2015 was updated to include 6 additional studies for a total of 59 RCT for meta-analysis and concluded that patients on standard hospital foam mattresses were more likely to suffer pressure injury than those on high-specification foam mattresses, and that those who used sheepskin overlays also developed fewer pressure injuries [16]. However, this analysis did not use the NPUAP S3I classification system.

A more recent advanced network meta-analysis was conducted by Shi et al. [17] They also examined the literature regarding support surfaces for pressure ulcer prevention, but expanded the search of RCT to April 2016, did not limit language or publication status, and in addition to all sites queried by McInnes et al. included the Chinese Biomedical Literature Database. Their primary outcome was also pressure ulcer development, but patient comfort was an additional outcome assessed. Full descriptions of the support surfaces utilized in each study were elicited. Support surfaces in all included studies were classified using the NPUAP S3I system then categorized into 1 of 14 intervention groups. A total of 65 studies were included; 44 from the McInnes review, 8 additional English studies, and 14 Chinese studies. Significant heterogeneity was found in terms of setting, baseline skin status, and follow-up in some of the studies and over half of the included studies had serious or very serious limitations, resulting in high levels of uncertainty of the evidence. The authors concluded that there is a moderate certainty of evidence that powered active air surfaces and powered hybrid air surfaces probably reduce the incidence of pressure injury by an average of 58% and 78%, respectively. There was too much uncertainty in the data to indicate that any of the other 12 interventions could prevent pressure injury.

Impaired mobility and physical inactivity are key risk factors in the development of pressure injury, particularly in the geriatric population as these patients frequently have other risk factors such as poor skin integrity and impaired circulation. Given that context, repositioning to decrease sustained pressure to a site is an almost uniformly recommended prevention method and widely employed. However, little evidence exists to support the effectiveness of this intervention or identify optimal intervals for repositioning. A Cochrane review by Gillespie et al. identified three RCTs, examining pressure injury prevention via repositioning [19]. Two studies compared 30° and 90° tilt positioning while supine with similar repositioning frequencies, and the third compared alternative repositioning frequencies (every 2 and 3 h versus every 4 and 6 h). All three trials were underpowered and had a high degree of bias. However, these authors reported a lower risk for pressure injury at 30° tilt with repositioning every 3 h over usual care of 90° tilt for 3 h [14, 19].

## Nutrition

The correlation between poor nutritional status and the development of pressure injury has been suggested by several studies. A Cochrane systematic review of 11 RCTs examining nutritional supplementation for pressure injury prevention was published by Langer et al. in 2014 [20]. A meta-analysis of eight of these trials compared the effects of mixed (protein/carbohydrate) nutritional supplementation versus a standard hospital diet on pressure injury development and revealed no clear evidence of benefit for supplementation. However, a high risk of bias exists in these trials as well as inadequate allocation concealment, failure to blind patients, and selective reporting.

## Topical Agents and Dressings for Prevention

Topical creams/lotions and dressings are utilized with the goal of optimizing skin health to prevent the development of pressure injury. Moore et al. conducted a Cochrane review of five RCTs of topical agents and four trials of dressings over bony prominences as preventive measures for pressure injury [21]. The five RCTs included 940 participants. Analysis showed a reduction in pressure ulcer incidence of 36%; however, this fell to 22% when a single cluster randomized trial was excluded.

The four RCTs (561 total participants) examining application of a dressing over a bony prominence found a reduced

risk of pressure injury. However, the authors noted a substantial risk of bias—most had manufacturer sponsorship with heterogeneous populations and interventions.

## Evaluation

### Staging

The NPUAP has changed the terminology of "pressure ulcer" to "pressure injury" to more accurately describe the spectrum of injury from sustained pressure. The term "pressure injury" has been redefined as follows:

Localized damage to the skin and/or underlying soft tissue usually over a bony prominence or related to a medical or other device. The injury can present as intact skin or an open ulcer and may be painful. The injury occurs as a result of intense and/or prolonged pressure or pressure in combination with shear. The tolerance of soft tissue for pressure and shear may also be affected by microclimate, nutrition, perfusion, comorbidities, and condition of the soft tissue [18].

The redefined NPUAP staging system is detailed in Table 3 [18].

## Treatment

### Support Surfaces

A hallmark of pressure injury treatment is alleviation of pressure. Pressure relief can be achieved via mobilization (when feasible), support surfaces and repositioning. We were unable to identify any RCTs assessing the effect of repositioning on pressure injury healing [22]. We, therefore, cannot conclude that repositioning affects healing of pressure injury despite its being internationally agreed upon as a best practice.

Numerous specialized support surfaces designed to redistribute pressure exist; however, clear evidence of the relative effectiveness of these various support surfaces is lacking.

McInnes et al. completed a Cochrane review of support surfaces in the treatment of pressure injury. The review included 19 studies with more than 3200 participants. All of the studies were noted to have low or very low certainty, and downgraded because of risk of bias or imprecision. No benefit was found for any particular support surface including low air loss, alternating pressure mattresses (dynamic mattresses), static foam gel, water, or alternating pressure overlays, nor was any benefit demonstrated with air-fluidized beds [23].

An older systematic review published by the Medical Advisory Secretariat of Ontario, Canada, in 2009 came to the same conclusion except one study suggested an improved rate of healing with air fluidized beds compared with alternating pressure mattresses or overlays [ 24].

### Dressings

When an ulcer is present, dressings may be used for treatment; however, the best practice is to prepare the ulcer bed to optimize treatment. Preparation of the pressure ulcer wound bed is a critically necessary step before choosing a wound dressing. Typically, preparation consists of debridement of necrotic tissue in the wound bed, which can help reduce the bio-burden and minimize bacterial colonization. Debridement can be accomplished through various methods including autolytic, chemical, enzymatic, mechanical, and surgical. There are several means of achieving autolytic debridement (i.e., use of the body's moisture and the wound's exudate with an occlusive or semi-occlusive dressing to debride devitalized tissue). Chemical debridement is via the application of a topical agent (enzymatic or nonenzymatic), which chemically disrupts or digests devitalized extracellular material present in the wound.

**Table 3** Redefined NPUAP staging system

| NPUAP redefined level of injury | Definition | Previous terminology |
|---|---|---|
| Stage 1 pressure injury | Nonblanchable erythema of intact | Stage I pressure ulcer |
| Stage 2 pressure injury | Partial-thickness skin loss/exposed dermis | Stage II pressure ulcer |
| Stage 3 pressure injury | Full-thickness skin loss | Stage III pressure ulcer |
| Stage 4 pressure injury | Full-thickness skin and tissue loss | Stage IV pressure ulcer |
| Unstageable | Obscured full-thickness skin and tissue loss | Unstageable |
| Deep tissue injury | Persistent nonblanchable, deep, red, maroon, or purple discoloration | Suspected deep tissue injury |
| Medical device-related pressure injury | Injury results from devices designed and applied for diagnostic or therapeutic purpose. Staged using the NPUAP staging system. | N/A |
| Mucosal membrane pressure injury | Injury of mucous membranes with a medical device in use at the location of the injury; cannot be staged. | N/A |

Collagenase (Santyl®) remains the only enzymatic debriding agent available in the United States. A 2008 review by Ramundo and Gray evaluating all prospective and retrospective studies that compared enzymatic debridement using collagenase found collagenase ointment to be more effective than placebo (inactivated ointment or petrolatum ointment) for debridement of necrotic tissue from pressure ulcers [25]. Mechanical debridement is done through using mechanical force (i.e., pulsatile lavage, or wound irrigation). Surgical debridement is often the most efficient method and utilizes sharp instruments such as a scalpel, scissors, or curettes. This can be performed bedside, in the office or wound care center, or in the operating room depending on the necessity for anesthesia and the ability to control perioperative complications (e.g., bleeding, pain).

Further evaluation of the condition of the wound bed includes management of infection and inflammation in the wound, calculation of wound area and depth, tunneling, evaluation of the moisture status in the wound, and an assessment of the condition of the wound edge and periwound skin.

Pressure ulcers present a unique environment for microbial colonization, especially if there has been bacterial contamination from fecal material. It is important to determine where a ulcer/wound lies on the spectrum of contamination; this may range from simple contamination (bacteria present but no growth), to colonization (bacteria present and growing in wound but being managed by the host immune system and not causing damage to the wound), to critical contamination (growth beginning to exceed host immune system), and finally to infection (invasion into tissue with host immune response). Determining where on this spectrum a wound resides helps inform decisions about the choice of dressings (antibiotic or not?) and the need for systemic antimicrobial therapy [26–28].

The Cochrane Database of Systematic Reviews contains a suite of studies investigating the comparative effectiveness of various dressings. Walker et al. reviewed nine trials in 2014 (483 participants) finding low- to very-low-quality of evidence and no difference in ulcer healing with foam dressings as compared to other dressings [29]. Another Cochrane review by Dumville et al. reviewed six studies (336 participants) comparing alginate with other dressings (including hydrocolloids and radiant heat) also found the evidence to be of low or very low quality in these small studies with no evidence of a difference in ulcer healing with alginate as compared to the other dressings [30].

In a 2017 Cochrane review, Westbury et al. conducted a network meta-analysis of 51 studies (2947 total participants) comparing 21 different interventions—13 dressings (including hydrocolloids, alginates, protease-modulating dressings, foams, contact layers, honey, and cadexomer iodine–containing dressings and saline gauze), 6 topical agents (collagenase, silver sulfadiazine, zinc oxide, phenytoin, honey, and iodine) as well as mixed treatments and 2 supplementary interventions (radiant heat and skin substitutes) examining the probability of complete healing of pressure ulcers. They judged the network to be sparse and consequently a high degree of imprecision in the evidence. Coupled with the high risk of bias, they found the evidence to be largely of low or very low certainty. They reported no confidence in the findings regarding any rank order of the interventions studied. They concluded that protease-modulating dressings (moderate certainty), as well as foam dressings and collagenase (low to very low certainty) may provide a greater probability of healing than simple saline gauze dressings [31].

While not a dressing per se, a Cochrane systematic review of negative pressure wound therapy (NPWT) for pressure ulcer healing yielded four small studies (149 total participants)—two studies of NPWT versus dressings, one study of NPWT versus topical gel, and one versus moist wound therapy. Studies yielded evidence of low quality chiefly due to the poor reporting of outcome data [32]. Better quality studies need to be undertaken before recommendations regarding NPWT can be reasonably made.

### Nutrition

Just as adequate nutrition is needed to prevent pressure ulcers, it is considered just as important for the healing of pressure ulcers. Two systematic reviews, one by Langer et al. (11 trials) [20] and the second by Smith et al. (11 trials and 5 observational studies) [33] demonstrated no evidence of additional improvement in healing with zinc and vitamin C supplementation as compared to without supplementation. The analysis by Smith yielded 12 studies (10 RCTs and 2 observational studies) that cumulatively suggested more rapid healing with protein supplementation. [33]

### Other Therapeutic Interventions

Numerous smaller studies have been published recently suggesting benefit for a variety of adjunctive therapies including electrical stimulation (Estim), ultrasound (US), massage therapy, electromagnetic therapy (EMT), light therapy, and laser therapy.

A review of controlled trials on the impact of Estim on pressure ulcer healing rates was conducted by Lui et al. [34, 35] Eight trials were reviewed and included comparisons of pulsed and constant current versus sham Estim, and of electrodes on the wound bed versus the surrounding skin. Pooled analyses of these studies suggest that Estim improved pressure ulcer healing rates, with pulsed current more efficacious than constant current. A RCT comparing the effectiveness of Estim to US in pressure ulcer healing was done by Karsli et al. though no sham or control group was included. These groups experienced mean healing rates of 43% (Estim) and 63% (US) [36].

The previously noted comparative effectiveness review by Smith et al. also evaluated other adjunctive interventions.

Seventeen studies of the effect of Estim on pressure ulcer healing were reviewed (1988–2011) and revealed moderately consistent results of improved healing rates but insufficient data about complete wound healing [33].

A recent Cochrane review yielded no new RCTs on the use of massage therapy in the treatment of pressure ulcer since 2010 [37]. Two previously reviewed RCTs comparing EMT to sham EMT revealed no difference in healing [38]. No recent trials, randomized controlled or clinically controlled, studying the effect of light therapy or laser therapy could be identified.

## Conclusions

We have provided an updated review of the literature regarding the broad variety of prevention and treatment options for pressure injury and ulcer. This is a highly relevant issue for older adults due to the high prevalence of this condition in this population.

Unfortunately, there is limited good-quality research focused on the prevention and management of pressure ulcers. For geriatric patients, education, regular inspection, adequate nutrition, and pressure relief as well as shear optimization are the keys to preventing pressure injury. Several tools for pressure injury risk assessment exist although clinician experience has been demonstrated to be equally effective in assessing risk. A multitude of support surfaces for the prevention and treatment of pressure injury exist; however, current evidence of effectiveness is of poor quality, due in part to differences in terminology and a lack of product standardization, making comparative analysis difficult and determination of the best therapeutic choice challenging. The recent introduction of NPUAP's Support Surface Standards Initiative (S3I) should better enable a critical evaluation of the comparative effectiveness of similar products as well as products across classes. Higher quality randomized controlled trials to determine the surfaces most effective for the prevention and treatment of pressure injury are urgently needed.

A myriad of wound care dressing options lie before the clinician seeking products to facilitate pressure ulcer healing. Dressing choice is driven to some extent by wound condition, as well as provider expertise and resources, patient and caregiver support, as well as economic considerations. This decision is made even more difficult by patient comorbidities, many of which adversely affect healing. Only limited moderate-quality and no high-quality evidence exists to guide the clinician in assessing the effectiveness of the various dressing options. More rigorous study with clear randomization, consistent blinding in as far as is feasible and longer follow-up with clear documentation of degree of healing is critically needed. At this time, dressing choice can often, admittedly, be more art than science.

The prevention and management of pressure injury requires a multipronged approach as outlined in the Best Practices section of this article.

## Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflicts of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

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