SKIN TEARS

Epidemiology, Classification and Measurement

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Every mountain top is within reach if you just keep climbing.

~ Barry Finlay

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LIST OF ABBREVIATIONS

ADL	Activities of daily living
APrIAD	Attitude towards the Prevention of IAD instrument
APuP	Attitude towards Pressure ulcer Prevention instrument
CENTRAL	Cochrane Central Register of Controlled Trials
CI	Confidence interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
COSMIN	Consensus-based Standards for the selection of health Measurement Instruments
CVI	Content validity index
DEJ	Dermo-epidermal junction
DF	Degrees of freedom
DTI	Deep tissue injury
EPUAP	European Pressure Ulcer Advisory Panel
EPV	Events per predictor variable
EWMA	European Wound Management Association
GLOBIAD	Ghent Global IAD Categorisation Tool
GRADE	Grading of Recommendations Assessment, Development and Evaluation
GRASS	Guidelines for Reporting Reliability and Agreement Studies
IAD	Incontinence-associated dermatitis
ICC	Intraclass correlation coefficient
ICD	International Classification of Diseases
IQR	Interquartile range
ISTAP	International Skin Tear Advisory Panel
ITD	Intertriginous dermatitis
MARSI	Medical adhesive-related skin injury
MASD	Moisture-associated skin damage
MDS	Minimum data set
MeSH	Medical Subject Heading
MMP	Matrix metalloproteinase
NMF	Natural moisturising factor
NPUAP	National Pressure Ulcer Advisory Panel
OR	Odds ratio

PHMB	Polyhexamethylene biguanide
PPPIA	Pan Pacific Pressure Injury Alliance
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROM	Patient-reported outcome measure
PU	Pressure ulcer
PUCLAS	Pressure Ulcer Classification education tool
RCT	Randomised controlled trial
SD	Standard deviation
SPSS	Statistical Package for the Social Sciences
SSM	Skin Safety Model
ST	Skin tear
STAR	Skin Tear Audit Research
STARD	Standards for Reporting of Diagnostic Accuracy
TEWL	Transepidermal water loss
TPB	Theory of Planned Behaviour
UV	Ultraviolet
WHO	World Health Organization
X^2	Chi-squared statistic

Chapter 1

Introduction and research aims

Maintaining and enhancing skin health and preventing skin barrier damage are integral parts of daily nursing practice across the continuum of healthcare settings (Lichterfeld-Kottner et al., 2020). The maintenance of skin integrity is an important quality indicator contributing to positive patient outcomes and is widely accepted as being more cost-effective compared to wound treatment (Meraviglia et al., 2002; Nakrem et al., 2009; Lichterfeld et al., 2015). During the life course, there are periods of increased skin vulnerability which render individuals more susceptible to developing a broad range of skin injuries (Beeckman et al., 2020; Kottner et al., 2020a). This dissertation focuses on one of the most common superficial skin lesions: skin tears.

Despite their clinical relevance, skin tears are frequently under-recognised, poorly reported, and inadequately treated and prevented (LeBlanc et al., 2018a). This dissertation aims to contribute to the scant but emerging evidence base on skin tear epidemiology in order to gain a better insight into the extent of the problem, provide benchmarking data, and permit a more accurate risk assessment and targeted prevention. Furthermore, this dissertation aims to develop psychometrically sound measurement instruments to (1) support a more systematic, accurate and consistent classification and documentation of skin tears, and (2) inform the development of effective and tailored education programs for (future) healthcare professionals. These instruments are of utmost importance to enhance the quality and comparability of epidemiological data and to be able to measure the effectiveness of preventive, therapeutic, and educational interventions in a standardised way.

This introductory chapter provides background information to understand the studies included in this dissertation and their contributions to the current knowledge base on skin tears. In the first section of this introduction, the structure and function of normal skin are described. Insights into the skin's physiology are central to understand how skin tears develop and are to be prevented. In the following sections, the definition, aetiology, prevention, prevalence, classification, and treatment of skin tears are outlined. The final section provides an overview of the included studies, their research objectives, and the corresponding knowledge gaps addressed.

THE SKIN: STRUCTURE AND FUNCTION

The skin is the largest organ of the human body, accounting for approximately 15% of the total body weight in adults (Wingerd, 2013). The primary function of the skin is to act as a protective barrier against trauma, ultraviolet (UV) light, chemicals, infections, micro-organisms, and allergens, as well as to protect the body from excessive water loss (Butcher & White, 2005; Proksch et al., 2008). Other functions of the skin include sensory perception, thermoregulation, innate and adaptive immune functions, absorption, excretion (e.g. sweat), and vitamin D production (Wounds UK, 2018; Kottner et al., 2020a). Additionally, physical appearance and skin sensations are important for our self-esteem, attractiveness, communication, and well-being (Kottner et al., 2020a).

The skin consists of three main layers: the epidermis, the dermis, and the subcutaneous tissue or hypodermis (Figure 1) (Wounds UK, 2018). The thickness of these layers varies considerably, depending on the anatomical location (Hussan & Hunter, 2020).

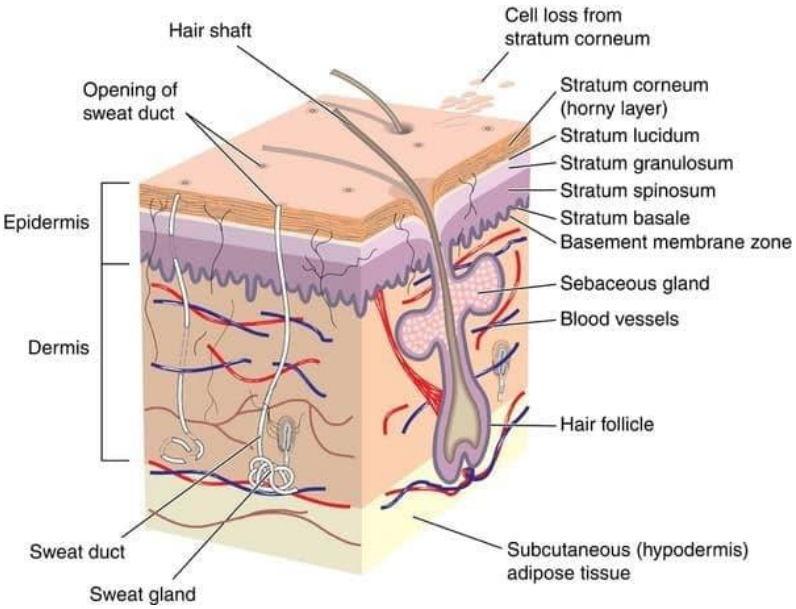


Figure 1. Structure of the skin (CliniMed, 2020)

The epidermis is primarily composed of keratinocytes (95% of epidermal cells) at different stages of differentiation and can be subdivided in four to five strata: stratum corneum, stratum lucidum (only present in thick skin, such as hand palms, feet soles and digits), stratum granulosum, stratum spinosum, and stratum basale (Figure 2) (Lawton, 2019; Hussan & Hunter, 2020). Keratinocytes are produced in the deepest epidermal layer, the stratum basale, and gradually differentiate and mature while moving to the upper epidermal layers (Lawton, 2019; Kottner et al., 2020a). In the

stratum spinosum, keratinocytes become connected through desmosomes (adhesive proteins) and start to produce lamellar bodies, glycosphingolipids, free sterols, phospholipids, and catabolic enzymes (Fraser & Lott, 2019). A tight intercellular junction is crucial to promote the epidermal barrier function (Tortora & Derrickson, 2018). In the stratum granulosum, the keratinocytes become flatter and generate large amounts of the proteins keratin and keratohyalin. The nuclei and other cell organelles disintegrate as the cells die, leaving behind the keratin, keratohyalin, and cell membranes that form the stratum lucidum (Biga et al., 2020). Finally, the outer layer of the epidermis, the stratum corneum, consists of 25-30 layers of flattened, dead, protein-enriched keratinocytes (corneocytes; 'bricks') embedded in a lipid matrix of ordered lamellar structure ('mortar'). The corneocytes are continuously shed from the skin surface (desquamation) and replaced by new keratinocytes from the deeper epidermal strata to maintain the integrity of the stratum corneum (Lawton, 2019). As corneocytes contain natural moisturising factors (NMF) such as amino acids, urea, and lactate, they attract and hold water in the stratum corneum, keeping the skin hydrated and elastic (Lawton, 2019; Kottner et al., 2020a). Besides its water-holding function, the stratum corneum forms an extremely strong and resistant barrier against external insults (Kottner et al., 2020a).

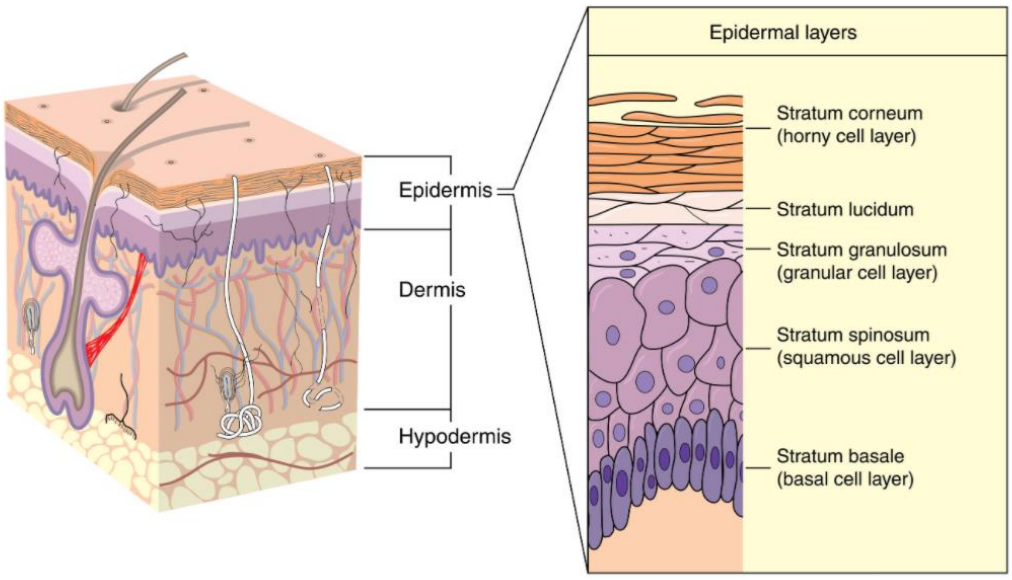


Figure 2. Layers of the epidermis (Ozderm, 2019)

The middle layer of the skin, the dermis, is a thick layer of connective tissue consisting of collagen and elastic fibres which allow for skin's strength and flexibility. The dermis also contains blood vessels, nerve endings, hair shafts, sweat glands, and sebaceous glands (Agarwal & Krishnamurthy, 2019; Lawton, 2019). The dermis is tightly connected to the epidermis through the undulating basement membrane or dermo-epidermal junction (DEJ), which supplies cohesion between the two layers and helps the skin resist shearing forces (Sidbury, 2018; Lawton, 2019).

The DEJ contains epidermal protrusions that reach down into the dermis (rete ridges) and dermal projections up into the epidermis (dermal papillae) (Newton et al., 2017). Capillary loops in the dermal papillae ensure the exchange of nutrients, oxygen, and waste products between the dermis and the epidermis (Lawton, 2019). The hypodermis is the subcutaneous layer below the dermis and consists largely of fat tissue that provides thermal and mechanical protection (Lawton, 2019; Kottner et al., 2020a).

SKIN TEARS

Healthy skin is strong, resilient and has an extensive capacity for repair (Wounds UK, 2018). However, due to ageing and altered physiology, skin integrity may become compromised in certain populations. Individuals with an enhanced skin vulnerability are at increased risk of a range of skin lesions, with skin tears being one of the most prevalent conditions (LeBlanc et al., 2018a; Wounds UK, 2018; Beeckman et al., 2020).

Definition and terminology

The International Skin Tear Advisory Panel (ISTAP) advocates a universal taxonomy and defines skin tears as *"traumatic wounds caused by mechanical forces, including removal of adhesives. Severity may vary by depth (not extending through the subcutaneous layer)"* (LeBlanc et al., 2018a). Although skin tears can occur on any anatomical location, they are particularly common on the extremities such as the upper and lower limbs or the dorsal aspect of the hands (Campbell et al., 2018a; Serra et al., 2018). Skin tears are reported across all healthcare settings and age groups, but are predominantly found in the elderly, neonates, and people who are critically and chronically ill (LeBlanc et al., 2013a; LeBlanc & Baranoski, 2017).

Although skin tears are acute wounds with the potential to heal by primary intention, they have a high risk of developing into chronic wounds if managed inappropriately (LeBlanc et al., 2014; Vanzi & Toma, 2017; LeBlanc et al., 2018b; Brown, 2019; Idensohn et al., 2019a). Individuals suffering from difficult-to-heal wounds are prone to experiencing protracted pain, emotional distress, embarrassment, infection, and reduced quality of life (LeBlanc & Baranoski, 2011; LeBlanc et al., 2013a; Strazzieri-Pulido et al., 2015a; Serra et al., 2018). The conduct of qualitative studies examining patients' experiences and the impact skin tears can have on physical, psychological and social functioning is strongly encouraged (LeBlanc et al., 2018a). From a health economic perspective, skin tears can result in high labour and material costs, increased nursing workload, and prolonged hospitalisation (Bank & Nix, 2006; Vandervord et al., 2016; Bermark et al., 2018; Brimelow & Wollin, 2018).

Despite their considerable impact, skin tears are often under-recognised and poorly reported in clinical practice, leading to suboptimal prevention and delayed or inappropriate management (Stephen-Haynes, 2012; Carville et al., 2014; Campbell et al., 2018a; Vanzi & LeBlanc, 2018). One reason may be that skin tears are frequently regarded as unavoidable and relatively insignificant wounds. They are perceived to be a normal manifestation of ageing skin and their impact is often minimised by healthcare professionals (White, 2001; Carville et al., 2014; Rayner et al., 2015; LeBlanc, 2017; Vanzi & LeBlanc, 2018; Campbell & Samolyk, 2020; Hardie & Wick, 2020).

A second reason may be the lack of standardised terminology. The term 'skin tear' is not universally adopted and skin tears are often referred to as 'lacerations', 'abrasions', 'geri tears' or 'epidermal tears' (Rayner et al., 2015; LeBlanc et al., 2018a). The absence of a specific code for skin tears in the World Health Organization (WHO) International Classification of Diseases, 11th Revision (ICD-11) may reinforce their perceived insignificance and potential for underreporting (LeBlanc et al., 2018a; Rayner et al., 2019). In the ICD-11, skin tears are subsumed under the general term 'laceration' and labelled according to their anatomical site of injury (World Health Organization, 2018). However, a skin tear is a specific injury that differs from a general laceration which is defined as a jagged and irregular cut or tearing of soft body tissue (LeBlanc et al., 2018a; National Library of Medicine, 2019). Since soft tissue encompasses muscles, adipose and fibrous tissue, tendons, ligaments, nerves, and blood vessels, lacerations can involve more extensive tissue types than skin tears (Al-Buriahi et al., 2019; Rayner et al., 2019).

A third reason may be that skin tears are frequently misdiagnosed as other wound aetiologies, such as medical adhesive-related skin injuries (MARSI) or pressure ulcers (PUs) (LeBlanc et al., 2018a; Rayner et al., 2019). MARSI is a relatively new category of skin damage which is defined as *"an occurrence in which erythema and/or other manifestation of cutaneous abnormality (including, but not limited to, vesicle, bulla, erosion, or tear) persists 30 minutes or more after removal of an adhesive"* (McNichol et al., 2013). Although skin tears are a common manifestation of MARSI, they may also be caused by factors other than medical adhesives (McNichol et al., 2013; Ousey & Wasek, 2016; Hitchcock & Savine, 2017; Yates et al., 2017). A pressure ulcer is defined as *"a localised injury to the skin and/or underlying tissue, usually over a bony prominence, resulting from sustained pressure (including pressure associated with shear)"* (National Pressure Ulcer Advisory Panel (NPUAP), European Pressure Ulcer Advisory Panel (EPUAP) & Pan Pacific Pressure Injury Alliance (PPPIA), 2014). The severity of pressure ulcers varies from non-blanchable erythema of the intact skin to tissue destruction involving skin, subcutaneous fat, muscle, and bone (Beeckman et al., 2018a). In contrast to skin tears, pressure ulcers are chronic wounds where damage is initiated by changes within soft tissues below and within the skin due to prolonged mechanical load in the form of pressure or pressure combined with shear (Quintavalle et al., 2006; Beeckman,

2018). Although skin tears and pressure ulcers differ in aetiology, healthcare professionals experience difficulties in distinguishing both conditions because of their similar clinical presentation (National Pressure Ulcer Advisory Panel et al., 2014; Black et al., 2016; LeBlanc et al., 2016a). It is, however, critical that skin tears and pressure ulcers are correctly diagnosed and documented as separate wound types to ensure that effective prevention and management strategies can be implemented (National Pressure Ulcer Advisory Panel et al., 2014; LeBlanc et al., 2016a; Vanzi & LeBlanc, 2018).

Aetiology and pathophysiology

Skin tears can be caused by a variety of mechanical forces such as shear and friction, including blunt trauma, falls, poor positioning/transferring techniques, equipment injury, and removal of adherent dressings (LeBlanc et al., 2018a). As a result, the epidermis is separated from the dermis (partial-thickness wound) or both the epidermis and the dermis are separated from underlying structures (full-thickness wound) (LeBlanc & Baranoski, 2011; Holmes et al., 2013). In individuals with fragile or vulnerable skin, less force is required to cause a skin tear (LeBlanc et al., 2018a).

Due to age-related physiological skin changes, neonates and older individuals are particularly susceptible to developing skin tears (LeBlanc & Baranoski, 2011; Lichterfeld et al., 2014; Kottner et al., 2020a). Neonates have significantly fewer layers of stratum corneum, less collagen and elastic fibers, increased transepidermal water loss (TEWL), and a decreased cohesion between the epidermis and the dermis (Douma, 2008; Oranges et al., 2015). Because the skin of neonates is not fully mature, it is more fragile and less resistant to mechanical stress such as friction and shearing forces (LeBlanc & Baranoski, 2011; Kottner et al., 2020a).

Later in life, the normal ageing process causes structural and functional changes of the skin that result in increased vulnerability (Figure 3) (Kottner et al., 2013). As skin ages, it loses collagen and elastin, the epidermis gradually becomes thinner, and there is loss of dermal and subcutaneous tissue, rendering the skin more fragile and less elastic (Busse, 2016; Benbow, 2017; Wounds UK, 2018). There is reduced keratinocyte proliferation and turnover time in the epidermis (Levine, 2020). Furthermore, the dermo-epidermal junction (DEJ) begins to flatten, increasing the susceptibility of the epidermis to detach from the underlying dermis (Xu et al., 2009; Woo & LeBlanc, 2018). The barrier function and mechanical protection are compromised (Kottner et al., 2013). In addition, the content of natural moisturising factors (NMF) and lipids in the stratum corneum is reduced and sweat and sebum production are decreased, leading to dry and itchy skin (Holmes et al., 2013; Lichterfeld-Kottner et al., 2020). Other skin changes associated with the normal ageing process include an increased skin surface pH, diminished immune responses, decreased sensory perception, and reduced blood supply (Holmes et al., 2013; Lichterfeld et al.,

2014). Blood vessels become thinner, more fragile, and rupture easily, leading to appearances of subcutaneous haemorrhaging known as senile purpura and ecchymosis (White et al., 1994; Norman, 2008; Sussman & Golding, 2011; Holmes et al., 2013). Bleeding underneath the epidermis enables the skin to lift off more easily when friction or shearing forces are applied (Lewin et al., 2016; Koyano et al., 2020). Due to their similar clinical and pathophysiological features, the distinction between senile purpura and ecchymosis is not always clear with the potential for these terms to be used interchangeably within the literature and in practice (Rayner et al., 2015; Newall et al., 2017). Senile purpura refers to the appearance of small purple spots with defined borders measuring 0.3 – 1 centimeter, while ecchymosis is characterised by reddish or bluish discolorations larger than 1 centimeter with more diffuse borders (Verner et al., 2019; Mahajan & Handa, 2020). These lesions should not be confused with a haematoma, which is usually defined as a palpable bruise or localised collection of blood in the tissues caused by trauma to an underlying blood vessel (Beldon, 2011; Lewin et al., 2016; LeBlanc, 2017; Newall et al., 2017). The skin tightness resulting from haematoma formation may make the skin more vulnerable to breakdown from any further trauma (Lewin et al., 2016).

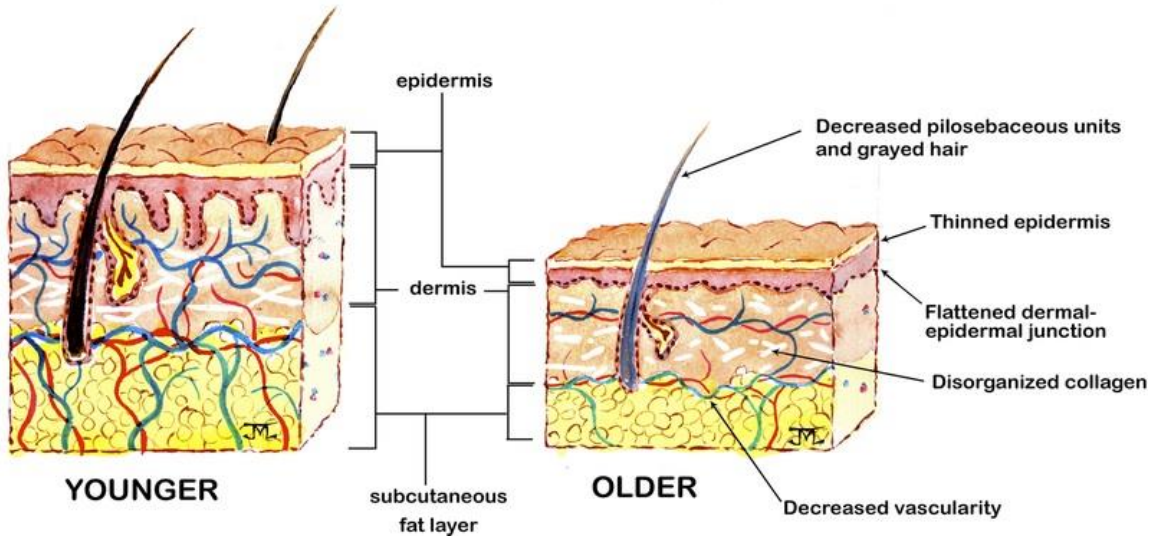


Figure 3. Histologic changes in ageing skin (Levine, 2020)

Skin atrophy, senile purpura, ecchymosis, and haematoma have been previously identified as intrinsic skin changes attributed to ageing and represent a chronic condition of cutaneous insufficiency/ fragility termed ‘dermatoporosis’ (Kaya & Saurat, 2007; LeBlanc, 2017; Woo & LeBlanc, 2018). The ageing process is genetically determined but can be largely influenced by environmental factors such as extended UV exposure (photoageing), air pollution, and smoking (Wollina et al., 2019). Several studies have identified chronic renal failure, anticoagulant therapy, and long-term use of topical and systemic corticosteroids as additional significant risk factors for

dermatoporosis (Mengeaud et al., 2012; Saurat et al., 2017; Dyer & Miller, 2018; Kluger & Impivaara, 2019; Chanca et al., 2021). The skin of individuals with dermatoporosis has a reduced protective mechanical function and a decreased tolerance for friction and shearing forces (Kaya & Saurat, 2007; Rayner et al., 2015; Vanzi & Toma, 2018). As a consequence of this skin frailty, these individuals are at increased risk of skin breakdown from even minor force or trauma (White et al., 1994; Benbow, 2017; LeBlanc et al., 2018a; Serra et al., 2018; Levine, 2020). Some studies in the French and Finnish elderly population have reported prevalence rates for dermatoporosis between 27.0% and 37.5%. Dermatoporosis was mainly located on the upper limbs (Mengeaud et al., 2012; Saurat et al., 2017; Kluger & Impivaara, 2019; Chanca et al., 2021).

Besides intrinsic and extrinsic skin ageing, there are several other factors that may compromise skin integrity (Beeckman et al., 2020; Kottner et al., 2020a). Excessive washing with alkaline soap, for example, causes a significant increase in skin pH and TEWL and removal of natural oils from the stratum corneum, resulting in a disruption of the epidermal barrier and dry skin (Voegeli, 2008; Benbow, 2017). Dry skin is more susceptible to friction and shearing (LeBlanc & Baranoski, 2011). Other factors that may contribute to skin frailty, causing the skin to be vulnerable and at risk, include chronic and critical diseases, poor nutrition, reduced mobility, and polypharmacy (Holmes et al., 2013; Wounds UK, 2018; Beeckman et al., 2020; Kottner et al., 2020a; Levine, 2020).

The populations at highest risk of skin tears are also at increased risk of complications such as infection and delayed wound healing, which can cause skin tears to evolve into complex chronic wounds (LeBlanc & Baranoski, 2011; Sussman & Golding, 2011; LeBlanc et al., 2018a; LeBlanc et al., 2018b; Vanzi & LeBlanc, 2018; Idensohn et al., 2019a).

Prevention

Since skin tears are largely preventable wounds that may cause considerable suffering and avoidable costs, there should be primarily focused on effective prevention (Stephen-Haynes, 2012; Lewin et al., 2016; LeBlanc & Baranoski, 2017; LeBlanc et al., 2018a; Hardie & Wick, 2020). Unfortunately, the cost of managing skin tears is poorly reported, although a North American study reported the economic benefits of the implementation of a skin tear prevention program (Bank & Nix, 2006). The program consisted of staff education, skin sleeves and padded side rails for high-risk patients, gentle skin cleansers, and application of skin lotion. Bank & Nix (2006) found a significant reduction in skin tear incidence, from a mean of 9.1% to a mean of 4.3% per month, after implementing the prevention program in a 209-bed nursing and rehabilitation center. This reduction was associated with a decrease in dressing and labour costs for managing skin tears of 1,698 dollars per month (18,168.60 dollars annually) (Bank & Nix, 2006).

Prevention should focus on early recognition of patients at risk, minimising the causes of skin tears, and changing modifiable risk factors (Xu et al., 2009; LeBlanc et al., 2018b; Serra et al., 2018). Non-modifiable risk factors, such as age, cannot be changed but can be controlled to reduce their effects, for example by more frequent skin inspection or application of moisturisers (LeBlanc et al., 2018a).

Risk assessment

As preventive measures can be costly and labour intensive, patients with a clear risk of developing skin tears should be accurately identified so that targeted interventions can be applied (LeBlanc et al., 2018a; Rayner et al., 2018a). The use of a valid, reliable, and easy-to-use risk assessment tool, combined with a comprehensive skin assessment and clinical judgement may support a structured risk assessment (Newall et al., 2017; LeBlanc et al., 2018a; Serra et al., 2018). Such a risk assessment tool must accurately and consistently identify those patients who are at risk, as well as those who are not (Newall et al., 2017). In the field of pressure ulcers, several risk assessment tools have been developed, of which the Norton Scale (Norton et al., 1962), the Waterlow Scale (Waterlow, 1985) and the Braden Scale (Bergstrom et al., 1987) are the most commonly used. Unfortunately, no risk assessment tool with adequate predictive validity has been developed for skin tears yet (Newall et al., 2017; LeBlanc et al., 2018b). In order to create such a tool and to allow targeted prevention and appropriate allocation of resources, a profound knowledge of key risk factors associated with skin tear development and multivariate risk models are necessary (Strazzieri-Pulido et al., 2017; Rayner et al., 2018a; Serra et al., 2018). To date, a number of studies have identified a broad range of skin tear risk factors, but reliable predictive risk models are lacking (Vanzi & LeBlanc, 2018).

According to LeBlanc et al. (2013a), risk factors associated with skin tear development can be subdivided into three categories: general health, mobility, and skin. All risk factors identified in previous studies could be classified according to this framework (LeBlanc et al., 2013a). Risk factors related to general health include: *having a chronic/ critical disease* (LeBlanc, 2017), *polypharmacy* (McGough-Csarny & Kopac, 1998; Serra et al., 2018), *chronic use of corticosteroids/ anticoagulants* (Holmes et al., 2013; Serra et al., 2018), *cognitive impairment* (Payne & Martin, 1990; LeBlanc et al., 2013b; Rayner et al., 2015; Strazzieri-Pulido et al., 2015a), *dementia* (McGough-Csarny & Kopac, 1998; Strazzieri-Pulido et al., 2017), *sensory/ visual/ auditory impairment* (McGough-Csarny & Kopac, 1998; Serra et al., 2018), *aggressive behaviour* (Amaral et al., 2012; Strazzieri-Pulido et al., 2015a; LeBlanc, 2017), *malnutrition* (McGough-Csarny & Kopac, 1998; Munro et al., 2018; Serra et al., 2018), and *dehydration* (Serra et al., 2018).

Risk factors related to mobility include: *dependence on assistance for ADLs (e.g. washing, dressing, transfers)* (Payne & Martin, 1990; Malone et al., 1991; McGough-Csarny & Kopac, 1998; Amaral et al., 2012; LeBlanc et al., 2013b; LeBlanc, 2017), *history/ risk of falls* (Malone et al., 1991; Everett & Powell, 1994; Kennedy & Kerse, 2011; Bermark et al., 2018; Rayner et al., 2018a), *being bedridden* (Payne & Martin, 1990), *impaired mobility* (Payne & Martin, 1990; Everett & Powell, 1994; McGough-Csarny & Kopac, 1998; McErlean et al., 2004; Rayner et al., 2015; Hawk & Shannon, 2018), *spasticity* (McGough-Csarny & Kopac, 1998; LeBlanc et al., 2013b; Strazzieri-Pulido et al., 2015a), *inability to reposition oneself independently* (Payne & Martin, 1990; Lewin et al., 2016; Newall et al., 2017), and *use of assistive devices (e.g. prostheses, wheelchairs, hoists)* (Malone et al., 1991; Everett & Powell, 1994; McGough-Csarny & Kopac, 1998; Serra et al., 2018).

Finally, risk factors related to skin include: *age-related skin changes* (Payne & Martin, 1990; Malone et al., 1991; Carville & Lewin, 1998; McGough-Csarny & Kopac, 1998; Carville & Smith, 2004; Santamaria et al., 2009; Kennedy & Kerse, 2011; Koyano et al., 2017; LeBlanc, 2017; Newall et al., 2017; Hawk & Shannon, 2018; Woo & LeBlanc, 2018), *photo-damage* (Koyano et al., 2016), *evidence of a previously healed skin tear* (Payne & Martin, 1990; McGough-Csarny & Kopac, 1998; Rayner et al., 2015; Sanada et al., 2015; Lewin et al., 2016; LeBlanc, 2017; Newall et al., 2017; Skiveren et al., 2017; Bermark et al., 2018; Rayner et al., 2018a), *increased pressure ulcer risk* (Amaral et al., 2012; Sanada et al., 2015; Woo & LeBlanc, 2018), *use of adhesives on fragile skin* (Everett & Powell, 1994; Serra et al., 2018), *ecchymosis* (McGough-Csarny & Kopac, 1998; Rayner et al., 2015; Lewin et al., 2016; Skiveren et al., 2017; Bermark et al., 2018), *senile purpura* (Payne & Martin, 1990; Rayner et al., 2015; Lewin et al., 2016; Newall et al., 2017; Rayner et al., 2018a), *haematoma* (Lewin et al., 2016; Newall et al., 2017), *oedema* (Rayner et al., 2015; Lewin et al., 2016), and *dry skin* (LeBlanc et al., 2018a).

The variety and inconsistency in risk factors can partly be explained by differences in sample (size), methodological design, diagnostic accuracy of skin tears, initial list of potential risk factors to study, and statistical analyses between the studies. Further robust research is needed to confirm the identified risk factors, to examine their influence and interdependence, and to develop reliable predictive models to accurately identify patients at risk for skin tear development (Lewin et al., 2016; Vanzi & LeBlanc, 2018).

Preventive strategies

Careful and timely identification of patients at risk for skin tears is an essential part of prevention (LeBlanc & Baranoski, 2011; LeBlanc et al., 2018a). Since risk of skin frailty, and thus of skin tears, may change for different individuals at different times, it is vital to assess and reassess individuals on a regular basis (LeBlanc et al., 2018a; Beeckman et al., 2020). Accurate, consistent and comprehensive documentation should be a key part of this process (Beeckman et al., 2020). Once an individual is deemed to be at risk, tailored preventive care should be provided in accordance with international evidence-based guidelines (Wounds UK, 2018). Three new best practice guidelines have recently been developed to guide healthcare professionals in improving the assessment, classification, treatment, and prevention of skin tears: the ISTAP Best Practice Recommendations for the Prevention and Management of Skin Tears in Aged Skin (LeBlanc et al., 2018a), the Wounds Canada Best Practice Recommendations for the Prevention and Management of Skin Tears (LeBlanc et al., 2018b), and the ISTAP Best Practice Recommendations for Holistic Strategies to Promote and Maintain Skin Integrity (Beeckman et al., 2020). It should, however, be noted that the evidence regarding skin tear prevention is scant and mainly based on expert opinion since systematic reviews and randomised controlled trials are lacking (Lewin et al., 2016; Newall et al., 2017; LeBlanc et al., 2018b).

A multidisciplinary team approach is recommended for the implementation of a skin tear prevention program. Team members can include, but are not limited to, nurses, physicians, wound specialists, occupational therapists, physical therapists, social workers, dietitians, and pharmacists (LeBlanc & Baranoski, 2011; LeBlanc et al., 2018b). Patients, their family, and caregivers, should also be involved and educated wherever possible, and their needs and preferences should be prioritised (LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020). Empowering patients, families, and caregivers to actively engage in preventative strategies has been found to be associated with better health outcomes, enhanced care experiences, improved quality of life, and reduced healthcare costs (Hibbard & Greene, 2013; Finch et al., 2018; LeBlanc et al., 2018b).

An international study performed in 2010 recognised equipment injury, patient transfer, performing ADLs, dressing removal, and falls as the most common causes of skin tears (LeBlanc et al., 2014). It should be noted that many of these causes are avoidable, for example by the use of skin-friendly dressings and removal techniques (e.g. non-adherent silicone mesh dressings), hoists and glide sheets, protective clothing (e.g. shin/ elbow guards, long sleeves/ pants/ gloves, knee-high socks), padding on equipment and furniture (e.g. bed rails, wheelchair arm and leg supports), fall prevention (e.g. remove clutter, ensure proper lighting, wear sturdy shoes), avoiding sharp fingernails and jewellery, and educating healthcare professionals, patients and family concerning appropriate positioning/ transferring techniques and skin-friendly equipment, preferably by

occupational and physical therapists (Xu et al., 2009; Sussman & Golding, 2011; Stephen-Haynes, 2012; LeBlanc et al., 2013a; LeBlanc et al., 2018a; LeBlanc et al., 2018b; Vanzi & LeBlanc, 2018; Idensohn et al., 2019b; Beeckman et al., 2020).

Adequate skin care strategies are an effective method for maintaining and enhancing skin health and integrity and restoring the skin barrier function in individuals with vulnerable skin (Lichterfeld-Kottner et al., 2020). A structured, individualised skin care regimen, consisting of gentle skin cleansing and moisturising is recommended (Lichterfeld et al., 2015; LeBlanc et al., 2018a; LeBlanc et al., 2018b; Wounds UK, 2018; Beeckman et al., 2020). Traditional washing with water and alkaline soap should be avoided as it compromises skin barrier integrity and increases skin pH (Lichterfeld et al., 2015; Moncrieff et al., 2015; Wounds UK, 2018). The use of no-rinse cleansers or soap-free liquid wash products, reflecting the pH-range of the acid mantle of healthy skin (pH 4.5-6.5), as soap substitutes can help hydrate and protect vulnerable skin from damage (Birch & Coggins, 2003; Wounds UK, 2018; Beeckman et al., 2020; Lichterfeld-Kottner et al., 2020). Excessive cleansing should be avoided as this can cause skin dryness and irritation (Lichterfeld et al., 2015; Beeckman et al., 2020). Frequency of bathing should be minimised where possible, the water temperature should be lukewarm (not hot), and the skin should be pat dry gently with a soft towel since drying the skin by rubbing causes additional friction (Moncrieff et al., 2015; LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020).

Cleansing is often followed by the application of leave-on products with moisturising properties such as lotions, creams or ointments (Lichterfeld et al., 2015). Skin moisturisers aim to repair or strengthen the skin barrier, retain or increase its water content, reduce TEWL, and restore or improve the intercellular lipid structure (Moncrieff et al., 2015; Beeckman et al., 2020). Emollient therapy is considered a vital part of daily skin care in individuals with dry, frail skin in order to promote general skin health and reduce the risk of skin damage (Wounds UK, 2018; Beeckman et al., 2020). Dry skin, or xerosis cutis, has been reported to affect between 30% and 100% of aged care residents, and is an important risk factor for skin tear development (Hahnel et al., 2017; Brown, 2019; Lichterfeld-Kottner et al., 2020). An Australian trial found that twice-daily application of a pH neutral, perfume-free moisturiser to the extremities of aged care residents reduced the incidence of skin tears by almost 50% (Carville et al., 2014). Emollients are available in a wide range of formulations, including topical moisturisers (ointments, creams, lotions, gels and sprays) as well as liquid body wash products, and should be pH-balanced, fragrance-free, and non-sensitising (Moncrieff et al., 2015; LeBlanc et al., 2018a; Wounds UK, 2018; Beeckman et al., 2020). Many emollients contain humectants, such as urea, glycerol or isopropyl myristate, which either mimic or comprise the same molecules as NMF (Wounds UK, 2018). Where simple emollients work by ‘trapping’ moisture into the skin which slows the evaporation of water (occlusion), humectant

emollients actively draw water from the dermis to the epidermis, compensating for the reduced level of natural moisturisers in the stratum corneum (LeBlanc et al., 2018a; Wounds UK, 2018). Humectant emollients have been shown to prevent TEWL for considerably longer than simple emollients (Moncrieff et al., 2015; Wounds UK, 2018). Simple emollients should be used as soap substitutes, whereas more sophisticated humectant emollients should be the choice for leave-on treatments (Moncrieff et al., 2015). Patient preference and acceptability are particularly important in emollient product selection as they are key to adherence (Moncrieff et al., 2013; LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020). For example, oil-in-water emollients are more cosmetically acceptable as they are easily absorbed by the skin. Heavy emollients (water-in-oil) have significantly better TEWL effects, but are usually considered too greasy for everyday use (Moncrieff et al., 2015; Wounds UK, 2018). To be effective emollients should be liberally applied by patting in a gentle way and spread to leave a thin layer on the skin. The use of excessive amounts should be avoided, especially in the skin folds, in order to prevent softening of the skin and maceration (British Dermatological Nursing Group, 2012; Moncrieff et al., 2015; Wounds UK, 2018). Self-care for the skin should be encouraged wherever possible, as this can be a powerful tool as part of a skin care regimen to increase engagement and improve outcomes (Moncrieff et al., 2015; Beeckman et al., 2020).

In addition to creating a safe environment and the implementation of a tailored skin care regimen, nutritional, polypharmacy, and mobility-related issues should also be taken into consideration in skin tear prevention programs (LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020). Adequate nutrition and hydration play important roles in the maintenance of skin integrity and health (Timms, 2011; Beeckman et al., 2020). A poor nutritional status diminishes tissue tolerance, which increases the likelihood of developing skin tears (LeBlanc et al., 2013a; LeBlanc et al., 2018b). Furthermore, malnutrition and dehydration can cause delayed wound healing and infections, increasing the risk of skin tears to evolve into complex chronic wounds (Stechmiller, 2010). Monitoring should be ongoing and, where necessary, a dietitian can be consulted to optimise the patient's nutrition and hydration (LeBlanc et al., 2013a; Idensohn et al., 2019b; Beeckman et al., 2020).

A variety of medications can cause changes to the skin that need to be managed appropriately (LeBlanc et al., 2013a; Beeckman et al., 2020). Corticosteroids, for example, inhibit collagen synthesis, decrease the proliferation of keratinocytes, and reduce the strength and elasticity of the skin (Holmes et al., 2013; Ghosh & Coondoo, 2018). The use of anticoagulants can cause dermatological changes such as senile purpura and ecchymosis, which have been identified as contributing factors to skin tear development (Bassas et al., 2009; LeBlanc & Baranoski, 2011; Koyano et al., 2016). Antidepressants, dopaminergic medicines and antipsychotics can cause

dizziness, unsteady gait and confusion, potentially leading to falls and resulting skin injury (LeBlanc et al., 2018b; Idensohn et al., 2019b). The effects of medications and polypharmacy on the patient's skin and wound healing should be continuously monitored and eventually discussed with the prescriber or a pharmacist (LeBlanc et al., 2013a; LeBlanc et al., 2018b; Idensohn et al., 2019b).

Patients who are dependent on others for ADLs or who have impaired mobility are at increased risk for skin tears (Idensohn et al., 2019a). Dependent patients frequently acquire skin tears during routine activities such as bathing, dressing, toileting, repositioning, and transferring (LeBlanc & Baranoski, 2011; LeBlanc et al., 2013a). Mobility exercises and active involvement in ADLs should be encouraged where possible and assistive devices considered for suitability (LeBlanc et al., 2018a; Idensohn et al., 2019b; Beeckman et al., 2020). Referral to an occupational and/or physical therapist may be beneficial (LeBlanc et al., 2018b; Beeckman et al., 2020).

Prevalence and incidence

Despite being largely avoidable, skin tears are perceived to be commonly occurring wounds with prevalence and incidence rates that closely resemble those of pressure ulcers (White, 2001; Carville et al., 2007; LeBlanc et al., 2016a; Woo & LeBlanc, 2018). To date, a limited number of studies have examined the prevalence and incidence of skin tears in various patient populations, healthcare settings and countries. Prevalence reflects the number of *existing* cases of a disease or injury at a specific *point in time*. Incidence refers to the number of *new* cases of a disease or injury over a specified *period of time* (Kuhn et al., 1997; Noordzij et al., 2010). Knowledge of skin tear prevalence and incidence is essential to understand the magnitude of the problem and may aid in the allocation of resources, provide benchmarking, enable goal setting, and support prevention programs (Koyano et al., 2016; LeBlanc & Baranoski, 2017; Woo & LeBlanc, 2018). Furthermore, prevalence and incidence rates can be used to evaluate the effectiveness of preventive measures, treatment strategies, and educational interventions in clinical practice and research (Noordzij et al., 2010).

Prevalence of skin tears

The prevalence of skin tears is estimated between 1.1% and 41.2%, with highest prevalence in long-term care facilities (Table 1). Studies in long-term care have reported skin tear prevalence rates between 3.9% and 41.2%, measured in a sample ranging from 34 to 1253 residents (LeBlanc et al., 2013b; Koyano et al., 2016; Ayello, 2017; Edwards et al., 2017; Hahnel et al., 2017; LeBlanc, 2017; Skiveren et al., 2017; Woo et al., 2017; Hawk & Shannon, 2018; Woo & LeBlanc, 2018; LeBlanc et al., 2020; Parker et al., 2020). In acute care settings, skin tear prevalence is slightly lower, varying from 1.1% to 19.8% (McErlean et al., 2004; McLane et al., 2004; Santamaria et al.,

2009; Hsu & Chang, 2010; Lopez et al., 2011; Amaral et al., 2012; Chang et al., 2016; Bermark et al., 2018; Feng et al., 2018; Munro et al., 2018). One study was conducted in the palliative care setting, reporting a skin tear prevalence of 16.1% (Maida et al., 2012). Carville & Lewin (1998) and Carville & Smith (2004) documented skin tear prevalence rates of respectively 5.5% and 19.5% among 1638 Australian home care patients. To date, only three studies have been conducted in European countries. Hahnel et al. (2017) studied the prevalence of skin tears in 223 residents from 10 nursing homes in Germany and found a point prevalence of 6.3%. The study of Skiveren et al. (2017) showed a skin tear prevalence of 4.6% in 128 residents from a Danish nursing home. Bermark et al. (2018) reported a prevalence of 11.4% in 202 acute and critical care patients from a hospital in Denmark. In the two Danish studies, as well as in some other studies, only the extremities of the body were observed which may result in omission and underreporting of skin tears.

Table 1. Prevalence of skin tears

Author (year)	**Country**	**Healthcare setting**	**Skin tear prevalence** % (number of participants with 1 or more STs / total study sample)
Carville & Lewin (1998)	Australia	Community care (1146 home care patients)	5.5% (63/1146)
Carville & Smith (2004)	Australia	Community care (492 home care patients)	19.5% (96/492)
McErlean et al. (2004)	Australia	Acute and critical care (1 tertiary hospital)	10.7% (20/187)
McLane et al. (2004)	USA	Acute pediatric care (9 children's hospitals)	3.7% (39/1064)
Santamaria et al. (2009)	Australia	Acute care (86 public hospitals)	8.0% (464/5800)
Hsu & Chang (2010)	Taiwan	Acute and critical care (1 hospital)	11.0% (80/724)
Lopez et al. (2011)	Australia	Acute care (2 public hospitals)	19.8% (19/96)
Amaral et al. (2012)	Brazil	Acute and critical care (1 teaching oncology hospital)	3.3% (5/157)
Maida et al. (2012)	Canada	Palliative care (hospital + community program)	16.1% (83/517)
LeBlanc et al. (2013b)	Canada	Long-term care (1 facility)	22.1% (25/113)
Chang et al. (2016)	Singapore	Acute care (1 teaching tertiary hospital)	6.2% (9/144)

Koyano et al. (2016)	Japan	Long-term care (1 facility, age ≥ 65 years)	3.9% (16/410)
Ayello (2017)	USA	Long-term care (CMS national health database)	In 2012: 4.7% (NR/NR) In 2013: 5.4% (NR/NR)
Edwards et al. (2017)	Australia	Long-term care (7 aged care facilities)	23.5% (47/200)
Hahnel et al. (2017)	Germany	Long-term care (10 facilities, age ≥ 65 years)	6.3% (14/223)
LeBlanc (2017), LeBlanc et al. (2020)	Canada	Long-term care (4 facilities, age ≥ 65 years)	20.8% (79/380)
Skiveren et al. (2017)	Denmark	Long-term care (1 nursing home, age ≥ 65 years)	4.6% (6/128)
Woo et al. (2017)	Canada	Long-term care (ICES Ontario health databases)	26.0% (NR/NR)
Bermark et al. (2018)	Denmark	Acute and critical care (1 university hospital)	11.4% (23/202)
Feng et al. (2018)	China	Acute care (9 tertiary research hospitals)	1.1% (141/13176)
Hawk & Shannon (2018)	USA	Long-term care (6 facilities, age ≥ 65 years)	9.5% (119/1253)
Munro et al. (2018)	Australia	Acute care (1 tertiary hospital)	8.1% (177/2197)
Woo & LeBlanc (2018)	Canada	Long-term care (4 facilities, age ≥ 65 years)	14.7% (100/678)
Parker et al. (2020)	Australia	Long-term care (2 facilities for people with dementia)	41.2% (14/34)

STs: skin tears, NR: not reported

Incidence of skin tears

Skin tear incidence rates vary between 2.2% and 62.0%, with highest incidence in rehabilitation and critical care settings (Table 2) (Bajwa et al., 2010; Groom et al., 2010). Everett & Powell (1994) and Finch et al. (2018) reported skin tear incidence rates of respectively 6.3% and 8.8% among 1524 Australian acute care patients over a 1-month follow-up period. The study of Kennedy & Kerse (2011) showed a skin tear incidence of 5.0% in 2401 outpatients from a primary healthcare facility in New Zealand over a 2-year follow-up period. In long-term care facilities, skin tear incidence rates between 2.2% and 44.8% were found, measured in a sample ranging from 29 to 1567 residents (Payne & Martin, 1990; Malone et al., 1991; White et al., 1994; Birch & Coggins, 2003; Carville et al., 2014; Sanada et al., 2015; Koyano et al., 2017; LeBlanc, 2017; Furukawa, 2019; Kapoor et al., 2019; LeBlanc et al., 2020). In line with the studies reporting on skin tear prevalence, almost all

skin tear incidence studies were performed in Asia, Australia, Canada, and the United States. Only one incidence study was conducted in Europe. Powell et al. (2017) reported a skin tear incidence of 20.0% in 90 primary healthcare outpatients and care home residents (aged ≥ 65 years) in the United Kingdom over a 112-day follow-up period.

Table 2. Incidence of skin tears

Author (year)	**Country**	**Healthcare setting**	**Skin tear incidence** % (number of participants with 1 or more *new* STs / total study sample [a])
Payne & Martin (1990)	USA	Long-term care (10 facilities, age ≥ 55 years)	2.2% (20/896) *Time period: 5 months*
Malone et al. (1991)	USA	Long-term care (1 nursing home)	42.1% (147/349) *Time period: 1 year*
Everett & Powell (1994)	Australia	Acute care (1 hospital)	6.3% (22/347) *Time period: 1 month*
White et al. (1994)	USA	Long-term care (1 nursing home)	14.2% (17/120) *Time period: 1 month*
Birch & Coggins (2003)	USA	Long-term care (1 facility, age ≥ 65 years, bed-bound)	44.8% (13/29) *Time period: 1 month*
Bank & Nix (2006)	USA	Rehabilitation care (1 rehabilitation center)	9.1% (19/209) *Time period: 1 month*
Bajwa et al. (2010)	USA	Critical care (1 academic medical center)	58.8% (10/17) *Time period: median length of stay in ICU: 22 days*
Groom et al. (2010)	USA	Rehabilitation care (1 convalescent care hospital-based center, age ≥ 65 years)	62.0% (62/100) *Time period: 6 months*
Kennedy & Kerse (2011)	New Zealand	Community care (2401 outpatients from a rural primary healthcare facility, age ≥ 65 years)	5.0% (120/2401) *Time period: 2 years*
Carville et al. (2014)	Australia	Long-term care (14 facilities, age ≥ 65 years or < 65 years with dementia or severe disability)	43.1% (424/984) *Time period: 6 months*
Sanada et al. (2015)	Japan	Long-term care (1 facility, age ≥ 65 years)	3.8% (14/368) *Time period: 3 months*
Koyano et al. (2017)	Japan	Long-term care (1 facility, age ≥ 65 years)	14.1% (21/149) *Time period: 8 months*

LeBlanc (2017), LeBlanc et al. (2020)	Canada	Long-term care (4 facilities, age ≥ 65 years)	18.9% (72/380) *Time period: 4 weeks*
Powell et al. (2017)	UK	Community + long-term care (GP practices + care homes, age ≥ 65 years)	20.0% (18/90) *Time period: 112 days*
Finch et al. (2018)	Australia	Acute care (1 hospital, age ≥ 65 years)	8.8% (104/1177) *Time period: 1 month*
Furukawa (2019)	Japan	Long-term care (1 facility)	9.7% (152/1567) *Time period: 1 year*
Kapoor et al. (2019)	USA	Long-term care (32 nursing homes)	7.2% (40/555) *Time period: 45 days*

STs: skin tears, [a]: number of ST-free participants at the beginning of the assessment period

The wide variety in prevalence and incidence rates may in part be attributable to varying patient populations and differences in methodological design, prevention and management practices, nursing staff, knowledge, attitude and equipment. Another explanation for this variability may be the complexity of correctly diagnosing a skin tear and distinguishing it from other skin lesions such as superficial pressure ulcers (LeBlanc et al., 2016a). The lack of an ICD code for skin tears and a standardised, universally accepted classification system to support accurate and consistent assessment may have contributed significantly (LeBlanc et al., 2014; LeBlanc et al., 2018a).

Identification and classification

Correct identification of skin tears is essential to ensure accurate scientific and clinical reporting and to optimise management from the earliest possible stage of care (Chang et al., 2016; LeBlanc et al., 2018a). Classification systems are valuable tools to aid and standardise the diagnostic process by providing common descriptions of skin tear severity based on the extent of tissue loss (McErlean et al., 2004; Kumar & Leaper, 2008; LeBlanc et al., 2018b). The amount of tissue (skin flap) loss is important to informing treatment decisions (Stephen-Haynes, 2013). Furthermore, the use of a common classification system enables clinical and scientific communication and promotes uniformity of documentation for the purposes of clinical practice, audit, and research (Kumar & Leaper, 2008; LeBlanc & Baranoski, 2017; Kottner et al., 2020b). Classification systems should be valid and reliable in order to assess skin tears accurately and consistently (Garbuz et al., 2002; Kimberlin & Winterstein, 2008; Polit & Beck, 2008). Validity is defined as the degree to which an instrument measures what it purports to measure and can be divided into content validity, criterion validity, and construct validity (Polit & Beck, 2008; de Souza et al., 2017; Mokkink et al., 2018a; Prinsen et al., 2018). Reliability estimates evaluate the stability of measures when repeated under identical conditions (test-retest or intrarater reliability), internal consistency of measurement

instruments, and interrater reliability of instrument scores (Kimberlin & Winterstein, 2008; Polit & Beck, 2008; de Souza et al., 2017).

To date, three skin tear classification systems have been developed (Table 3). The first classification was proposed by Payne & Martin in 1990 and slightly revised in 1993 (Payne & Martin, 1990; Payne & Martin, 1993). The Payne-Martin Classification System differentiates three categories and four subcategories based on the extent of tissue loss, measured as a percentage (Payne & Martin, 1993). The system has never been evaluated on its psychometric properties and has been criticised for its complexity, ambiguity, and poor international uptake outside the United States of America (Carville et al., 2007; LeBlanc & Baranoski, 2011; LeBlanc et al., 2018a). In 2007, Carville et al. established and psychometrically tested the Skin Tear Audit Research (STAR) Classification System, which was developed as a modified version of the Payne-Martin classification, additionally including skin/flap colour distinction. The STAR classification assesses the skin and any remnant flap for haematoma and ischaemia, which could affect tissue viability and treatment decisions (Carville et al., 2007). Similarly to the Payne-Martin classification, the STAR classification was found to be subjective and complex for use in clinical practice, which may reduce the consistency of documentation (Skiveren et al., 2015; Chaplain et al., 2018; LeBlanc et al., 2018a). Furthermore, it has not been widely implemented outside Australia, Brazil, and Japan (Skiveren et al., 2015; LeBlanc, 2017).

A descriptive study among 520 nurses from 104 Australian nursing homes revealed the need for a uniform language for the description and classification of skin tears. None of the participating nurses used the Payne-Martin Classification System and 89% indicated the willingness to use a common, user-friendly skin tear assessment and documentation tool if made available (White, 2001). In 2010, a cross-sectional international study including 1127 healthcare professionals from 16 countries was conducted to explore current practices in the assessment, prevention, and treatment of skin tears (LeBlanc et al., 2014). Seventy percent of the respondents reported problems with the current assessment and documentation of skin tears in their practice settings, with an overwhelming majority (90%) favouring a simplified method. Eighty-one percent of the respondents indicated that they did not use any tool or classification system for assessing and documenting skin tears, despite performing a weekly wound assessment on skin tears. Ten percent of all respondents used the Payne-Martin Classification System and 5.8% used the STAR Classification System.

In an effort to fulfil the need for a user-friendly and simple classification tool, an international expert consensus panel developed and psychometrically tested the ISTAP Classification System, which categorises skin tears as type 1 (no skin/flap loss), type 2 (partial skin/flap loss), or type 3 (total

skin/flap loss) (LeBlanc et al., 2013c). The presence or absence of haematoma and ischaemia was not incorporated into the ISTAP classification as it appears to be prescriptive (e.g. predictability of potential skin tear risk and healing time) rather than descriptive, diminishing the simplicity of the tool (Skiveren et al., 2015; LeBlanc, 2017). Although the ISTAP classification categorises skin tears based on the severity of 'skin flap' loss, it does not provide a definition of a 'skin flap'. In their best practice document (2018), the ISTAP panel indicated a need for standardised terminology and definitions in order to avoid confusion (LeBlanc et al., 2018a). Since its development in 2013, the ISTAP classification has been translated into several languages and psychometrically tested in several countries. It is acknowledged, however, that further translation and psychometric testing with larger samples of healthcare professionals across different settings and countries are required (LeBlanc, 2017; LeBlanc et al., 2018a).

Table 3. Description of the skin tear classification systems

Classification system	Instrument description	Available languages
Payne-Martin Classification System for Skin Tears (Payne & Martin, 1993)	**Category I: Skin tears without tissue loss** ***A. Linear type*** A full thickness wound which occurs in a wrinkle or furrow of the skin. Both the epidermis and the dermis are pulled apart as if an incision has been made, exposing the tissue below. ***B. Flap type*** A partial thickness wound in which the epidermal flap can be completely approximated or approximated so that no more than one millimeter of the dermis is exposed. **Category II: Skin tears with partial tissue loss** ***A. Scant tissue loss type*** A partial thickness wound in which ≤ 25% of the epidermal flap is lost and ≥ 75% of the dermis is covered by the flap. ***B. Moderate-to-large tissue loss type*** A partial thickness wound in which > 25% of the epidermal flap is lost and > 25% of the dermis is exposed. **Category III: Skin tears with complete tissue loss** A partial thickness wound in which the epidermal flap is absent.	English

Skin Tear Audit Research (STAR) Classification System (Carville et al., 2007)	**Category 1a** A skin tear where the edges **can** be realigned to the normal anatomical position (without undue stretching) and the skin or flap colour **is not** pale, dusky or darkened. **Category 1b** A skin tear where the edges **can** be realigned to the normal anatomical position (without undue stretching) and the skin or flap colour **is** pale, dusky or darkened. **Category 2a** A skin tear where the edges **cannot** be realigned to the normal anatomical position and the skin or flap colour **is not** pale, dusky or darkened. **Category 2b** A skin tear where the edges **cannot** be realigned to the normal anatomical position and the skin or flap colour **is** pale, dusky or darkened. **Category 3** A skin tear where the skin flap is completely absent.	English, Portuguese
International Skin Tear Advisory Panel (ISTAP) Classification System (LeBlanc et al., 2013c)	**Type 1: No skin loss** Linear or flap tear that can be repositioned to cover the wound bed. **Type 2: Partial flap loss** Partial flap loss that cannot be repositioned to cover the wound bed. **Type 3: Total flap loss** Total flap loss exposing the entire wound bed.	English, Danish, French, Italian, Portuguese, Swedish

Together with the absence of standardised terminology, the lack of a uniform method for assessing and documenting skin tears using a valid, reliable and internationally accepted classification system may result in insufficient diagnostic accuracy and incorrect prevalence and incidence data (Carville et al., 2007; LeBlanc et al., 2014). This may complicate communication between healthcare professionals, benchmarking, making appropriate treatment decisions, and analysis of care outcomes (Carville et al., 2007; Chang et al., 2016; Chaplain et al., 2018; LeBlanc et al., 2018b). In addition to the need for further psychometric testing and translation of the existing classification systems, it would be useful to critically appraise, compare, and summarise the quality of their measurement properties to find out which classification can be recommended for use in daily practice and research (LeBlanc et al., 2018a).

Comprehensive assessment and treatment

Classification is only one aspect of skin tear assessment that should be considered. Effective wound treatment and further preventive care that are tailored to the individual patient, their skin and their wound rely on a comprehensive assessment of the wound as well as the patient (Ousey & Cook, 2012; Wounds UK, 2021). A thorough wound assessment must consider and document the following aspects: cause of the wound, duration of injury, anatomical location, dimensions (length, width, depth), wound bed characteristics, percentage of viable/non-viable tissue, extent of skin flap loss (classification), type and amount of exudate, presence of bleeding or haematoma, integrity of surrounding skin, signs and symptoms of infection, and associated pain. Holistic assessment of the patient should include: medical history, past history of skin tears, general health status, comorbidities, medications, mental health issues, socio-economic and psychosocial factors, self-management potential, mobility, and nutrition and hydration (LeBlanc et al., 2018a).

Based on the thorough holistic assessment, an individualised care plan that maintains a continuous link between prevention, assessment and treatment should be developed in collaboration with the patient, his/her family and the multidisciplinary team. The plan of care should include realistic goals taking into account patient needs, abilities and preferences, opportunities and potential barriers to ongoing management (LeBlanc et al., 2018b). Factors that might impede the wound healing process (e.g. diabetes, smoking, malnutrition, anticancer drugs, peripheral oedema) must be addressed where possible (Ousey & McIntosh, 2010; Wounds UK, 2013; Hardie & Wick, 2020). The assessment process and plan of care should be clearly documented, including dates for reassessment and the rationale for intervention choices (Wounds UK, 2013). Because the management of skin tears is multifaceted, a multidisciplinary team approach is required to optimise care outcomes and patient experiences (LeBlanc & Baranoski, 2011; LeBlanc et al., 2018b). Engaging patients and their families in a collaborative care plan is crucial to set appropriate goals, ensure adherence to the planned interventions, improve quality of life, and optimise clinical and financial outcomes (Fletcher, 2008; Ousey & Cook, 2012; LeBlanc et al., 2018b; Kapp & Santamaria, 2020). All patients should be given the opportunity to understand their condition, be involved in prevention and treatment decisions, and take responsibility for managing their wound where possible. The degree of involvement strongly depends on the willingness and ability of the individual patient to be involved in his/her own care, goal setting, and decision-making (Moore et al., 2016). Active participation in self-care could include for example wound cleansing, changing dressings, the application of a skin barrier product, optimising nutrition and hydration, and/or applying and removing compression bandaging when oedema is an issue (Idensohn et al., 2019a; Kapp & Santamaria, 2020).

Where possible, treatment of skin tears should aim to preserve the skin flap, re-approximate the edges of the wound, maintain the surrounding tissue, and minimise the risk of infection and further injury (Wounds UK, 2015; LeBlanc et al., 2018a). When a skin tear occurs, the first steps are to control bleeding, cleanse the wound, and remove any residual debris or haematoma. The surrounding skin should be gently patted dry to avoid further injury (LeBlanc et al., 2018b). Skin tears with necrotic tissue or slough may require debridement as the presence of devitalised tissue provides a focus for infection, prolongs the inflammatory response, and delays wound healing (Schultz et al., 2003; Dowsett & Newton, 2005; Wounds UK, 2013). The method of debridement should be discussed with the patient/ family where appropriate and a wound specialist be consulted (Ousey & McIntosh, 2010; LeBlanc et al., 2018b). If viable, the skin flap should be re-approximated to cover the wound surface as much as possible (without stretching the skin) (Ewart, 2016). The flap can be eased back into place using a dampened cotton tip, gloved finger, tweezers or a silicone strip. Topical skin glue can be used to approximate the wound edges for primary closure in type 1 skin tears. Adhesive wound closure strips, sutures and staples are not recommended due to the fragility of the skin (LeBlanc et al., 2018a).

Once the skin flap is in place, a non-adherent and atraumatic dressing that optimises the healing environment and protects the fragile skin from further injury should be applied (e.g. silicone mesh/ foam/ hydrogel, eventually combined with a secondary cover dressing) (LeBlanc et al., 2018a). If possible, the dressing should be left in place for at least 5-6 days to avoid disturbing the skin flap (Stephen-Haynes, 2013; LeBlanc et al., 2016b). The ideal dressing should be easy to apply and remove, prevent trauma to the wound bed, skin flap and periwound skin on removal/dressing change, provide a protective anti-shear barrier, maintain moisture balance, and afford extended wear time (LeBlanc et al., 2018a). Dressings should be selected in accordance with the local wound conditions, patient-related factors and treatment goals (Wounds UK, 2015; LeBlanc et al., 2018b). When local or deep tissue infection is suspected or confirmed, the use of atraumatic antimicrobial dressings (e.g. methylene blue and gentian violet) should be considered (LeBlanc et al., 2018a). Wound infections can increase healthcare costs, delay healing, cause complications (e.g. sepsis), and significantly affect daily living for patients (Ousey & McIntosh, 2010; Wounds UK, 2013; Dissemond et al., 2020). Exudate must be effectively managed to create the optimal moist environment necessary for wound healing and to protect the periwound skin from the risks of maceration and excoriation (White & Cutting, 2006; Wounds UK, 2013). If a skin tear is heavily exudating, an absorbent dressing (e.g. foam, calcium alginate, gelling fibre) and skin barrier product to protect the surrounding skin may be beneficial (LeBlanc et al., 2018a; Nair et al., 2020). Dressings need to be changed more frequently if signs of infection or high exudate are present (Wounds UK, 2015; LeBlanc et al., 2018b). At each dressing change, the dressing should be removed slowly, working away from the attached skin flap (Figure 4) (Stephen-Haynes, 2013).

The correct direction of removal can be indicated with an arrow on the dressing (Ewart, 2016; Idensohn et al., 2019b). Changes in wound status should be carefully monitored to determine treatment response. If the wound does not improve promptly (e.g. after four assessments) or deterioration is observed, the underlying conditions should be reassessed and the care plan adapted accordingly (Wounds UK, 2013; LeBlanc et al., 2018a).

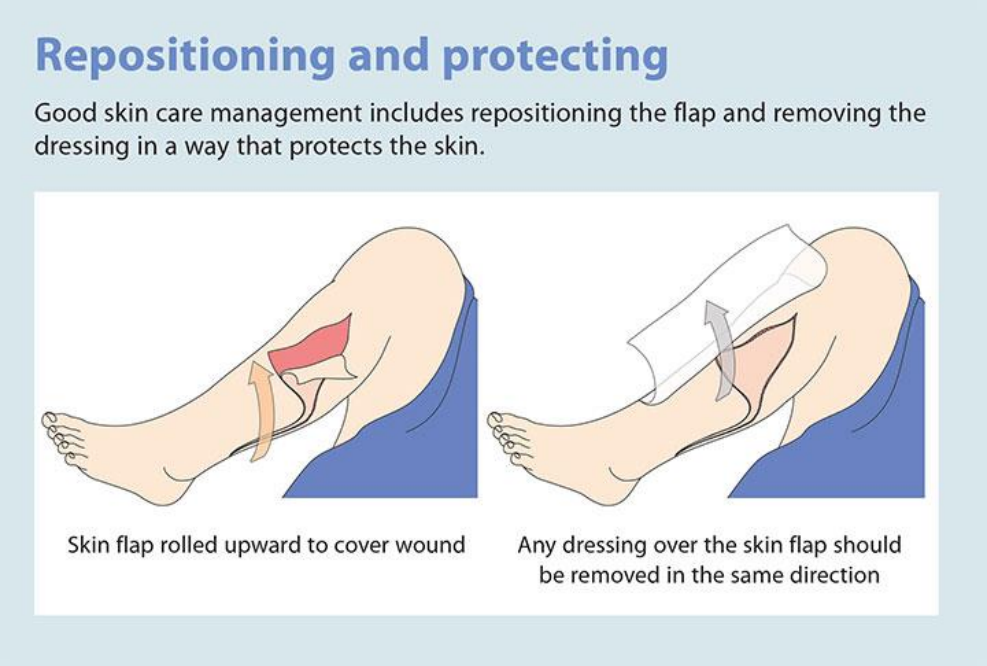


Figure 4. Repositioning the skin flap and dressing removal (Davis, 2018)

Education of (future) healthcare professionals

Although several best practice guidelines for the prevention and management of skin tears have been published during the last decade, there is a lack of uptake within clinical practice (Stephen-Haynes, 2012; Edwards et al., 2017). Lack of knowledge and a negative attitude towards skin tear prevention and management among healthcare professionals may be important factors contributing to this 'evidence-practice gap' (Edwards et al., 2017). In order to raise awareness and improve clinical and financial outcomes, healthcare professionals should possess profound and up-to-date knowledge regarding the aetiology, risk factors, assessment, classification, prevention, and treatment of skin tears (Stephen-Haynes, 2012; LeBlanc et al., 2018b). Higher skin tear knowledge has been found to be associated with fewer misconceptions, better assessment and documentation, an increase in implementation of evidence-based prevention and management strategies, and a decrease in skin tear incidence and severity (Hsu et al., 2009; McTigue et al., 2009; Chang et al., 2016; Edwards et al., 2017; Campbell et al., 2018a; Pagan & Harvey, 2019).

Educational programs may play a key role in the dissemination of skin tear guidelines and research findings to healthcare professionals, narrowing the evidence-practice gap (White, 2001; LeBlanc et al., 2018a; LeBlanc et al., 2018b). In order to be able to identify knowledge gaps and determine educational needs and priorities, a valid and reliable instrument to assess skin tear knowledge is required. In addition to supporting the development of educational programs, such an instrument can also be useful to evaluate their effectiveness using a pretest-posttest design (White, 2001). To date, four instruments assessing skin tear knowledge have been developed (Table 4). However, none of them had been psychometrically tested, and no information about their developmental processes was provided. Additionally, these instruments are no longer up-to-date as several new best practice guidelines, with updated definitions, assessment, classification, prevention and treatment strategies, have been published recently (LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020).

Table 4. Description of the skin tear knowledge assessment instruments

Author (year)	Number and format of questions	Themes covered
White (2001)	7 open-ended questions	▪ Payne-Martin definition of a skin tear ▪ Ageing skin ▪ Risk factors ▪ Payne-Martin classification ▪ Prevention
Baranoski & Ayello (2004)	7 multiple-choice questions	▪ Aetiology ▪ Assessment ▪ Risk factors ▪ Payne-Martin classification ▪ Treatment
McTigue et al. (2009)	12 multiple-choice questions	▪ Identification and assessment ▪ Payne-Martin classification ▪ Treatment
LeBlanc & Baranoski (2014)	35 multiple-choice questions	▪ Aetiology ▪ Assessment ▪ Risk factors ▪ ISTAP classification ▪ Prevention ▪ Treatment

OBJECTIVES AND MAIN RESEARCH QUESTIONS

With an ageing population and increased prevalence of chronic diseases, skin tears are expected to remain a common health problem that poses a significant burden on the healthcare system and individual patients (Carville et al., 2014; Woo & LeBlanc, 2018). As a consequence, more patients will benefit from early and accurate identification and classification, comprehensive documentation, appropriate treatment, and effective prevention. Although there has been an increased focus on the issue of skin tears in recent years, there are still gaps in knowledge and awareness, and areas that require further research (LeBlanc et al., 2018a). This dissertation aims to contribute to the gathering of epidemiological data, the standardisation of assessment and documentation, and the integration of best practice recommendations into practice. For this purpose, the reports of four studies are presented, which address different knowledge gaps using various research methodologies. The knowledge gaps and related research objectives are outlined below.

OBJECTIVE 1: To investigate the prevalence and associated factors of skin tears

Due to poor record-keeping and limited prevalence studies on skin tears, the scope of the problem is not fully understood (LeBlanc et al., 2018a). To date, there are no studies that have investigated the prevalence of skin tears in Belgium. Knowledge of skin tear prevalence is important to gain insight into the extent of the problem, allow benchmarking, facilitate goal setting, and aid in resource allocation. Additionally, skin tear prevalence rates can be used to evaluate the effectiveness of prevention, management, and education programs (Chang et al., 2016; Koyano et al., 2016; Woo & LeBlanc, 2018). In order to accurately identify patients at risk for skin tears and to develop targeted prevention strategies, a profound knowledge of skin tear risk factors is necessary (Koyano et al., 2016; Bermark et al., 2018; Rayner et al., 2018a). To date, a wide variety of skin tear risk factors has been identified, but reliable predictive risk models are lacking (Vanzi & LeBlanc, 2018). A cross-sectional observational study will be carried out to address the following research questions (**chapter 2**):

- What is the prevalence of skin tears in Belgian nursing home residents?
- Which factors are independently associated with skin tear presence in Belgian nursing home residents?

OBJECTIVE 2: To standardise the assessment and documentation of skin tears

Skin tears are often under-recognised, misdiagnosed, and poorly reported in clinical practice (LeBlanc et al., 2018a). A standardised and globally accepted skin tear classification system would be useful to support accurate and consistent assessment and reporting and to enhance the quality and comparability of epidemiological data across different healthcare settings and countries

(LeBlanc & Baranoski, 2017). Two cross-sectional studies including 1647 healthcare professionals indicated the need for a common, user-friendly and simple classification tool (White, 2001; LeBlanc et al., 2014). As a result, the ISTAP Classification System was developed and psychometrically tested (LeBlanc et al., 2013c). More extensive psychometric testing and translation into multiple languages are, however, required. Furthermore, the ISTAP panel proposed the development and content validation of a definition of a 'skin flap' to be added to the ISTAP classification in order to avoid terminology confusion (LeBlanc et al., 2018a). An international psychometric instrument validation study will be designed to develop and content validate a 'skin flap' definition and to evaluate the measurement properties of the ISTAP Classification System (**chapter 3**). The following research question will be answered:

- What is the diagnostic accuracy, agreement and reliability of the ISTAP Classification System?

Besides the ISTAP classification, a few other skin tear classifications have been developed and psychometrically tested (Payne & Martin, 1993; Carville et al., 2007). To date, no attempts have been made to systematically review and summarise the available evidence to find out which classification can be recommended for use in daily practice and research. A systematic review will be conducted to address the following research questions (**chapter 4**):

- Which skin tear classifications are available and what is the quality of their measurement properties?
- What is the methodological quality of the reported studies?

<u>OBJECTIVE 3</u>: To support the integration of skin tear evidence into practice

Despite the availability of evidence-based guidelines and the need for evidence-based care, a gap between evidence and practice regarding skin tear prevention and management exists (Stephen-Haynes, 2012; Edwards et al., 2017). The provision of adequate care is based on in-depth and up-to-date knowledge among healthcare professionals (LeBlanc et al., 2018b). In order to be able to assess skin tear knowledge adequately and to determine educational needs and priorities, a valid and reliable instrument is needed. Four instruments measuring skin tear knowledge exist, but these are not in line with the most recent updated guidelines and none of them had been psychometrically tested (White, 2001; Baranoski & Ayello, 2004; McTigue et al., 2009; LeBlanc & Baranoski, 2014). An international psychometric instrument validation study will be designed to develop, content validate and psychometrically test a new skin tear knowledge assessment instrument integrating the recent evidence-based guidelines (**chapter 5**). The following research question will be answered:

- What is the validity of the multiple-choice test items, construct validity and test-retest reliability of a new instrument to assess nurses' knowledge on skin tears?

Finally, **chapter 6** will provide a general discussion of the research findings, methodological considerations, and recommendations for clinical practice, policy, education, and future research.

Table 5 provides an overview of the four studies performed, including the research objective and methodology used. Each study is presented as a standalone chapter relying on a manuscript that has been published in an international peer-reviewed journal.

Table 5. Overview of the studies included in this dissertation

	Chapter	Study objective	Methodology	Design
PREVALENCE AND ASSOCIATED FACTORS	**2**	To determine the prevalence and associated factors of skin tears.	10 Belgian nursing homes, 1153 residents	Cross-sectional observational study
STANDARDISED ASSESSMENT AND DOCUMENTATION	**3**	To psychometrically test the International Skin Tear Advisory Panel (ISTAP) Classification System.	(1) Design and content validation of a definition of a 'skin flap' using a two-round Delphi procedure with 17 experts from 11 countries (2) Psychometric evaluation with 1601 healthcare professionals from 44 countries	Prospective psychometric instrument validation study
	4	To critically appraise, compare, and summarise the quality of the measurement properties of available skin tear classification systems.	According to the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) guideline for systematic reviews	Systematic review
INTEGRATION OF EVIDENCE INTO PRACTICE	**5**	To develop and psychometrically test an instrument measuring nurses' knowledge on skin tears (OASES).	(1) Development based on literature review and expert input (19 experts from 13 countries) (2) Content validation using a two-round Delphi procedure with 10 international experts affiliated with ISTAP (3) Psychometric evaluation with 387 nurses from 37 countries	Prospective psychometric instrument validation study

Chapter 2

The prevalence and associated factors of skin tears in Belgian nursing homes: a cross-sectional observational study

Chapter based on:

Van Tiggelen, H., Van Damme, N., Theys, S., Vanheyste, E., Verhaeghe, S., LeBlanc, K., Campbell, K., Woo, K., Van Hecke, A., & Beeckman, D. (2019). The prevalence and associated factors of skin tears in Belgian nursing homes: a cross-sectional observational study. *Journal of Tissue Viability, 28*(2), 100-106. doi:10.1016/j.jtv.2019.01.003

Impact factor: 2.932, rank (nursing): 15/124 (Q1), rank (dermatology): 34/68 (Q2)

ABSTRACT

Background: Although skin tears are among the most prevalent acute wounds in nursing homes, their recognition as a unique condition remains in its infancy. Elderly patients are at risk of developing skin tears due to increased skin fragility and other contributing risk factors. In order to provide (cost-) effective prevention, patients at risk should be identified in a timely manner.

Objectives: (1) To determine the point prevalence of skin tears and (2) to identify factors independently associated with skin tear presence in nursing home residents.

Methods: A cross-sectional observational study was set up, including 1153 residents in 10 Belgian nursing homes. Data were collected by trained researchers and study nurses using patient records and skin observations. A multiple binary logistic regression model was designed to explore independent associated factors (significance level $\alpha < 0.05$).

Results: The final sample consisted of 795 nursing home residents, of which 24 presented with skin tears, resulting in a point prevalence of 3.0%. Most skin tears were classified as category 3 (defined as complete flap loss) according to the International Skin Tear Advisory Panel (ISTAP) Classification System and 75.0% were located on the lower arms/legs. Five independent associated factors were identified: age, history of skin tears, chronic use of corticosteroids, dependency for transfers, and use of adhesives/dressings.

Conclusion: This study revealed a skin tear prevalence of 3.0% in nursing home residents. Age, history of skin tears, chronic use of corticosteroids, dependency for transfers, and use of adhesives/dressings were independently associated with skin tear presence.

Keywords: Associated factor, Elderly, Prevalence, Prevention, Skin integrity, Skin tear

SUMMARY STATEMENT

- This study was the first prevalence investigation of skin tears in Belgian nursing homes.
- Skin tear prevalence was 3.0%.
- Age, history of skin tears, chronic use of corticosteroids, dependency for transfers, and use of adhesives/dressings were independently associated with skin tear presence.
- Our findings may enable benchmarking, contribute to timely identification of patients at risk, and support the selection of specific preventive interventions.

INTRODUCTION

Maintaining and improving skin health is internationally recognised as one of the salient quality indicators across the entire continuum of healthcare settings. Evidence-informed practices to promote skin integrity and prevent breakdown are strongly recommended to safeguard patient safety, minimise risks, benchmark performance, and deliver care that is more cost-effective compared to wound treatment (Meraviglia et al., 2002; Lichterfeld et al., 2015; LeBlanc et al., 2016a). With an ageing population, age-related skin conditions are increasingly prevalent, demanding a shift in knowledge, attitude, and practice to address skin health. Ageing is associated with anatomical and physiological skin changes as evident by the flattening of the dermo-epidermal junction, loss of cutaneous collagen, and reduction in subcutaneous tissue, rendering the skin more fragile and less elastic (Kottner et al., 2013; Lichterfeld et al., 2014; Lichterfeld et al., 2015). In addition to age-related skin changes, other risk factors such as immobility, sensory impairment, functional and cognitive disorders, multi-morbidities, and incontinence may make older individuals more susceptible to developing a broad range of skin injuries, with skin tears being one of the most prevalent conditions (Lichterfeld et al., 2014; Lichterfeld et al., 2015).

Skin tears are common acute wounds, occurring frequently in the elderly population (Bermark et al., 2018). The International Skin Tear Advisory Panel (ISTAP) defines skin tears as *"traumatic wounds caused by mechanical forces, including removal of adhesives. Severity may vary by depth (not extending through the subcutaneous layer)"* (LeBlanc et al., 2018a). Skin tears can occur on all areas of the body and are particularly common on the extremities (Serra et al., 2018).

Although skin tears are often unnoticed as they are shallow traumatic wounds, some experts feel they are more prevalent than pressure injuries (LeBlanc et al., 2016a; Bermark et al., 2018). Studies in acute care settings have reported skin tear prevalence to be between 3.3% and 17% (McErlean et al., 2004; McLane et al., 2004; Santamaria et al., 2009; Amaral et al., 2012; Chang et al., 2016; Bermark et al., 2018). In long-term care facilities, skin tear prevalence is slightly higher, ranging from 3.9% to 26% (Carville & Smith, 2004; Lopez et al., 2011; LeBlanc et al., 2013b; Koyano et al., 2016; LeBlanc, 2017; Skiveren et al., 2017; Brimelow & Wollin, 2018). Prevalence studies of skin tears are limited, and most of them were conducted in Australia, Canada, Asia, and the United States (LeBlanc & Baranoski, 2017; Bermark et al., 2018).

Previous studies have identified both modifiable and non-modifiable risk factors for skin tear development (LeBlanc & Baranoski, 2017). Non-modifiable risk factors include skin changes associated with advanced age, the presence of oedema and ecchymosis, spasticity, haematoma, impaired mobility, being bedridden, dependence on others for activities of daily living such as

dressing, feeding and transfers, evidence of a previously healed skin tear, increased pressure ulcer risk, history of falls, sensory deficits, cognitive impairment, and aggressive behaviour. Use of adhesives, assistive devices (orthoses/prostheses), feeding tubes and wheelchairs, poor nutritional intake, and polypharmacy have been reported as modifiable risk factors that contribute to the development of skin tears (Rayner et al., 2015; Sanada et al., 2015; Strazzieri-Pulido et al., 2015a; Koyano et al., 2016; Lewin et al., 2016; LeBlanc & Baranoski, 2017; Strazzieri-Pulido et al., 2017; Bermark et al., 2018; Serra et al., 2018).

Skin tears are often underestimated and trivialised, leading to suboptimal prevention and delayed or inappropriate management (LeBlanc & Baranoski, 2011). The consequence of mismanagement can be serious, predisposing individuals to intractable pain, negative mood states (anxiety), delayed wound healing, infection, and diminished quality of life. From a health economic perspective, skin tears may be associated with prolonged hospitalisation, intensive care needs, and high healthcare costs (LeBlanc & Baranoski, 2011; LeBlanc et al., 2013a; LeBlanc et al., 2013b; Sanada et al., 2015; Strazzieri-Pulido et al., 2015a; Chang et al., 2016; LeBlanc et al., 2016a; Bermark et al., 2018; Brimelow & Wollin, 2018; Serra et al., 2018). Clinical experts agree that there are measures to prevent skin tears or minimise their severity (LeBlanc & Baranoski, 2017). However, reliable predictive models based on associated factors to accurately identify people at risk for skin tear development are lacking. By identifying key factors associated with skin tear presence, targeted strategies can be customised to prevent skin tears in the most vulnerable populations. There is some evidence that risk assessment and preventative measures are effective to reduce the occurrence of skin tears (Strazzieri-Pulido et al., 2015a; Koyano et al., 2016; LeBlanc & Baranoski, 2017). Knowledge about prevalence and associated factors will aid in the allocation of resources and support the operationalisation of outcomes that are relevant, meaningful, and achievable to patients, professionals, and payers (LeBlanc & Baranoski, 2017). Studies that focus on skin tears are generally limited (LeBlanc et al., 2013a; LeBlanc et al., 2013b; LeBlanc & Baranoski, 2014; Sanada et al., 2015; Chang et al., 2016; Koyano et al., 2016; LeBlanc & Baranoski, 2017; Bermark et al., 2018), and to date there are no studies that have investigated prevalence and associated factors in Belgium.

The aim of this study was to determine the prevalence of skin tears and to explore factors independently associated with skin tear presence in residents at nursing homes in Belgium.

METHODS

Study design

A cross-sectional observational study was designed.

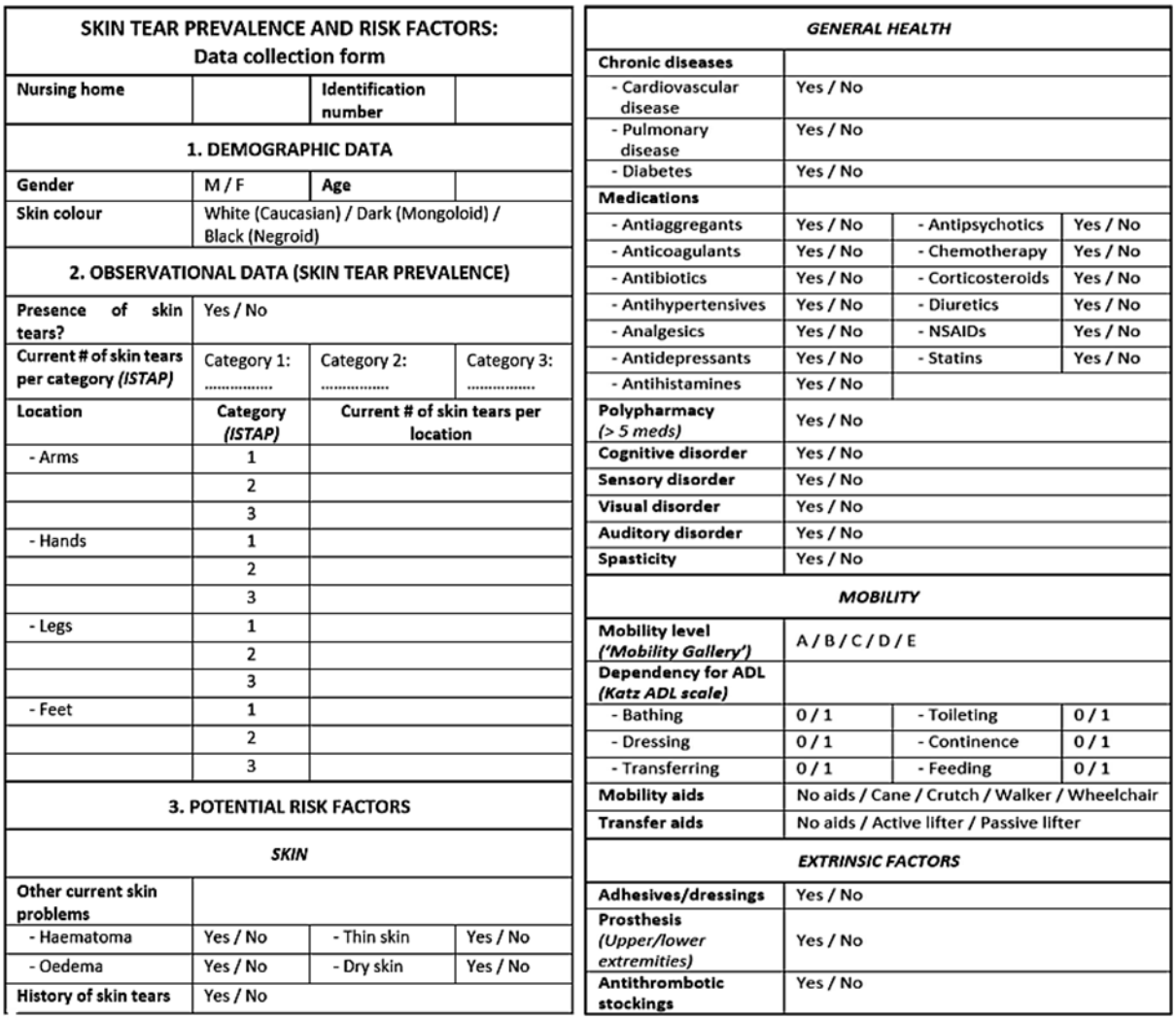
Settings and participants

Nursing homes located in East and West Flanders (Belgium) with at least 90 beds (n = 62) were eligible to take part in the study. A random sample of ten nursing homes that met these inclusion criteria was selected using an online random list generator. The management of the ten selected nursing homes was contacted and given a thorough description of the study by the researchers, after which they all consented to participate. All residents admitted to one of these ten nursing homes (n = 1153) were eligible to take part and they or their representatives were provided with information and asked for participation by the researchers. Seven hundred ninety-five residents consented to participate.

Data collection

Data were collected by two researchers between October 2017 and March 2018. In each participating nursing home, a local certified wound care nurse (study nurse) assisted with data collection in order to enhance the completeness and reliability of the data. The ten study nurses were trained by the researchers in the identification and categorisation of skin tears in order to properly differentiate skin tears from pressure ulcers and incontinence-associated dermatitis (IAD).

A standardised data collection form was developed based on literature review, clinical expertise of the research group, and expert consultations (Figure 1). Face validity was established by a panel of experts in skin integrity research. Data were obtained from patient health records and direct skin examination at the bedside. Each participant's skin status was assessed simultaneously by the researchers and the study nurse. In case of disagreement or when a skin tear was present, high definition photographs were taken and reviewed by an expert in skin integrity research to confirm the diagnosis and classification.



SKIN TEAR PREVALENCE AND RISK FACTORS: Data collection form

Nursing home		**Identification number**	

1. DEMOGRAPHIC DATA

Gender	M / F	**Age**	
Skin colour	White (Caucasian) / Dark (Mongoloid) / Black (Negroid)		

2. OBSERVATIONAL DATA (SKIN TEAR PREVALENCE)

Presence of skin tears?	Yes / No		
Current # of skin tears per category *(ISTAP)*	Category 1:	Category 2:	Category 3: .....

Location	**Category *(ISTAP)***	**Current # of skin tears per location**
- Arms	1	
	2	
	3	
- Hands	1	
	2	
	3	
- Legs	1	
	2	
	3	
- Feet	1	
	2	
	3	

3. POTENTIAL RISK FACTORS

SKIN

Other current skin problems			
- Haematoma	Yes / No	- Thin skin	Yes / No
- Oedema	Yes / No	- Dry skin	Yes / No
History of skin tears	Yes / No		

GENERAL HEALTH

Chronic diseases			
- Cardiovascular disease	Yes / No		
- Pulmonary disease	Yes / No		
- Diabetes	Yes / No		
Medications			
- Antiaggregants	Yes / No	- Antipsychotics	Yes / No
- Anticoagulants	Yes / No	- Chemotherapy	Yes / No
- Antibiotics	Yes / No	- Corticosteroids	Yes / No
- Antihypertensives	Yes / No	- Diuretics	Yes / No
- Analgesics	Yes / No	- NSAIDs	Yes / No
- Antidepressants	Yes / No	- Statins	Yes / No
- Antihistamines	Yes / No		
Polypharmacy *(> 5 meds)*	Yes / No		
Cognitive disorder	Yes / No		
Sensory disorder	Yes / No		
Visual disorder	Yes / No		
Auditory disorder	Yes / No		
Spasticity	Yes / No		

MOBILITY

Mobility level *('Mobility Gallery')*	A / B / C / D / E		
Dependency for ADL *(Katz ADL scale)*			
- Bathing	0 / 1	- Toileting	0 / 1
- Dressing	0 / 1	- Continence	0 / 1
- Transferring	0 / 1	- Feeding	0 / 1
Mobility aids	No aids / Cane / Crutch / Walker / Wheelchair		
Transfer aids	No aids / Active lifter / Passive lifter		

EXTRINSIC FACTORS

Adhesives/dressings	Yes / No
Prosthesis *(Upper/lower extremities)*	Yes / No
Antithrombotic stockings	Yes / No

Figure 1. Data collection form

Measurement instruments

Skin tears were assessed and classified using the validated ISTAP Classification System (Figure 2) (LeBlanc et al., 2013c). Using this system, skin tears were classified as type 1 (no skin/flap loss), type 2 (partial skin/flap loss), or type 3 (complete flap loss). The 'Mobility Gallery' assessment tool was used to determine the mobility level of the participants (Knibbe & Waaijer, 2005). This validated classification system is based on five different levels of functional mobility, ranging from A (active/completely mobile) to E (passive/entirely bedridden). Dependency for ADL was assessed using the validated Katz ADL scale, which scores six activities (bathing, dressing, transferring, toileting, continence, and feeding) from 0 (dependent/assistance required) to 1 (independent/no assistance required) (Katz et al., 1970).

Figure 2. ISTAP Skin Tear Classification System (LeBlanc et al., 2013c)

Data analysis

Data were analysed using IBM® SPSS® Statistics (Version 24, IBM Corporation, New York, NY). Categorical variables were described using frequencies (percentages). The only continuous variable, age, was found to be normally distributed using a Q-Q plot, box-and-whisker plot, and Shapiro-Wilk test, and thus described using mean and standard deviation (SD). Skin tear prevalence was calculated by dividing the number of participants with one or more skin tears present at the time of observation by the total number of residents participating in the study.

In order to identify factors independently associated with skin tear presence, a multiple binary logistic regression model was designed (Bursac et al., 2008). In a first step, all variables were analysed for significant association with skin tear presence in single binary logistic regression analyses. Variables with $p < 0.05$ in the single analyses were considered statistically significant and pairwisely tested for collinearity using chi-square (χ^2) test or independent sample *t*-test. In case of collinearity between two variables ($p < 0.05$), the variable most strongly associated with skin tear presence was included. In a second step, all variables that were statistically significant in the single analyses and not mutually correlated were combined into a multiple binary logistic regression model. Using the Backward Wald method, the least significant variables were removed one by one from the model until all variables remaining had a value of $p < 0.05$ in the analysis of effect. Nagelkerke R^2 and Hosmer-Lemeshow statistic were calculated as measures of model fit (Chan, 2004). The tolerance and variance inflation factor were calculated to identify multicollinearity between the variables in the model. The significance level was set at $\alpha < 0.05$.

Ethical approval and trial registration

This study was performed in accordance with the ethical guidelines of the Declaration of Helsinki and approved by the Ethics Committee of Ghent University Hospital (B670201733162). Confidentiality and anonymity of the participants were guaranteed. All participants or their representatives provided oral and written informed consent.

RESULTS

Characteristics of the participants

The study sample consisted of 795 participants (68.9% female, mean (SD) age: 85 (8.6) years), representing a 69% response rate. Thirty-one percent of residents were not available for data collection due to hospitalisation or refusal to participate. Table 1 provides an overview of the sample characteristics.

Table 1. Characteristics of the participants (n = 795)

Characteristics	N	n (%) / Mean (SD)
Gender	795	
Male		247 (31.1)
Female		548 (68.9)
Age (years) [Mean (SD)]	795	85.0 (8.6)
Skin colour	795	
White (Caucasian)		790 (99.4)
Dark (Mongoloid)		5 (0.6)
Black (Negroid)		0 (0.0)
Chronic diseases	795	
Cardiovascular disease		485 (61.0)
Pulmonary disease		119 (15.0)
Diabetes		153 (19.3)
Mobility level	795	
(Knibbe & Waaijer, 2005)		
Level A		196 (24.7)
Level B		316 (39.7)
Level C		194 (24.4)
Level D		63 (7.9)
Level E		26 (3.3)
History of skin tears	770	218 (28.3)

SD: standard deviation

Skin tear prevalence

Skin tears were detected in 24 out of the 795 participants, resulting in a point prevalence of 3.0% (Table 2). A total of 28 skin tears were observed in these 24 participants. The majority of skin tears were classified as type 3 (n = 12, 42.9%). Skin tears were predominately located on the lower arms (n = 9, 32.1%) and lower legs (n = 12, 42.9%).

Table 2. Skin tear prevalence

	N	n (%)
Participants with one or more skin tears	795	24 (3.0)
Total skin tears observed		28
Skin tear type (ISTAP)		
Type 1		9 (32.1)
Type 2		7 (25.0)
Type 3		12 (42.9)
Location (upper/lower extremities)		
Arm		15 (53.6)
Upper arm		6 (21.4)
Lower arm		9 (32.1)
Hand		1 (3.6)
Leg		12 (42.9)
Upper leg		0 (0.0)
Lower leg		12 (42.9)
Foot		0 (0.0)

Factors associated with skin tear presence

Single binary logistic regression revealed 17 variables significantly associated with skin tear presence ($p < 0.05$) (Table 3). Prior to composing a multiple binary logistic regression model, the 17 univariate significant variables were tested for collinearity. Two variables for the assessment of ADL dependency, including 'dependency for transfers' and 'dependency for feeding', were correlated ($\chi^2 = 112.835$, DF = 2, $p < 0.001$). 'Dependency for transfers' was selected to be entered into the model because this variable was most strongly associated with skin tear presence (OR = 5.58; 95% CI = 1.65 – 18.87; p = 0.006).

After step-by-step elimination of the least significant variable according to the Backward Wald method, a final model consisting of five independent associated factors for skin tear presence was

reached (Table 4). Age (OR = 4.03; 95% CI = 1.29 – 12.61; p = 0.017), history of skin tears (OR = 3.83; 95% CI = 1.30 – 11.32; p = 0.015), chronic use of corticosteroids (OR = 2.96; 95% CI = 1.06 – 8.53; p = 0.044), dependency for transfers (OR = 3.74; 95% CI = 1.09 – 13.31; p = 0.042), and use of adhesives/dressings (OR = 7.05; 95% CI = 2.74 – 18.14; p < 0.001) were significantly associated with skin tear presence in nursing home residents. The Nagelkerke R^2 showed that 33.0% of variance in the presence of skin tears is explained by our multiple binary logistic regression model. The Hosmer-Lemeshow goodness of fit test indicated no significant difference between the observed and the expected values ($\chi^2 = 3.65$, DF = 6, p = 0.724). The tolerance values were above 0.4, indicating acceptable correlations between the independent variables in the final model (Chan, 2004).

Table 3. Univariate binary logistic regression for association between possible associated factors and skin tears

	Participants with STs (n = 24) n (%) / Mean (SD)	**Participants without STs (n = 771)** n (%) / Mean (SD)	**P value**	**OR (95% CI)**
Age (years) [Mean (SD)]	91.00 (7.5)	84.85 (8.6)	0.003	5.07 (1.72 - 14.96)
History of skin tears	19 (79.2)	199 (26.7)	< 0.001	10.45 (3.85 - 28.35)
Haematoma	14 (58.3)	157 (20.4)	< 0.001	5.46 (2.38 - 12.52)
Oedema	12 (50.0)	185 (24.0)	0.006	3.17 (1.34 - 7.17)
Thin skin	20 (83.3)	332 (43.2)	0.001	6.58 (2.23 - 19.44)
Dry skin	22 (91.7)	387 (50.3)	0.001	10.86 (2.54 - 46.49)
Pulmonary disease	8 (33.3)	111 (14.4)	0.014	2.97 (1.24 - 7.11)
Antibiotics	4 (16.7)	41 (5.3)	0.026	3.56 (1.16 - 10.90)
Antidepressants	4 (16.7)	287 (37.2)	0.049	0.34 (0.11 - 0.99)
Corticosteroids	7 (29.2)	67 (8.7)	0.002	4.33 (1.73 - 10.80)
Mobility level D	5 (20.8)	58 (7.5)	0.022	3.30 (1.19 - 9.15)
Mobility level E	3 (12.5)	23 (3.0)	0.022	4.45 (1.24 - 15.93)
Dependency for transfers	21 (87.5)	429 (55.6)	0.006	5.58 (1.65 - 18.87)
Dependency for feeding	13 (54.2)	255 (33.1)	0.036	2.39 (1.06 - 5.41)
Wheelchair	18 (75.0)	369 (47.9)	0.013	3.27 (1.28 - 8.32)
Passive lifter for transfers	6 (25.0)	78 (10.1)	0.026	2.96 (1.14 - 7.68)
Adhesives/dressings	16 (66.7)	102 (13.2)	< 0.001	13.12 (5.47 - 31.43)

STs: skin tears, SD: standard deviation, OR: odds ratio, 95% CI: 95% confidence interval

Table 4. Multivariate binary logistic regression for association between possible associated factors and skin tears

	P value	OR (95% CI)	Tolerance	Variance inflation factor
Age	0.017	4.03 (1.29 - 12.61)	0.988	1.012
History of skin tears	0.015	3.83 (1.30 - 11.32)	0.993	1.007
Corticosteroids	0.044	2.96 (1.06 - 8.53)	0.990	1.010
Dependency for transfers	0.042	3.74 (1.09 - 13.31)	0.980	1.020
Adhesives/dressings	< 0.001	7.05 (2.74 - 18.14)	0.982	1.018

OR: odds ratio, 95% CI: 95% confidence interval

Nagelkerke $R^2 = 0.330$; Hosmer-Lemeshow: $\chi^2 = 3.65$, degrees of freedom (DF) = 6, $p = 0.724$

DISCUSSION

This study aimed to determine the prevalence of skin tears and to identify factors independently associated with skin tear presence in residents at nursing homes in Belgium. This study is the first prevalence investigation of skin tears in Belgian nursing homes and revealed a prevalence rate of 3.0%. It is noteworthy that more than a quarter of all participants (28.3%) had a history of skin tears. Previous studies in long-term care facilities in other countries reported skin tear prevalence rates between 3.9% and 26% (Carville & Smith, 2004; Lopez et al., 2011; LeBlanc et al., 2013b; Koyano et al., 2016; LeBlanc, 2017; Skiveren et al., 2017; Brimelow & Wollin, 2018). To date, only one other skin tear prevalence study was performed in European nursing homes. In their study, Skiveren et al. (2017) reported a prevalence rate of 4.6% in a Danish nursing home. The wide variety in prevalence rates may be attributed to differences in prevention and management practices, diagnostic criteria, nursing staff, knowledge, and equipment between countries, but further research on this topic is required. Although skin tears can occur on any area of the body, most skin tear prevalence studies (including the current study) only examine the extremities. Inability to conduct a thorough examination of the full body may lead to omission and underreporting of skin tears. Previous studies are fraught with methodological issues including relatively small, single-site samples, and thus caution is recommended when interpreting the relevance and generalisability of their findings. Similar to findings from previous studies, our research findings showed that the majority of skin tears (57.2%) occurred on the upper extremities (McErlean et al., 2004; LeBlanc et al., 2013b; Chang et al., 2016; Koyano et al., 2016; LeBlanc, 2017; Skiveren et al., 2017; LeBlanc et al., 2018a). Most skin tears (42.9%) were classified as type 3 according to the ISTAP Classification System. In previous studies, skin tears were mainly categorised using the Skin Tear Audit Research (STAR) Classification System and the Payne-Martin Classification System (McErlean et al., 2004; Amaral et al., 2012; LeBlanc et al., 2013b; Chang et al., 2016;

Koyano et al., 2016). Only two recent studies, performed in nursing homes, also used the ISTAP Classification System (LeBlanc, 2017; Skiveren et al., 2017). In these two studies, type 1 skin tears were most common (38.0% and 40.0%).

In our multivariate analyses, we found that age, history of skin tears, chronic use of corticosteroids, dependency for transfers, and use of adhesives/dressings appeared to be independently associated with skin tear presence in nursing home residents. The associated factors identified were theoretically supported and in accordance with findings from other studies. In nursing home residents aged ≥ 87 years, the odds of presenting with skin tears was 4.03 times as high as in residents aged < 87 years. In their study, Lewin et al. (2016) also reported advanced age as being a major predictor for skin tear development (OR = 1.06; $p < 0.001$). Due to physiological changes associated with ageing, the elderly population is particularly vulnerable for developing skin tears. Experts agree that this increased skin vulnerability can be explained by two reasons: the weakening of the skin and susceptibility to trauma (Strazzieri-Pulido et al., 2015a). The natural ageing process of the skin includes thinning of the epidermis and a loss of dermal and subcutaneous tissue due to decreased production of collagen, resulting in a reduced cohesion between the skin layers. Because of this, the epidermis can be more easily separated from the underlying dermis. In addition, the skin becomes more dehydrated, dry, and inelastic, increasing the risk of developing skin tears even more (Peters & Campbell, 2014; Strazzieri-Pulido et al., 2015a; Baranoski et al., 2016; Busse, 2016; Chang et al., 2016).

Almost 80% of the residents observed with skin tears, had a history of skin tears. In residents with a history of skin tears, the odds of presenting with skin tears was almost four times as high as in residents without a history of skin tears. Similarly, in the studies of Sanada et al. (2015), Lewin et al. (2016), and Bermark et al. (2018), having a history of skin tears was identified as a factor independently associated with skin tear development. Experts suggest that skin tears frequently occur in individuals who have a history of skin tears as a result of the reduced tensile strength of scar tissue (Chang et al., 2016; LeBlanc, 2017). A more likely explanation may be that having a history of skin tears simply indicates that an individual's skin is particularly susceptible to tearing and/or that one's skin is subject to more frequent trauma due to their own or others' behaviour (Lewin et al., 2016).

The third associated factor identified, chronic use of corticosteroids, was also determined as an important risk factor in the studies of Sanada et al. (2015) and Koyano et al. (2017). Prolonged use of corticosteroids can be considered as a risk factor for skin tear development due to potential side effects of the altered collagen synthesis (Koyano et al., 2016). Corticosteroids are known to regulate the expression of genes encoding collagens, elastin, matrix metalloproteinases (MMPs),

and tissue inhibitors of MMPs, and it is supposed that corticosteroids greatly increase skin atrophy associated with skin changes in the ageing population (LeBlanc, 2017).

Dependency for transfers was the fourth associated factor identified. This finding is similar to the findings of LeBlanc & Baranoski (2011) and Lewin et al. (2016), who reported that there is a significant increased risk for developing skin tears when assistance is required for transferring. In their study, Carville et al. (2014) showed that more than 11% of all skin tears occur during transfer activities. During transferring, skin tears may be caused by medical devices, such as beds, bed rails, lifters, and wheelchairs, as well as by assistance from others (LeBlanc et al., 2008; LeBlanc & Baranoski, 2011; LeBlanc et al., 2013a).

Use of adhesives/dressings was the factor most strongly associated with skin tear presence. In residents with adhesives/dressings on the extremities, the odds of presenting with skin tears was 7.05 times as high as in residents without adhesives/dressings. In a survey conducted by LeBlanc & Baranoski (2011), adhesive/dressing removal belonged to the top three causes of skin tears. Adhesive/dressing removal may cause skin tears due to external forces this intervention applies to the skin surface (LeBlanc et al., 2008; Koyano et al., 2016). Although we identified five independent associated factors, some skin tear associated factors identified in other studies, such as haematoma, ecchymosis, purpura, and oedema, were not confirmed (Lewin et al., 2016; LeBlanc & Baranoski, 2017; Skiveren et al., 2017; LeBlanc et al., 2018a). In our study, no distinction was made between haematoma, ecchymosis, and purpura because these variables are difficult to distinguish from each other. The presence of haematoma and oedema were univariate significant associated factors, but were not statistically significant in the multivariate analyses.

The results showed that a significant proportion of the associated factors identified are modifiable factors. In order to reduce the occurrence of skin tears, there should be preventively focused on these associated factors so that skin integrity is maintained and injuries are avoided. In addition, skin tear prevalence and incidence rates should be used as an indicator and a benchmark for quality of care (LeBlanc & Baranoski, 2017). Primary prevention is considered as the best strategy for managing these largely avoidable wounds and can include, for example, the use of skin-friendly adhesives/ dressings and removal techniques, long sleeves/ pants/ gloves as a protective barrier, padding on bed rails/ wheelchair arm and leg supports/ other equipment, and educating healthcare professionals/ patients/ family concerning appropriate positioning/ transferring techniques and skin-friendly equipment, preferably by occupational and physical therapists (Sussman & Golding, 2011; LeBlanc & Baranoski, 2017). Furthermore, (future) healthcare professionals should be educated in recognising and reporting skin tears as these wounds are often unnoticed and unreported, and in identifying patients at risk (White, 2001). Our findings may support a more accurate skin tear risk

assessment which promotes early identification of high risk patients. Clear prevention programs, including the identification of patients at risk, will reduce the incidence of skin tears (Sussman & Golding, 2011). Further research on the effectiveness of preventive interventions in patients at risk for skin tears is needed. In a recent study, Woo & LeBlanc (2018) concluded that skin tears and pressure ulcers share common risk factors, and that therefore a bundled approach to wound prevention should be developed. In addition, studies that explore skin tear risk factors, prevalence and incidence across various populations and healthcare settings, preferably by using a validated data collection instrument, are strongly required (LeBlanc et al., 2013b; LeBlanc, 2017; LeBlanc & Baranoski, 2017).

Strengths and limitations

Our study was a large multisite study, including 1153 residents from ten randomly selected Belgian nursing homes. The response rate was high (69%) and the study sample was representative of the entire population residing in Belgian nursing homes in terms of age, gender, and mobility level (Socialistische Mutualiteiten, 2017). This all increases the generalisability of our findings. Furthermore, data collection was performed on site jointly by the two researchers, experienced in the assessment and classification of skin tears, and a trained study nurse. In case of disagreement or when a skin tear was present, high definition photographs were taken and reviewed by an expert in skin integrity research. This all optimised the validity and reliability of our results.

The main limitation of this study was the low event rate, leading to wide confidence intervals of the factors associated with skin tear presence in the multivariate analyses. Although skin tears can occur on any area of the body, we only examined the extremities which may lead to underreporting. Due to the cross-sectional character of our study, we were not able to study causal associations between potential associated factors and skin tear presence as would be possible in a longitudinal design. Besides, data collection was mainly focused on identifying health-related associated factors. However, the occurrence of skin tears may also depend upon nurse-related factors (e.g. knowledge and attitude) and external/ environmental factors (e.g. the absence of padding on bed rails, wheelchair arm and leg supports, and other equipment) (LeBlanc et al., 2013a).

CONCLUSION

This study revealed a skin tear prevalence of 3.0% in Belgian nursing home residents. Age, history of skin tears, chronic use of corticosteroids, dependency for transfers, and use of adhesives/ dressings were independently associated with skin tear presence. These associated factors are theoretically supported and provide useful guidance to identify patients at risk in need for specific skin tear prevention strategies. Further research across the continuum of healthcare settings is needed to determine the true extent of skin tears and factors that contribute to their development.

Conflicts of interest

None to declare.

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Chapter 3

Standardising the classification of skin tears: validity and reliability testing of the International Skin Tear Advisory Panel (ISTAP) Classification System in 44 countries

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Chapter based on:

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ABSTRACT

Background: Skin tears are acute wounds that are frequently misdiagnosed and underreported. A standardised and globally adopted skin tear classification system with supporting evidence for diagnostic validity and reliability is required to allow assessment and reporting in a consistent way.

Objectives: To measure the validity and reliability of the International Skin Tear Advisory Panel (ISTAP) Classification System internationally.

Methods: A multicountry study was set up to validate the content of the ISTAP Classification System through expert consultation in a two-round Delphi procedure involving 17 experts from 11 countries. An online survey including 24 skin tear photographs was conducted in a convenience sample of 1601 healthcare professionals from 44 countries to measure diagnostic accuracy, agreement, interrater reliability, and intrarater reliability of the instrument.

Results: A definition for the concept of a 'skin flap' in the area of skin tears was developed and added to the initial ISTAP Classification System consisting of three skin tear types. The overall agreement with the reference standard was 0.79 (95% CI 0.79 – 0.80) and sensitivity ranged from 0.74 (95% CI 0.73 – 0.75) to 0.88 (95% CI 0.87 – 0.88). The interrater reliability was 0.57 (95% CI 0.57 – 0.57). The Cohen's Kappa measuring intrarater reliability was 0.74 (95% CI 0.73 – 0.75).

Conclusion: The ISTAP Classification System is supported by evidence for validity and reliability. The ISTAP Classification System should be used for systematic assessment and reporting of skin tears in clinical practice and research globally.

Keywords: Classification, ISTAP, Reliability, Skin tear, Validity

SUMMARY STATEMENT

What's already known about this topic?

- Skin tears are common acute wounds that are misdiagnosed and underreported too often.
- A skin tear classification system is needed to standardise documentation and description for clinical practice, audit, and research.

What does this study add?

- The ISTAP Classification System was psychometrically tested in 1601 healthcare professionals from 44 countries.
- Diagnostic accuracy was high when differentiating between type 1, 2 and 3 skin tears using a set of validated photographs.

INTRODUCTION

Skin tears are common acute wounds with high potential risk of evolving into complex chronic wounds if not properly managed (LeBlanc et al., 2013b; LeBlanc & Baranoski, 2014; Skiveren et al., 2015; Bermark et al., 2018). The International Skin Tear Advisory Panel (ISTAP) defines skin tears as *"traumatic wounds caused by mechanical forces, including removal of adhesives. Severity may vary by depth (not extending through the subcutaneous layer)"* (LeBlanc et al., 2018a). They are reported across all healthcare settings and are predominantly found in the elderly, neonates, and the critically and chronically ill populations (LeBlanc & Baranoski, 2011; LeBlanc & Baranoski, 2017). Although skin tears can occur on any location of the body, they are particularly common on the upper and lower extremities (Strazzieri-Pulido et al., 2017; LeBlanc et al., 2018a; Serra et al., 2018).

The prevalence of skin tears varies across countries, healthcare settings, and patient populations (Chaplain et al., 2018; LeBlanc et al., 2018a). Studies report skin tear prevalence between 3.3% and 19.8% in acute care (McErlean et al., 2004; McLane et al., 2004; Santamaria et al., 2009; Hsu & Chang, 2010; Lopez et al., 2011; Amaral et al., 2012; Chang et al., 2016; Bermark et al., 2018), 14.3% in palliative care (Maida et al., 2012), 5.5% – 19.5% in the community (Carville & Lewin, 1998; Carville & Smith, 2004), and 3.0% – 26.0% in long-term care (LeBlanc et al., 2013b; Strazzieri-Pulido et al., 2015a; Koyano et al., 2016; LeBlanc, 2017; Skiveren et al., 2017; Woo et al., 2017; LeBlanc et al., 2018a; LeBlanc & Baranoski, 2018; Woo & LeBlanc, 2018; Van Tiggelen et al., 2019a). Skin tear incidence rates vary between 2.2% and 92.0%, with highest incidence in long-term care facilities (Payne & Martin, 1990; White et al., 1994; Bank & Nix, 2006; Bajwa et al., 2010; Carville et al., 2014; Sanada et al., 2015; LeBlanc, 2017; Strazzieri-Pulido et al., 2017). The variety in prevalence and incidence rates may in part be attributed to varying patient populations, differences in prevention and management practices, nurses' knowledge and equipment, but can also be explained by the lack of a uniform method for assessment and documentation (LeBlanc et al., 2014; LeBlanc et al., 2018a). A cross-sectional international study including 1127 healthcare professionals from 16 countries revealed significant problems with the assessment, classification and documentation of skin tears (LeBlanc et al., 2014). The majority of respondents (70%) reported issues with the assessment and documentation of skin tears in their settings, with an overwhelming majority (90%) preferring a simplified method. Eighty-one per cent of respondents reported not using any tool or classification system for the classification of skin tears, and 40% admitted to ignoring and not documenting any information about these wounds (LeBlanc et al., 2014). In addition, skin tears are often not recognised as unique wounds distinct from other wound types, making them frequently misdiagnosed and underreported (LeBlanc et al., 2018a).

The lack of diagnostic accuracy results in delayed or inappropriate management, causing increased pain and suffering, delayed wound healing, infection, prolonged hospitalisation and high healthcare costs, all negatively affecting the quality of care (LeBlanc & Baranoski, 2011; Strazzieri-Pulido et al., 2015a). In order to set appropriate treatment goals and optimise management from the earliest possible stage of care, the systematic assessment of skin tears using a valid and reliable international classification tool is recommended (LeBlanc et al., 2018a).

To date, three skin tear classification tools have been developed (Payne & Martin,1993; Carville et al., 2007; LeBlanc et al., 2013a). The Payne-Martin Classification System grades skin tears based on the extent of tissue loss, measured as a percentage (Payne & Martin,1993). In 2007, Carville et al. established and psychometrically tested the Skin Tear Audit Research (STAR) Classification System, which was developed as a modified version of the Payne-Martin scale, additionally including skin/flap colour distinction (Carville et al., 2007). However, both systems were found to be complex for use in clinical practice and neither of them gained widespread acceptance (LeBlanc & Baranoski, 2011; LeBlanc et al., 2013c). In addition, the Payne-Martin Classification System has never been evaluated on its psychometric properties (LeBlanc et al., 2018a). In an effort to fulfil the need for a user-friendly and simple classification tool (LeBlanc et al., 2014), an ISTAP consensus panel developed and psychometrically tested the ISTAP Classification System, which categorises skin tears as type 1 (no skin/flap loss), type 2 (partial skin/flap loss), or type 3 (total skin/flap loss) (LeBlanc et al., 2013a; LeBlanc et al., 2013c). The ISTAP tool classifies skin tears based on the severity of 'skin flap' loss, but does not provide a definition of a 'skin flap'. In their best-practice document, developed in 2018, the ISTAP panel indicated a need for standardised terminology in order to avoid confusion (LeBlanc et al., 2018a). Since 2013, the ISTAP Classification System has been translated and its psychometric properties have been measured in Denmark, Sweden, French Canada, and Brazil (Skiveren et al., 2015; Chaplain et al., 2018; da Silva et al., 2018; Källman et al., 2019). It is acknowledged that further psychometric testing with larger samples of healthcare professionals across settings and countries is required (LeBlanc et al., 2013c; LeBlanc et al., 2018a).

The aim of this study was to evaluate the validity and reliability of the ISTAP Classification System internationally.

METHODS

The study consisted of two phases. Phase 1 was a study to validate the content of the ISTAP Classification System through expert consultation in a two-round Delphi procedure. Phase 2 included the measurement of the psychometric properties of the instrument. Diagnostic accuracy, agreement, interrater reliability, and intrarater reliability were measured.

Phase 1: Design and content validation of a definition for the concept of a 'skin flap' in skin tears

Following the development of the ISTAP best-practice document (LeBlanc et al., 2018a), a definition of a 'skin flap' was proposed to be added to the current ISTAP classification tool. A first proposal of a definition was developed by the core team of this study based on a literature review. A two-round Delphi procedure (March – May 2018) was conducted to collect feedback and to achieve consensus on the proposed definition. The expert panel consisted of 17 international key opinion leaders based in Australia (n = 1), Belgium (n = 1), Canada (n = 3), Chile (n = 1), Italy (n = 1), Japan (n = 1), South Africa (n = 1), Switzerland (n = 1), the United Arab Emirates (n = 1), the U.K. (n = 2), and the U.S.A. (n = 4). All were executive board members of ISTAP. In the first Delphi round, the experts were invited to provide comments on the proposed definition. The feedback was summarised and a new proposal was developed. In the second round, the experts were asked for approval and/or additional comments on the revised definition. Consensus was achieved after the second Delphi round.

Phase 2: Psychometric evaluation of the ISTAP Classification System

The aim of this phase was to examine diagnostic accuracy, interrater reliability, intrarater reliability and agreement of the ISTAP Classification System. An online survey including 24 photographs of skin tears was developed using the software package LimeSurvey (version 2.05+). A second survey was sent to the participants 1 week after completion of the first survey. This survey (retest) included the identical 24 photographs in a different random order to reduce potential bias. No feedback was provided between the test and retest. Both English-language surveys were translated into 15 languages by native speakers with extensive content expertise to allow data collection in 44 countries. Survey participants were invited to categorise the photographs using the ISTAP Classification System. They did not receive an education session prior to the survey or between the test and retest. Diagnostic accuracy was evaluated by comparing the classifications of the participants with those of three experts in skin integrity research as reference standard (K.L.B., K.V.d.B., D.B.). Interrater reliability and agreement were measured within the ratings of the

participants. Intrarater reliability and agreement with a 1-week interval between ratings were calculated for all participants who completed both the first and the second survey.

Participants

Data were collected between September and November 2018 in a convenience sample of healthcare professionals in 44 countries. The sample included healthcare professionals within the network of the study team and a selection of major wound care organisations, such as the World Council of Enterostomal Therapists (WCET), Nurses Specialized in Wound, Ostomy and Continence Canada (NSWOCC), Wounds Canada, Wounds Australia, Tissue Viability Society (TVS), Wound, Ostomy and Continence Nurses Society (WOCN), Wound Healing Association of Southern Africa (WHASA), Saudi Chapter of Enterostomal Therapy (SCET), V&VN Wound Expertise, and the Swedish Wound Care Nurses Association (SSiS).

Photographs

Twenty-four skin tear photographs (obtained with informed consent from patients to be applied for research purposes) were selected and categorised by three experts in skin integrity research (Table 1). The set equally represented the three types of skin tears and included three photographs from patients with a darkly pigmented skin. There was 100% consensus between the raters in categorising the photographs (reference standard). Sample size calculation was performed by the statistical software package R using the function CI3Cats in the kappaSize package (version 1.2) (Rotondi & Donner, 2012; R Core Team, 2018; Rotondi, 2018). The confidence interval (CI) approach was used to determine the number of photographs needed to examine interrater reliability with three outcome categories. A minimum of 23 photographs was required, based on an anticipated κ-value of 0.65 (based on previous research (LeBlanc et al., 2013c)), an expected lower bound for a one-sided 95% CI of 0.51, and the proportions per skin tear type (type 1 = 0.33, type 2 = 0.33, type 3 = 0.34).

Table 1. Classification of the photographs by three experts

	Type	**Number of photographs** [a]		
		Non-pigmented skin (n = 21)	Pigmented skin (n = 3)	Total (n = 24)
1	No skin/flap loss	8	0	8
2	Partial skin/flap loss	5	3	8
3	Total skin/flap loss	8	0	8

[a]: the set of 24 photographs used in both survey 1 (test) and survey 2 (retest) was identical

Ethical considerations

This study was approved by the Ethics Committee of Ghent University Hospital (B670201836271). All participants received written information about the purpose and procedure before the start of the study. The confidentiality and anonymity of the participants were guaranteed. Return of a completed survey was considered as consent to participate.

Data analysis

Diagnostic accuracy, agreement, interrater reliability, and intrarater reliability were analysed. Summary measures of overall and specific agreement were calculated based on the comparison between the participants' ratings and the reference standard. The summary measures were the estimated mean with 95% CI, the estimated median value with the interquartile range (IQR), and the 2.5^{th} and 97.5^{th} percentile. In order to calculate diagnostic accuracy, three binary measures were considered: type 1 vs. type 2 and 3, type 2 vs. type 1 and 3, and type 3 vs. type 1 and 2 skin tears. Diagnostic accuracy was assessed by summary measures for sensitivity and specificity of each rater to the reference standard.

Interrater reliability among raters was assessed using the multirater Fleiss Kappa. Reference standard scores were not included in the analysis. Intrarater reliability and agreement were examined by comparing the first and second ratings of the same photographs for participants who completed both the first and the second survey. Summary measures of Cohen's Kappa, overall and specific agreement were calculated for each individual rater. Kappa coefficients criteria by Landis and Koch were applied (< 0.00 = poor; 0.00–0.20 = slight; 0.21–0.40 = fair; 0.41–0.60 = moderate; 0.61–0.80 = substantial; 0.81–1.00 = almost perfect) (Landis & Koch, 1977). All statistical analyses were performed in R (version 3.5.1) (R Core Team, 2018). The concordance function in the R-library 'raters' (version 2.0.1) was used to obtain Fleiss Kappa and 95% CIs, and the kappa2 function in the R-library 'irr' (version 0.84.1) to calculate Cohen's Kappa.

RESULTS

Phase 1: Design and content validation of a definition for the concept of a 'skin flap' in skin tears

The Delphi process resulted in the following definition of a 'skin flap' associated with the condition of a skin tear: *"A flap in skin tears is defined as a portion of the skin (epidermis/ dermis) that is unintentionally separated (partially or fully) from its original place due to shear, friction, and/or blunt force. This concept is not to be confused with tissue that is intentionally detached from its place of origin for therapeutic use, e.g. surgical skin grafting"*. The three categories of the initial ISTAP tool have remained unchanged. The ISTAP Classification System including the newly developed 'skin flap' definition is shown in Figure 1.

Figure 1. The revised ISTAP Skin Tear Classification System

Phase 2: Psychometric evaluation of the ISTAP Classification System

Participant characteristics

A total of 1601 participants (89.4% female, mean (SD) age: 41.2 (12.2) years) completed the first survey (test), of whom 952 (59.5%) completed the second survey (retest). No statistically significant differences were found in the demographic characteristics of the responders and non-responders

of the retest. Table 2 provides an overview of the sample demographics. Additional participant demographics are given in Appendix 1.

Table 2. Participant demographics

	Test (n = 1601) n (%) / Mean (SD)	**Retest (n = 952)** n (%) / Mean (SD)	**P value** [a]
Sex			0.901
Female	1432 (89.4)	853 (89.6)	
Age (years) [Mean (SD)]	41.2 (12.2)	42.1 (11.7)	0.131
Role			0.329
Student nurse	39 (2.4)	13 (1.4)	
Nurse assistant	26 (1.6)	12 (1.3)	
Nurse	745 (46.5)	416 (43.7)	
Head nurse	61 (3.8)	44 (4.6)	
Nurse specialist	644 (40.2)	404 (42.4)	
Educator	45 (2.8)	34 (3.6)	
Researcher	21 (1.3)	15 (1.6)	
Other	16 (1.0)	10 (1.1)	
Missing	4 (0.2)	4 (0.4)	
Education			0.289
Undergraduate	417 (26.0)	241 (25.3)	
Bachelor degree	633 (39.5)	352 (37.0)	
Master degree	475 (29.7)	310 (32.6)	
Doctoral degree	73 (4.6)	49 (5.1)	
Other / unknown	3 (0.2)	0 (0.0)	
Expertise in skin tears [b]			0.272
Novice	219 (13.7)	112 (11.8)	
Advanced beginner	261 (16.3)	138 (14.5)	
Competent	389 (24.3)	229 (24.1)	
Proficient	400 (25.0)	252 (26.5)	
Expert	332 (20.7)	221 (23.2)	
Wound care module [c]			0.230
Completed	869 (54.3)	540 (56.7)	
Experience with ISTAP tool [d]			0.096
No previous experience	1143 (71.4)	650 (68.3)	
Language [e]			0.065
Arabic	8 (0.5)	3 (0.3)	
Chinese	146 (9.1)	72 (7.6)	
Czech	112 (7.0)	61 (6.4)	

Danish	18 (1.1)	12 (1.3)
Dutch	295 (18.4)	216 (22.7)
English	381 (23.8)	195 (20.5)
French	70 (4.4)	55 (5.8)
German	109 (6.8)	62 (6.5)
Hebrew	62 (3.9)	35 (3.7)
Italian	31 (2.0)	15 (1.6)
Japanese	54 (3.4)	46 (4.8)
Portuguese	47 (2.9)	37 (3.9)
Spanish	70 (4.4)	45 (4.7)
Swedish	56 (3.5)	35 (3.7)
Turkish	141 (8.8)	63 (6.6)

[a]: chi-square (χ^2) test ($p < 0.05$ considered statistically significant), [b]: expertise in relation to the assessment and management of skin tears (based on the levels of proficiency defined by Benner (1982)), [c]: completion of a recognised wound care module, [d]: previous experience with using the ISTAP Classification System, [e]: languages in which the ISTAP Classification System and the online survey were translated

Diagnostic accuracy and agreement

The diagnostic accuracy and agreement between the ratings of the participants and the reference standard are presented in Table 3. The average overall agreement was 0.79 (95% CI 0.79 – 0.80). The mean specific agreement ranged from 0.75 (95% CI 0.74 – 0.75) for type 2 to 0.76 (95% CI 0.76 – 0.77) for type 3 to 0.86 (95% CI 0.85 – 0.86) for type 1 skin tears. A higher overall agreement was found in participants who considered themselves as proficient or expert (0.82, 95% CI 0.81 – 0.83), participants with a master's degree (0.81, 95% CI 0.79 – 0.82), and participants who were familiar with the use of the ISTAP Classification System (0.82, 95% CI 0.81 – 0.83). A mean sensitivity of 88% (95% CI 0.87 – 0.88) and a mean specificity of 92% (95% CI 0.92 – 0.93) were found for differentiating type 1 from type 2 and 3 skin tears. Slightly lower sensitivity and specificity were observed for differentiating type 2 from type 1 and 3 skin tears, and type 3 from type 1 and 2 skin tears.

Inter- and intrarater reliability

The multirater Fleiss Kappa for the entire group of participants was 0.57 (95% CI 0.57 – 0.57) (Table 4). Interrater reliability was higher in more experienced healthcare professionals. The mean Cohen's Kappa representing the intrarater reliability was 0.74 (95% CI 0.73 – 0.75) and the average overall agreement was 0.83 (95% CI 0.82 – 0.84) (Table 5). Higher mean specific agreement was found compared with the first time of assessment, ranging from 0.78 (95% CI 0.77 – 0.79) for type 2 to 0.83 (95% CI 0.82 – 0.84) for type 3 to 0.86 (95% CI 0.85 – 0.87) for type 1 skin tears.

Table 3. Diagnostic accuracy and agreement with reference standard (n = 1601 raters)

	Mean (95% CI)	Median (IQR)	2.5th – 97.5th percentile
P_o [a]	0.79 (0.79 - 0.80)	0.83 (0.75 - 0.88)	0.42 - 0.96
$P_{type\ 1}$ [b]	0.86 (0.85 - 0.86)	0.89 (0.80 - 0.94)	0.43 - 1.00
$P_{type\ 2}$ [b]	0.75 (0.74 - 0.75)	0.78 (0.67 - 0.88)	0.31 - 0.94
$P_{type\ 3}$ [b]	0.76 (0.76 - 0.77)	0.80 (0.71 - 0.88)	0.32 - 1.00
Type 1 vs. 2+3			
Sensitivity	0.88 (0.87 - 0.88)	0.88 (0.88 - 1.00)	0.38 - 1.00
Specificity	0.92 (0.92 - 0.93)	0.94 (0.88 - 1.00)	0.69 - 1.00
Type 2 vs. 1+3			
Sensitivity	0.77 (0.76 - 0.77)	0.75 (0.62 - 0.88)	0.25 - 1.00
Specificity	0.86 (0.86 - 0.87)	0.88 (0.81 - 0.94)	0.56 - 1.00
Type 3 vs. 1+2			
Sensitivity	0.74 (0.73 - 0.75)	0.75 (0.62 - 0.88)	0.25 - 1.00
Specificity	0.91 (0.90 - 0.91)	0.94 (0.88 - 1.00)	0.62 - 1.00

95% CI: 95% confidence interval, IQR: interquartile range, type 1: no skin/flap loss, type 2: partial skin/flap loss, type 3: total skin/flap loss, [a]: overall proportion of agreement, [b]: proportion of specific agreement

Table 4. Interrater reliability (n = 1601 raters)

	κ (95% CI)
Total sample *(n = 1601)*	0.57 (0.57 - 0.57)
Expertise in skin tears	
Novice *(n = 219)*	0.43 (0.42 - 0.43)
Advanced beginner *(n = 261)*	0.56 (0.56 - 0.56)
Competent *(n = 389)*	0.57 (0.57 - 0.57)
Proficient *(n = 400)*	0.62 (0.62 - 0.62)
Expert *(n = 332)*	0.64 (0.64 - 0.64)
Education	
Undergraduate *(n = 417)*	0.55 (0.55 - 0.55)
Bachelor degree *(n = 633)*	0.58 (0.57 - 0.58)
Master degree *(n = 475)*	0.59 (0.59 - 0.59)
Doctoral degree *(n = 73)*	0.53 (0.52 - 0.53)
Experience ISTAP tool	
No previous experience *(n = 1143)*	0.55 (0.55 - 0.55)
Previous experience *(n = 458)*	0.64 (0.64 - 0.64)

κ: Fleiss Kappa coefficient, 95% CI: 95% confidence interval

Table 5. Intrarater reliability and agreement (n = 952 raters)

	Mean (95% CI)	Median (IQR)	2.5th – 97.5th percentile
κ	0.74 (0.73 - 0.75)	0.75 (0.68 - 0.87)	0.31 - 0.94
P_o [a]	0.83 (0.82 - 0.84)	0.83 (0.79 - 0.92)	0.54 - 0.96
$P_{type\ 1}$ [b]	0.86 (0.85 - 0.87)	0.89 (0.82 - 0.94)	0.54 - 1.00
$P_{type\ 2}$ [b]	0.78 (0.77 - 0.79)	0.82 (0.71 - 0.89)	0.39 - 0.95
$P_{type\ 3}$ [b]	0.83 (0.82 - 0.84)	0.86 (0.78 - 0.92)	0.50 - 1.00

κ: Cohen's Kappa coefficient, 95% CI: 95% confidence interval, IQR: interquartile range, type 1: no skin/flap loss, type 2: partial skin/flap loss, type 3: total skin/flap loss, [a]: overall proportion of agreement, [b]: proportion of specific agreement

DISCUSSION

Although skin tears are unique and highly prevalent wounds, they are often under-recognised, misdiagnosed and poorly reported in clinical practice. Best practice includes early and accurate identification, classification, documentation, and the application of an evidence-based treatment protocol (LeBlanc et al., 2018a). A standardised and globally accepted skin tear classification system is needed to support consistent assessment and reporting (LeBlanc & Baranoski, 2011; LeBlanc & Baranoski, 2017). This study aimed to evaluate the validity and reliability of the ISTAP Classification System internationally.

Content validity of the ISTAP Classification System including the newly developed 'skin flap' definition was established by a panel of 17 international experts. After a two-round Delphi process, consensus was achieved on the definition for the concept of a 'skin flap' in skin tears. The development of such definition for the area of skin tears is important because this concept may be interpreted differently depending on one's educational background (da Silva et al., 2018). In the field of reconstructive surgery, for example, a 'skin flap' is considered a mass of tissue intentionally detached from its original place to be used for grafting for wound repair and organ reconstruction (Sun et al., 2017; Chai et al., 2019). A clear, internationally accepted definition of a 'skin flap' associated with the condition of a skin tear should help to eliminate confusion and to facilitate best practice (LeBlanc et al., 2018a).

In this study, psychometric properties of the ISTAP Classification System were examined in a sample of 1601 healthcare professionals from 44 countries. The results indicated a high level of agreement and diagnostic accuracy for differentiating between the three types of skin tears when healthcare professionals apply the ISTAP tool on presented photographs. Differences in

classifications were primarily limited to distinguishing between type 2 and type 3 skin tears, which is similar to the findings of Källman et al. (2019). The high level of agreement may reflect the ease of use of the tool (LeBlanc et al., 2013c). Interrater reliability was found to be 'moderate' to 'substantial' according to the interpretation by Landis and Koch (1977). Similar results have been reported in previous studies (LeBlanc et al., 2013c; Skiveren et al., 2015; Chaplain et al., 2018; Källman et al., 2019). The results showed a 'substantial' to 'almost perfect' level of intrarater reliability and agreement. Diagnostic accuracy, agreement and reliability may have been higher if live situations instead of photographs were used to classify skin tears. In order to be able to classify a skin tear accurately, the wound must be cleansed, necrotic tissue debrided, and the skin flap re-approximated where possible, which might be difficult to observe in photographs (LeBlanc et al., 2013a; LeBlanc et al., 2018a). Skin assessment in clinical practice, video recordings, or the exclusive use of photographs in which the skin flap, if viable, has been re-approximated could possibly offer a better alternative.

In general, we found higher reliability and agreement in more experienced and more highly educated healthcare professionals. As skin tears have a complex aetiology, extensive knowledge and experience are required to identify and classify these wounds correctly (LeBlanc et al., 2018a). Sufficient and adequate education and training of healthcare professionals may enhance the reliability of skin tear assessment. In 2006, a randomised controlled trial including 1217 nurses was conducted to assess the effectiveness of a training program on pressure ulcer classification skills (Beeckman et al., 2010b). The results of this study revealed a significant improvement in pressure ulcer identification and classification skills after attending the training program based on the Pressure Ulcer Classification (PUCLAS) education tool. In line with the PUCLAS tool, the development of an (e-learning) education tool for skin tear identification and classification that can be easily implemented by educators and healthcare organisations might facilitate learning and improve skills. Further research is needed to evaluate whether, and to what extent, education and training of (future) healthcare professionals would improve skin tear assessment and classification skills.

In the field of pressure ulcers, the National Pressure Ulcer Advisory Panel (NPUAP) (Edsberg et al., 2016) and European Pressure Ulcer Advisory Panel (EPUAP) (European Pressure Ulcer Advisory Panel, 2002) classification systems are widely used for the classification and documentation of pressure ulcers (Defloor et al., 2006; Beeckman et al., 2007). To support the assessment of incontinence-associated dermatitis (IAD), the Ghent Global IAD Categorisation Tool (GLOBIAD) has been developed and globally validated in 2017 (Beeckman et al., 2018b). In line with the GLOBIAD, NPUAP and EPUAP classification systems, the systematic assessment and reporting of skin tears using a valid and reliable international classification tool is recommended

(LeBlanc et al., 2018a). The results of this study show that skin tear photographs can be assessed in a valid and reliable way based on the ISTAP Classification System. In the context of our study, the ISTAP Classification System including the 'skin flap' definition has been translated into 15 languages and disseminated across 44 countries, encouraging global awareness and implementation (LeBlanc et al., 2013c). Integration of the ISTAP tool into the (electronic) medical record should be considered so that consistent documentation is guaranteed and more accurate skin tear prevalence and incidence data are obtained. Furthermore, the common use of the ISTAP Classification System to support skin tear assessment and documentation will facilitate and standardise communication, benchmarking, clinical audits, and research (LeBlanc & Baranoski, 2011; Chang et al., 2016; LeBlanc & Baranoski, 2017).

Strengths and limitations

Our study was a global validation study including a large number of international experts and healthcare professionals with different backgrounds across a variety of settings and countries. This increases the generalisability of our findings and may contribute to global awareness and implementation of the ISTAP Classification System.

A main limitation of this study might be the use of photographs, which only provide a static, two-dimensional image of wounds. Assessment in clinical practice might allow a more holistic evaluation involving additional factors such as the cause of the wound, accurate flap visualisation, partial/full-thickness, health status, wound history, and dependency for daily living activities (Skiveren et al., 2015; LeBlanc et al., 2018a). Whether skin tear assessment in clinical practice is more accurate than with photographs is yet to be established. Furthermore, we only included photographs of skin tears, but it is well known that skin tears are frequently incorrectly diagnosed as other lesions, such as pressure ulcers (LeBlanc & Baranoski, 2011; LeBlanc et al., 2013c). Therefore, it would be recommended to also include photographs of other wound types in future validation studies to evaluate whether the differential diagnosis between skin tears and other types of lesions can be made. Another limitation might be that there were only three photographs of darkly pigmented skin included, which may limit the applicability of our findings to all skin phototypes.

CONCLUSION

The global validation of the ISTAP Classification System is a major step forward towards a more systematic assessment and reporting of skin tears in clinical practice and research. The ISTAP Classification System seems to be a valid, reliable and easy-to-use tool for classifying skin tears according to their severity level. The ISTAP tool is available in 15 languages, which may enhance global implementation.

Conflicts of interest

None to declare.

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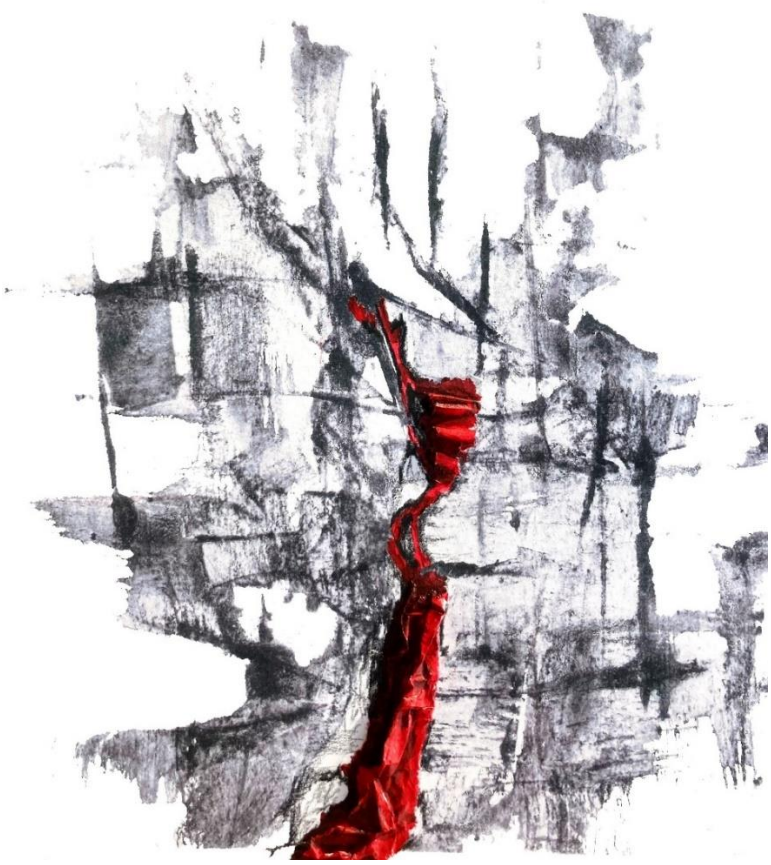
Chapter 4

Measurement properties of classifications for skin tears: a systematic review



Chapter based on:

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Impact factor: 5.837, rank (nursing): 1/124 (Q1)

ABSTRACT

Background: Skin tear classifications support the assessment and reporting of skin tears in a consistent way. The measurement properties of skin tear classifications have not been compared so far.

Objectives: To critically appraise, compare and summarise the quality of the measurement properties of available skin tear classifications.

Design: Systematic review.

Methods: The databases MEDLINE, EMBASE, CINAHL and CENTRAL were systematically searched until January 2020. Studies reporting the development and/or the evaluation of measurement properties of skin tear classifications were included. The COSMIN Risk of Bias checklist was applied to evaluate the methodological quality of the included studies. Each reported measurement property was rated against criteria for good measurement properties. The evidence was summarised and the quality of the evidence was graded using a modified GRADE approach. Study selection, data extraction, and quality appraisal were conducted independently by two reviewers and double-checked by a third reviewer.

Results: Fourteen studies, describing five classifications, were included. Content validity was examined in five studies, reliability in nine studies, measurement error in two studies, and criterion validity in four studies. For three classification systems, no measurement properties were reported.

Conclusion: Five skin tear classifications exist, of which only two have been psychometrically tested. The quality of evidence on their measurement properties varied between very low to moderate. To date, the ISTAP classification is the most commonly evaluated system with moderate quality evidence to support its reliability, measurement error, and criterion validity. More well-designed studies using direct skin observations are needed.

Protocol registration number: CRD42019138138 (PROSPERO).

Keywords: Classification, Measurement properties, Reliability, Skin tear, Systematic review, Validity

SUMMARY STATEMENT

What's already known about this topic?

- Skin tear classifications aim at providing consistent wound assessment and taxonomy that encourages consistent description, accurate communication, precise documentation and appropriate treatment decisions.
- Valid and reliable skin tear classifications should be used in research and clinical practice.

What does this study add?

- Five skin tear classifications exist, of which only two have been psychometrically tested.
- Moderate quality of evidence supports the validity and reliability of the ISTAP classification.
- Further studies on measurement properties of skin tear classifications in clinical practice are needed.

INTRODUCTION

Skin tears are a significant health problem worldwide (Chang et al., 2016; LeBlanc et al., 2018a), with prevalence estimates between 3.3 – 19.8% in acute care (McErlean et al., 2004; McLane et al., 2004; Santamaria et al., 2009; Hsu & Chang, 2010; Lopez et al., 2011; Amaral et al., 2012; Chang et al., 2016; Bermark et al., 2018), 14.3% in palliative care (Maida et al., 2012), 5.5 – 19.5% in the community (Carville & Lewin, 1998; Carville & Smith, 2004), and 3.0 – 26.0% in long-term care (LeBlanc et al., 2013b; Strazzieri-Pulido et al., 2015a; Koyano et al., 2016; LeBlanc, 2017; Skiveren et al., 2017; Woo et al., 2017; LeBlanc et al., 2018a; LeBlanc & Baranoski, 2018; Woo & LeBlanc, 2018; Van Tiggelen et al., 2019a). They are associated with pain and distress for the individuals affected, prolonged hospitalisation, diminished quality of life, and extensive healthcare costs (Strazzieri-Pulido et al., 2015a; LeBlanc et al., 2018a). The International Skin Tear Advisory Panel (ISTAP) defines skin tears as *"traumatic wounds caused by mechanical forces, including removal of adhesives. Severity may vary by depth (not extending through the subcutaneous layer)"* (LeBlanc et al., 2018a). They are particularly common on the upper and lower extremities and are predominantly found in the elderly, neonates, and people who are critically and chronically ill (LeBlanc et al., 2013a; Serra et al., 2018).

Despite their high prevalence and serious impact, skin tears are frequently under-recognised, misdiagnosed and poorly reported in clinical practice (Carville et al., 2007; LeBlanc et al., 2018a). One potential reason may be the absence of a specific code for skin tears in the World Health Organization (WHO) International Classification of Diseases (ICD) 10th edition (World Health Organization, 2016). The term 'skin tear' is not universally adopted and skin tears are often subsumed under general terms such as 'laceration' or 'cutaneous laceration' (Rayner et al., 2015; LeBlanc et al., 2018a). Another reason may be the lack of a uniform method for the assessment and documentation of skin tears using a standardised, valid and reliable classification system (Carville et al., 2007; LeBlanc et al., 2014). Skin tear classifications are valuable tools in research and clinical practice as they aim at providing consistent assessment that improves accurate communication, diligent outcome evaluation, and appropriate treatment decisions (Kottner et al., 2009; Chang et al., 2016; LeBlanc & Baranoski, 2017).

The first skin tear classification was proposed by Payne & Martin in 1990. The Payne-Martin Classification System differentiates three categories and four subcategories based on the extent of tissue loss, measured as a percentage (Payne & Martin, 1990). In the following years this classification was modified and new classification systems with varying numbers of categories were developed, of which the Skin Tear Audit Research (STAR) Classification System and the International Skin Tear Advisory Panel (ISTAP) Classification System are the most commonly used

(Payne & Martin, 1993; Dunkin et al., 2003; Carville et al., 2007; Lo et al., 2012; LeBlanc et al., 2013c).

To be useful for research and clinical practice, classification systems should be valid and reliable to assess skin tears accurately and consistently (Garbuz et al., 2002; Kimberlin & Winterstein, 2008). Validity is the degree to which an instrument measures what it purports to measure and may be divided into content validity, criterion validity, and construct validity (Mokkink et al., 2018a). Reliability estimates evaluate the relative measurement error of measures when repeated under identical conditions (test-retest reliability), internal consistency of measurement instruments, and interrater reliability of instrument scores (Kimberlin & Winterstein, 2008; Mokkink et al., 2018a).

To date, there are several studies investigating the measurement properties of skin tear classifications, however, no attempts have been made to systematically review and summarise the available evidence to find out which classification can be recommended for use in daily practice. The aim of this study was to systematically review the measurement properties of skin tear classifications, as well as to evaluate the methodological quality of the reported studies and the quality of the measurement properties.

METHODS

Design

This systematic review was conducted in accordance with the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) guideline for systematic reviews of patient-reported outcome measures (Prinsen et al., 2018). The protocol for this review was developed using the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) checklist (Moher et al., 2015) and has been registered in the PROSPERO International Prospective Register of Systematic Reviews (ID: CRD42019138138) (Van Tiggelen et al., 2019b).

Search methods

The following electronic databases were systematically searched until January 2020: MEDLINE (PubMed interface), EMBASE, CINAHL (EBSCO interface), and CENTRAL. No time limits or language restrictions were applied. The search was conducted by the first investigator and supported by a librarian technician specialised in medical databases.

The search strategy consisted of search terms, including indexing terms and free text words, for the concepts ‘skin tears’, ‘classification’, and ‘measurement properties’. Search terms of the same concept were combined using the Boolean operator OR. The concepts were combined using the Boolean operator AND. For the ‘measurement properties’ concept, the sensitive search filter as developed by Terwee et al. (2009) was applied. Appendix 2 shows the search strategy for MEDLINE (PubMed interface), which was later adapted for the other databases.

Study selection

Results of database searches were imported into the reference manager software EndNote X8.0.1 (Clarivate Analytics, Philadelphia, PA). Duplicates were removed via the duplicate search function and by manually reviewing the list. Articles were screened by title and abstract independently by two reviewers using the screening software Rayyan (Ouzzani et al., 2016). Disagreement was resolved by consensus and if consensus could not be reached, the full-text was reviewed and a third reviewer was consulted. Full-texts of the remaining records were assessed for eligibility independently by two reviewers. Any discrepancies were resolved by a third reviewer. Reasons for exclusion were documented. To identify additional relevant studies, cited and citing references of included studies were screened via Web of Science, Scopus, and Google Scholar.

Studies were included if they reported the development and/or the evaluation of one or more measurement properties (content validity, reliability, measurement error, criterion validity) of an instrument to classify skin tears in individuals of all ages, independently from any geographical location, healthcare setting, ethnicity, or skin colour. Reviews, discussion papers, letters, comments, and editorials were excluded.

Data extraction

Data from included studies were extracted independently by two reviewers using standardised data extraction tables and double-checked by a third reviewer. The extracted data contained: the authors, year of publication, classification system including the number of categories, instrument development, sample characteristics of raters (n, sex, mean age (SD), function), instrument administration (mode of administration, sample characteristics of patients, country, language), and the reported measurement properties. When information was unclear or incomplete, the corresponding authors of the relevant studies were contacted to provide further details.

Quality appraisal

Quality assessment was performed independently by two reviewers and double-checked by a third reviewer. The methodological quality was assessed using the COSMIN Risk of Bias checklist (Mokkink et al., 2018b). Each single study on a measurement property was rated as very good (V), adequate (A), doubtful (D), or inadequate (I) quality. The methodological quality assessment of content validity studies consisted of an evaluation of a relevance study and a comprehensiveness study in professionals. In accordance with the latest revision of the COSMIN methodology (Mokkink et al., 2018a), not only studies of very good or adequate quality were considered further. The result of each study on a measurement property was rated against the updated criteria for good measurement properties according to COSMIN (Prinsen et al., 2018). Each reported measurement property was rated sufficient (+), insufficient (-), or indeterminate (?). We defined the following criteria in addition because they were not included in the updated criteria for good measurement properties: kappa coefficients ≥ 0.7 (reliability), percent agreement ≥ 0.7 (measurement error), and sensitivity and specificity ≥ 0.7 (criterion validity) (Mokkink et al., 2018a).

Data synthesis

The results of all available studies on a measurement property were qualitatively summarised per classification system and the overall result was rated against the criteria for good measurement properties (Prinsen et al., 2018) to determine whether, overall, the measurement property of the classification system was sufficient (+), insufficient (-), inconsistent (±), or indeterminate (?). The quality of the evidence per measurement property per classification system was rated as high, moderate, low, or very low using the modified Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach proposed by COSMIN (Mokkink et al., 2018a). This modified GRADE approach is used to downgrade the quality of evidence when there are concerns about the trustworthiness of the results taking risk of bias, inconsistency, imprecision, and indirectness into account (Mokkink et al., 2018a; Prinsen et al., 2018). Risk of bias refers to the methodological quality of the studies as assessed with the COSMIN Risk of Bias checklist. Inconsistency concerns the unexplained discrepancy of the results between studies. Imprecision refers to the total sample size included in the studies. Indirectness means that the population or context of use in the included studies differ from what the review is interested in. Grading was done by two reviewers independently. Disagreements were resolved by consensus.

Three different statistical approaches were used to calculate reliability in the included studies: Fleiss Kappa, Cohen's Kappa, and weighted Kappa. Kappa coefficients were interpreted according to the criteria of Landis and Koch (< 0.00 = poor; 0.00–0.20 = slight; 0.21–0.40 = fair; 0.41–0.60 = moderate; 0.61–0.80 = substantial; 0.81–1.00 = almost perfect) (Landis & Koch, 1977).

Measurement error was expressed as percent agreement and criterion validity as diagnostic accuracy, sensitivity, and specificity.

RESULTS

Search and selection of studies

A total of 2002 records were identified through systematic database searching (849 in MEDLINE, 852 in EMBASE, 159 in CINAHL, and 142 in CENTRAL). After removal of duplicates, title/abstract screening, full-text reviews, and additional searches, fourteen studies were included in the review. The PRISMA flow diagram outlining the search and selection process is shown in Figure 1.

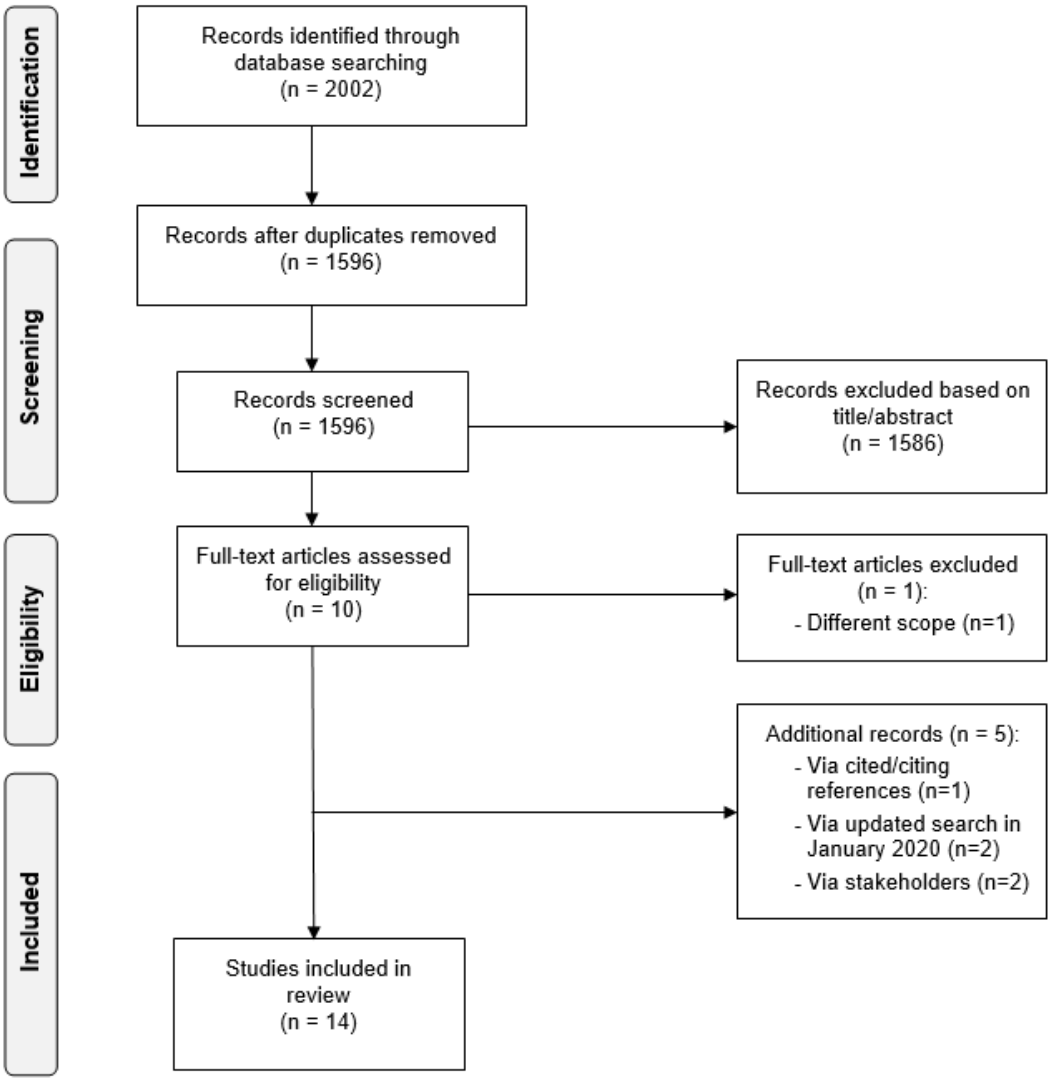

Figure 1. Flowchart of study selection according to PRISMA

Classification systems identified

Fourteen studies describing five skin tear classifications were identified: (a) the Payne-Martin Classification System for Skin Tears (Payne & Martin, 1990); (b) the Dunkin Classification of Pretibial Injuries (Dunkin et al., 2003); (c) the Lo Classification of Pretibial Lacerations (Lo et al., 2012); (d) the Skin Tear Audit Research (STAR) Classification System (Carville et al., 2007); and (e) the International Skin Tear Advisory Panel (ISTAP) Classification System (LeBlanc et al., 2013c). Three classifications were developed to provide a common description of skin tear severity based on morphological characteristics to facilitate communication between healthcare professionals, standardise documentation, and enable the conduct of prevalence and incidence studies (Payne-Martin, STAR and ISTAP). Two classifications were developed with the aim of guiding (surgical) management, including an algorithm that defines treatment options according to the type of injury (Dunkin and Lo). A detailed description of the included classification systems can be found in Appendix 3.

Study characteristics

The included studies were published in English between 1990 and 2020 and conducted in the USA (n = 2), the UK (n = 2), Australia (n = 1), Brazil (n = 2), Singapore (n = 1), Canada (n = 2), Denmark (n = 1), Sweden (n = 1), Italy (n = 1), and Belgium (n = 1). Four studies reported the development or revision of a classification system, eight studies the evaluation of one or more measurement properties, and two studies both the development and psychometric testing. The measurement properties that were examined were content validity (five studies), reliability (nine studies), measurement error (two studies), and criterion validity (four studies). In nine studies the measurement properties were investigated using photographs (indirect skin observation). Actual skin assessment in a clinical setting was conducted in one study (direct skin observation). Characteristics of the included studies and the reported measurement properties are presented in Table 1.

Quality of studies

Results of the methodological quality assessment of the included studies and ratings of reported measurement properties against criteria for good measurement properties are shown in Table 2. Of the twenty single studies on a measurement property, three were rated as very good (V), four as adequate (A), nine as doubtful (D), and four as inadequate (I) methodological quality. Nine reported measurement properties were found to be sufficient (+) when rated against the criteria for good measurement properties, twelve were rated insufficient (-), and one indeterminate (?).

Table 1. Characteristics of the included studies and the reported measurement properties

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
Payne & Martin (1990)	Payne-Martin (3) Cat. I: Without tissue loss *A. Linear type* *B. Flap type* Cat. II: Partial tissue loss *A. Scant tissue loss* *B. Moderate tissue loss* Cat. III: Complete tissue loss	▪ Inductively developed by the authors based on clinical observations of 10 individuals	N/A	N/A	N/A	N/A	N/A	N/A	None provided.
Payne & Martin (1993)	Payne-Martin (3) Cat. I: Without tissue loss *A. Linear type* *B. Flap type* Cat. II: Partial tissue loss *A. Scant tissue loss* *B. Moderate-to-large tissue loss* Cat. III: Complete tissue loss	▪ The original classification (1990) was revised by the authors, definitions per skin tear type were added and the term *"moderate tissue loss"* was changed into *"moderate-to-large tissue loss"* (cat. II, B)	N/A	N/A	N/A	N/A	N/A	N/A	None provided.

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
Dunkin et al. (2003)	Dunkin (4) Type 1: Laceration Type 2: Laceration or flap with minimal haematoma and/or skin-edge necrosis Type 3: Laceration or flap with moderate to severe haematoma and/or necrosis Type 4: Major degloving injury	▪ Not described *("…based on clinical practice and available published evidence…")*	N/A	N/A	N/A	N/A	N/A	N/A	None provided.
Lo et al. (2012)	Lo (5) Type 1: Linear laceration without skin loss Type 2: Flap laceration viable Type 3: Flap laceration non-viable Type 4: Skin loss Type 5: Laceration with haematoma	▪ Not described (likely based on the Dunkin classification: *"…a modification of that suggested by Dunkin et al…"* and own experience of the authors: *"…it is our experience that…"*)	N/A	N/A	N/A	N/A	N/A	N/A	None provided.

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
Carville et al. (2007)	STAR (5) Cat. 1a: Edges can be realigned, skin flap is not pale, dusky or darkened Cat. 1b: Edges can be realigned, skin flap is pale, dusky or darkened Cat. 2a: Edges cannot be realigned, skin flap is not pale, dusky or darkened Cat. 2b: Edges cannot be realigned, skin flap is pale, dusky or darkened Cat. 3: Skin flap completely absent	▪ A consensus panel of 7 clinical nurse consultants/ specialists developed STAR in 4 Delphi rounds based on the Payne-Martin classification, a library of photographs (n=20) and a literature review ▪ The resulting STAR classification was reviewed and further refined by 11 nationally recognised wound care experts (a glossary of terms, simple descriptions and photographic examples were added)	N = 36, sex and age not specified	Registered nurses from acute care (n=16), community care (n=10), residential aged care facilities (n=10)	Indirect skin observation using 25 skin tear photographs	Skin tears categories 1a, 1b, 2a, 2b, 3 (unequal distribution among categories)	Australia	English	RELIABILITY Interrater reliability - Overall Cohen's Kappa: 0.93 - Cohen's Kappa per category ranged between 0.83 to 0.97 *Comment: The authors indicated that data were analysed using Cohen's Kappa, but the results reported are percentages (level of agreement). It is most likely that the results reflect inter-rater reliability.*

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
Strazzieri-Pulido et al. (2015b)	STAR (5)	▪ The original STAR classification (2007) was culturally adapted into Brazilian Portuguese by 4 (back-) translators and a committee of judges (n = 6 stomatherapy/ dermatology specialists) in 3 phases: translation into Portuguese, content validation (evaluating clarity and relevance of each item), back-translation into English	N = 6, sex and age not specified	Stoma-therapy and dermatology specialists	Evaluation of clarity and relevance of the STAR items	N/A	Brazil	Portuguese	<u>VALIDITY</u> <u>Content validity</u> - Agreement 'Semantic and idiomatic equivalence': 81.8%
			N = 107, sex and age not specified	Nurses who participated in the VIII Brazilian Congress of Stoma-therapy (2009)	Indirect skin observation using 5 skin tear photographs	Skin tears cat.1a: n=1, 1b: n=1, 2a: n=1, 2b: n=1, 3: n=1	Brazil	Portuguese	<u>RELIABILITY</u> <u>Interrater reliability</u> - Weighted Kappa: 0.29 <u>VALIDITY</u> <u>Criterion validity</u> *Ratings of 107 participants vs. gold standard (11 experts (2007))* - Overall diagnostic accuracy: 43.3% - Diagnostic accuracy per category ranged between 34.6% to 52.3%

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
			N = 20, sex and age not specified	Nurses from 1 large hospital: Institute of Cancer of São Paulo (ICESP)	Direct skin observation: n= 6 skin tears in 4 patients	Skin tears cat.1a: n=1, 1b: n=1, 2a: n=1, 2b: n=1, 3: n=2 Hospitalised in inpatient and intensive care units, ≥ 18 years, female (n=3), white skin tone (n=3), mean age 63.7 years	Brazil	Portuguese	RELIABILITY Interrater reliability - Weighted Kappa: 0.60 VALIDITY Criterion validity *Ratings of 20 participants vs. 1 expert* - Overall diagnostic accuracy: 53.3% - Diagnostic accuracy per category ranged between 20.0% to 80.0%
Chang et al. (2016)	STAR (5)	See Carville et al. (2007)	N = 3, sex and age not specified	Registered nurses from 1 large teaching tertiary hospital	Indirect skin observation using 26 skin tear photographs (as part of an education session in the context of a prevalence study)	Skin tears categories 1a, 1b, 2a, 2b, 3 (distribution among categories is not described)	Singapore	English	RELIABILITY Interrater reliability - Interrater reliability: 80% (?) *Comment: The authors indicated that interrater reliability was calculated, but the result reported is a percentage. A Kappa coefficient was not reported. Overall design and results reporting unclear.*

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
LeBlanc et al. (2013c)	ISTAP (3) Type 1: No skin loss Type 2: Partial flap loss Type 3: Total flap loss	▪ A consensus panel of 12 internationally recognised key opinion leaders (ISTAP panel) developed the ISTAP classification based on the Payne-Martin and STAR classifications and a literature review	N = 12, sex and age not specified	ISTAP panel members (experts)	Indirect skin observation using 30 skin tear photographs (twice; retest after 2 months)	Skin tears type 1: n=10, type 2: n=10, type 3: n=10	Canada, United Kingdom, United States of America	English	RELIABILITY Interrater reliability - Fleiss Kappa: 0.62 (test), 0.65 (retest) Intrarater reliability *Two-month time interval* - Cohen's Kappa: 0.88
			N = 327, sex and age not specified	Registered nurses (n=259), registered practical nurses/ licensed vocational nurses/ licensed practical nurses/ certified nursing assistants (n=44), non-nurses (n=24)	Indirect skin observation using 30 skin tear photographs	Skin tears type 1: n=10, type 2: n=10, type 3: n=10	Brazil, Canada, China, United Kingdom, United States of America	English	RELIABILITY Interrater reliability - Fleiss Kappa: 0.55

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
Skiveren et al. (2015)	ISTAP (3)	▪ The original ISTAP classification (2013) was translated into Danish by wound care and dermatology nurse specialists (n=8), disagreement was resolved by a wound care physician, back-translation into English by 2 nurses	N = 270, sex and age not specified	Registered nurses (n=241), social and healthcare assistants (n=29) from primary healthcare (n=84) and a university hospital (n=186)	Indirect skin observation using 30 skin tear photographs *(the same photographs as in the study of LeBlanc et al. (2013c))*	Skin tears type 1: n=10, type 2: n=10, type 3: n=10	Denmark	Danish	RELIABILITY Interrater reliability - Fleiss Kappa: 0.46

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
Chaplain et al. (2018)	ISTAP (3)	▪ The original ISTAP classification (2013) was translated into French Canadian by nurses specialised in wound care (n=8), disagreement was resolved by a wound care specialist, back-translation into English by 2 nurses	N = 92, sex and age not specified	Registered nurses from a primary/ acute care hospital	Indirect skin observation using 30 skin tear photographs *(the same photographs as in the study of LeBlanc et al. (2013c))*	Skin tears type 1: n=10, type 2: n=10, type 3: n=10	Canada	French	RELIABILITY Interrater reliability - Fleiss Kappa: 0.69

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
da Silva et al. (2018)	ISTAP (3)	▪ The original ISTAP classification (2013) was culturally adapted into Brazilian Portuguese by 4 (back-) translators and a committee of judges (n= 5 nurses specialised in stomatherapy) in 3 phases: translation into Portuguese, content validation (evaluating clarity of each item), back-translation into English	N = 5, sex and age not specified	Nurses specialised in stoma-therapy	Nurses rated their agreement with the translated ISTAP items on a 4 point Likert scale (1 = totally disagree, 4 = totally agree) and suggested changes to improve the wording of the items	N/A	Brazil	Portuguese	VALIDITY Content validity - Content validity index (CVI): mean 0.66

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
Källman et al. (2019)	ISTAP (3)	▪ The original ISTAP classification (2013) was translated into Swedish by a professional translator and back-translated into English by a different professional translator ▪ A two-round online survey was conducted among wound care specialists (n=145) from Sweden to gain consensus on the best Swedish translation of a "skin tear" (*hudfliksskada*)	N = 84, 92.9% female, 51.8 (11.2) years	Registered nurses and assistant nurses who participated in the Wound Care Conference in Sweden (2017)	Indirect skin observation using 30 skin tear photographs *(the same photographs as in the study of LeBlanc et al. (2013c))*	Skin tears type 1: n=10, type 2: n=10, type 3: n=10	Sweden	Swedish	RELIABILITY Interrater reliability - Fleiss Kappa: 0.50 Measurement error (interrater) - Overall agreement: 0.68 VALIDITY Criterion validity *Ratings of 84 participants vs. gold standard (1 expert (2013))* - Overall diagnostic accuracy: 76.8% - Diagnostic accuracy per category ranged between 73.4% to 79.4%

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
Bassola et al. (2019)	ISTAP (3)	▪ The original ISTAP classification (2013) was translated into Italian by 2 healthcare professionals, disagreement was resolved by the authors and 15 nurses, back-translation into English by a nonhealth professional translator and a HCP	N = 209, 80% female, 42.7 (9.8) years	Nurses (n=197) and non-nurses (n=12) from medical, surgical and intensive care departments of a north Italian hospital	Indirect skin observation using 30 skin tear photographs *(the same photographs as in the study of LeBlanc et al. (2013c))*	Skin tears type 1: n=10, type 2: n=10, type 3: n=10	Italy	Italian	RELIABILITY Interrater reliability - Fleiss Kappa: 0.47 (95% CI 0.41 to 0.60) VALIDITY Criterion validity *Ratings of 209 participants vs. gold standard (1 expert (2013))* - Overall diagnostic accuracy: 72.5% - Diagnostic accuracy per category ranged between 64.0% to 79.0%

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
Van Tiggelen et al. (2020)	ISTAP (3) The following "skin flap" definition was added to the original ISTAP classification: *"A flap in skin tears is defined as a portion of the skin (epidermis/ dermis) that is unintentionally separated (partially or fully) from its original place due to shear, friction, and/or blunt force. This concept is not to be confused with tissue that is intentionally detached from its place of origin for therapeutic use, e.g. surgical skin grafting."*	▪ A definition of a "skin flap" was developed and added to the original ISTAP classification (2013) by an international expert panel (n=17, 11 countries) in a two-round Delphi study ▪ The ISTAP classification including "skin flap" definition was translated into 15 languages by native speakers with extensive content expertise	N = 1601, 89.4% female, 41.2 (12.2) years	Student nurses, nurse assistants, nurses, head nurses, nurse specialists, educators, researchers from hospitals, nursing homes, community care, education, clinical research	Indirect skin observation using 24 skin tear photographs (online survey)	Skin tears type 1: n=8, type 2: n=8, type 3: n=8 *(3 photographs from patients with darkly pigmented skin)*	Australia, Austria, Belgium, Botswana, Brazil, Canada, Chile, China, Colombia, Costa Rica, Cyprus, Czech Republic, Denmark, Germany, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Jersey, Kenya, Malaysia, Malta, Mauritius, Namibia, the Netherlands, Norway, Philippines, Portugal, Saudi Arabia, Singapore, Slovakia,	Arabic, Chinese, Czech, Danish, Dutch, English, French, German, Hebrew, Italian, Japanese, Portuguese, Spanish, Swedish, Turkish	RELIABILITY Interrrater reliability - Fleiss Kappa: 0.57 (95% CI 0.57 to 0.57) Measurement error (interrater) - Overall agreement: 0.79 (95% CI 0.79 to 0.80) VALIDITY Criterion validity *Ratings of 1601 participants vs. 3 experts* - Type 1 vs. 2+3: sensitivity 88% and specificity 92% - Type 2 vs. 1+3: sensitivity 77% and specificity 86% - Type 3 vs. 1+2: sensitivity 74% and specificity 91%

Author (year)	Classification system (number of categories)	Instrument development	Sample characteristics of raters		Instrument administration				Measurement properties
			N, sex, mean age (SD)	Function	Mode of administration	Sample characteristics of patients	Country	Language	
			N = 952, 89.6% female, 42.1 (11.7) years	Student nurses, nurse assistants, nurses, head nurses, nurse specialists, educators, researchers from hospitals, nursing homes, community care, education, clinical research	Indirect skin observation using 24 skin tear photographs (online survey; retest)	Skin tears type 1: n=8, type 2: n=8, type 3: n=8 *(3 photographs from patients with darkly pigmented skin)*	South Africa, Sri Lanka, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Arab Emirates, United Kingdom, United States of America	Arabic, Chinese, Czech, Danish, Dutch, English, French, German, Hebrew, Italian, Japanese, Portuguese, Spanish, Swedish, Turkish	RELIABILITY Intrarater reliability *One-week time interval* - Cohen's Kappa: 0.74 (95% CI 0.73 to 0.75) Measurement error (intrarater) - Overall agreement: 0.83 (95% CI 0.82 to 0.84)

SD: standard deviation, N/A: not applicable, STAR: Skin Tear Audit Research, ISTAP: International Skin Tear Advisory Panel, CVI: content validity index, 95% CI: 95% confidence interval

Table 2. Methodological quality of the included studies and ratings of measurement properties

Author (year)	Content validity		Reliability		Measurement error		Criterion validity	
	Meth Qual. studies		Meth Qual.	Result rating	Meth Qual.	Result rating	Meth Qual.	Result rating
	Relevance	Comprehensiveness						
Payne & Martin (1990)	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
Payne & Martin (1993)	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
Dunkin et al. (2003)	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
Lo et al. (2012)	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
Carville et al. (2007)	A	A	D	+	N/I	N/I	N/I	N/I
Strazzieri-Pulido et al. (2015b)	A	A	D	--	N/I	N/I	I	--
Chang et al. (2016)	N/I	N/I	I	?	N/I	N/I	N/I	N/I
LeBlanc et al. (2013c)	D	D	D	--+	N/I	N/I	N/I	N/I
Skiveren et al. (2015)	N/I	N/I	D	-	N/I	N/I	N/I	N/I
Chaplain et al. (2018)	N/I	N/I	D	-	N/I	N/I	N/I	N/I

Author (year)	Content validity		Reliability		Measurement error		Criterion validity	
	Meth Qual. studies		Meth Qual.	Result rating	Meth Qual.	Result rating	Meth Qual.	Result rating
	Relevance	Comprehensiveness						
da Silva et al. (2018)	D	A	N/I	N/I	N/I	N/I	N/I	N/I
Källman et al. (2019)	N/I	N/I	D	-	D	-	I	+
Bassola et al. (2019)	N/I	N/I	V	-	N/I	N/I	I	+
Van Tiggelen et al. (2020)	A	A	V	-+	A	++	V	++

N/I: not investigated, V: very good, A: adequate, D: doubtful, I: inadequate, +: sufficient, -: insufficient, ?: indeterminate

Final data synthesis

The summarised results and quality of evidence ratings per measurement property per classification system are presented in Table 3. In Appendix 4 the rationale for downgrading the quality of evidence by one, two, or three levels is described per measurement property per classification system.

Content validity

Content validity of the Payne-Martin, Dunkin, and Lo classifications has not been investigated in any of the included studies. Five studies examined the content validity of the STAR (Carville et al., 2007; Strazzieri-Pulido et al., 2015b) and ISTAP (LeBlanc et al., 2013c; da Silva et al., 2018; Van Tiggelen et al., 2020) classifications. The methodological quality of both the relevance study and comprehensiveness study in professionals was rated adequate for three studies (Carville et al., 2007; Strazzieri-Pulido et al., 2015b; Van Tiggelen et al., 2020) and doubtful for one study (LeBlanc et al., 2013c). The study of da Silva et al. (2018) was given a doubtful rating for the relevance study and an adequate rating for the comprehensiveness study in professionals.

In the study of Carville et al. (2007), the STAR classification was developed and its content validity was established by a panel of wound care experts (n = 18). The clarity and relevance of the STAR items (translated into Portuguese) were evaluated by six stomatherapy and dermatology specialists, which resulted in an agreement of 81.8% (Strazzieri-Pulido et al., 2015b).

The ISTAP classification was developed and content validated by a consensus panel of twelve international experts (ISTAP panel) in 2013 (LeBlanc et al., 2013c). A content validity index (CVI) of 0.66 was reported by da Silva et al. (2018) after five stomatherapy nurses were asked to rate their agreement with the ISTAP items (translated into Portuguese) on a 4-point Likert scale. In 2020, an international expert panel (n = 17) developed and content validated a definition of a “skin flap” to be added to the ISTAP classification (Van Tiggelen et al., 2020).

Reliability

Reliability of the Payne-Martin, Dunkin, and Lo classifications was examined in none of the included studies. Three studies assessed the interrater reliability of the STAR classification (Carville et al., 2007; Strazzieri-Pulido et al., 2015b; Chang et al., 2016). Carville et al. (2007) recruited 36 nurses to categorise 25 skin tear photographs according to the STAR classification, resulting in a Cohen’s Kappa of 0.93. Strazzieri-Pulido et al. (2015b) found a weighted Kappa of 0.29 through indirect skin observation based on photographs (n = 107) and a weighted Kappa of 0.60 through direct skin observation in clinical practice (n = 20). Chang et al. (2016) reported an interrater reliability of 80%

based on indirect skin observation (n = 3). The summary result (κ = 0.29 to 0.93) was rated insufficient when compared against the criteria for good measurement properties, and the quality of evidence was rated very low using the modified GRADE approach.

Interrater reliability of the ISTAP classification was measured in six studies (LeBlanc et al., 2013c; Skiveren et al., 2015; Chaplain et al., 2018; Bassola et al., 2019; Källman et al., 2019; Van Tiggelen et al., 2020) and intrarater reliability in two studies (LeBlanc et al., 2013c; Van Tiggelen et al., 2020) based on photographs (indirect skin observation). In all studies except one (Van Tiggelen et al., 2020), the same set of skin tear photographs (n = 30) was used. Interrater reliability coefficients (Fleiss Kappa) ranged from κ = 0.46 to κ = 0.69. In the studies of LeBlanc et al. (2013c) and Van Tiggelen et al. (2020), participants were asked to reassess the photographs at a later time, resulting in intrarater reliability coefficients (Cohen's Kappa) of κ = 0.88 and κ = 0.74 respectively. The summary result was rated insufficient for the interrater reliability (κ = 0.46 to 0.69) and sufficient for the intrarater reliability (κ = 0.74 to 0.88) of the ISTAP classification. The quality of evidence was rated moderate for both the inter- and intrarater reliability.

Measurement error

Measurement error of the Payne-Martin, Dunkin, Lo, and STAR classifications was not examined in any studies. Measurement error of the ISTAP classification was assessed in two studies (Källman et al., 2019; Van Tiggelen et al., 2020) based on photographs. Källman et al. (2019) found an overall agreement of 0.68 (n = 84). In the study of Van Tiggelen et al. (2020), the overall interrater agreement was 0.79 (95% CI 0.79 – 0.80; n = 1601) and the overall intrarater agreement was 0.83 (95% CI 0.82 – 0.84; n = 952). Higher overall agreement was found in more experienced and higher educated participants (Van Tiggelen et al., 2020). The summary result (p_o = 0.68 to 0.83) was rated sufficient when compared against the criteria for good measurement properties, and the quality of evidence was rated moderate using the modified GRADE approach.

Criterion validity

Criterion validity of the Payne-Martin, Dunkin, and Lo classifications was examined in none of the included studies. One study reported data on the criterion validity of the STAR classification (Strazzieri-Pulido et al., 2015b). Strazzieri-Pulido et al. (2015b) found a diagnostic accuracy of 43.3% through indirect skin observation (n = 107) and a diagnostic accuracy of 53.3% through direct skin observation in clinical practice (n = 20). The summary result (43.3% to 53.3%) was rated insufficient when compared against the criteria for good measurement properties, and the quality of evidence was rated very low using the modified GRADE approach.

Criterion validity of the ISTAP classification was assessed in three studies (Bassola et al., 2019; Källman et al., 2019; Van Tiggelen et al., 2020) based on photographs. Källman et al. (2019) reported a diagnostic accuracy of 76.8% (n = 84) and Bassola et al. (2019) one of 72.5% (n = 209). Van Tiggelen et al. (2020) found a mean sensitivity of 88% (95% CI 0.87 – 0.88) and a mean specificity of 92% (95% CI 0.92 – 0.93) for differentiating type 1 from type 2 and 3 skin tears (n = 1601). Slightly lower sensitivity and specificity were reported for differentiating type 2 from type 1 and 3 skin tears, and type 3 from type 1 and 2 skin tears. The summary result (72.5% to 92.0%) was rated sufficient and the quality of evidence was rated moderate.

Table 3. Summary of findings and quality of evidence per measurement property per classification system

Classification system	Author (year)	Language (country)	Reliability			Measurement error			Criterion validity		
			N	Meth Qual.	Result rating	N	Meth Qual.	Result rating	N	Meth Qual.	Result rating
Payne-Martin Classification System for Skin Tears	Payne & Martin (1990)	English (USA)	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
	Payne & Martin (1993)	English (USA)	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
Dunkin Classification of Pretibial Injuries	Dunkin et al. (2003)	English (UK)	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
Lo Classification of Pretibial Lacerations	Lo et al. (2012)	English (UK)	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
STAR Skin Tear Classification System	Carville et al. (2007)	English (Australia)	36	D	Cohen's Kappa (interrater): 0.93 (+) [a]	N/I	N/I	N/I	N/I	N/I	N/I
	Strazzieri-Pulido et al. (2015b)	Portuguese (Brazil)	107	D	Weighted Kappa (interrater): 0.29 (-) [a]	N/I	N/I	N/I	107	I	Diagnostic accuracy: 43.3% (-) [a]

Classification system	Author (year)	Language (country)	Reliability			Measurement error			Criterion validity		
			N	Meth Qual.	Result rating	N	Meth Qual.	Result rating	N	Meth Qual.	Result rating
			20	D	Weighted Kappa (interrater): 0.60 (-) [b]	N/I	N/I	N/I	20	I	Diagnostic accuracy: 53.3% (-) [b]
	Chang et al. (2016)	English (Singapore)	3	I	Interrater reliability: 80% (?) [a]	N/I	N/I	N/I	N/I	N/I	N/I
	Summary result (overall rating)		**166**		**0.29 to 0.93 (-)**				**127**		**43.3% to 53.3% (-)**
	Quality of evidence				**Very low**						**Very low**
ISTAP Skin Tear Classification System	LeBlanc et al. (2013c)	English (Brazil, Canada, China, UK, USA)	12	D	Fleiss Kappa (interrater): 0.65 (-) [a] Cohen's Kappa (intrarater): 0.88 (+) [a]	N/I	N/I	N/I	N/I	N/I	N/I
			327	D	Fleiss Kappa (interrater): 0.55 (-) [a]	N/I	N/I	N/I	N/I	N/I	N/I
	Skiveren et al. (2015)	Danish (Denmark)	270	D	Fleiss Kappa (interrater): 0.46 (-) [a]	N/I	N/I	N/I	N/I	N/I	N/I

Classification system	Author (year)	Language (country)	Reliability			Measurement error			Criterion validity		
			N	Meth Qual.	Result rating	N	Meth Qual.	Result rating	N	Meth Qual.	Result rating
	Chaplain et al. (2018)	French (Canada)	92	D	Fleiss Kappa (interrater): 0.69 (-) [a]	N/I	N/I	N/I	N/I	N/I	N/I
	da Silva et al. (2018)	Portuguese (Brazil)	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
	Källman et al. (2019)	Swedish (Sweden)	84	D	Fleiss Kappa (interrater): 0.50 (-) [a]	84	D	Overall agreement: 0.68 (-) [a]	84	I	Diagnostic accuracy: 76.8% (+) [a]
	Bassola et al. (2019)	Italian (Italy)	209	V	Fleiss Kappa (interrater): 0.47 (-) [a] *(95% CI 0.41-0.60)*	N/I	N/I	N/I	209	I	Diagnostic accuracy: 72.5% (+) [a]
	Van Tiggelen et al. (2020)	15 languages, 44 countries	1601 (test)	V	Fleiss Kappa (interrater): 0.57 (-) [a] *(95% CI 0.57-0.57)*	1601 (test)	A	Overall agreement (interrater): 0.79 (+) [a] *(95% CI 0.79-0.80)*	1601	V	Sensitivity: 88% (+) [a] Specificity: 92% (+) [a] Sensitivity: 77% (+) [a] Specificity: 86% (+) [a] Sensitivity: 74% (+) [a] Specificity: 91% (+) [a]

Classification system	Author (year)	Language (country)	Reliability			Measurement error			Criterion validity		
			N	Meth Qual.	Result rating	N	Meth Qual.	Result rating	N	Meth Qual.	Result rating
			952 (retest)	V	Cohen's Kappa (intrarater): 0.74 (+) [a] *(95% CI 0.73-0.75)*	952 (retest)	A	Overall agreement (intrarater): 0.83 (+) [a] *(95% CI 0.82-0.84)*	N/I	N/I	N/I
	Summary result (overall rating)		**Inter: 2595** **Intra: 964**		**Interrater: 0.46 to 0.69 (-)** **Intrarater: 0.74 to 0.88 (+)**	**2637**		**0.68 to 0.83 (+)**	**1894**		**72.5% to 92.0% (+)**
	Quality of evidence				**Moderate**			**Moderate**			**Moderate**

N/I: not investigated, STAR: Skin Tear Audit Research, ISTAP: International Skin Tear Advisory Panel, V: very good, A: adequate, D: doubtful, I: inadequate, +: sufficient, -: insufficient, ?: indeterminate, ±: inconsistent, [a]: indirect skin observation (based on photographs), [b]: direct skin observation

DISCUSSION

This is the first systematic review summarising and evaluating the evidence on the measurement properties of skin tear classifications. The use of a universally accepted, valid and reliable skin tear classification system is an essential prerequisite for consistent assessment and reporting, accurate communication, and for conducting prevalence and incidence studies (Carville et al., 2007; LeBlanc & Baranoski, 2017).

This systematic review followed the COSMIN approach, consisting of a sequential ten-step procedure. Although this procedure was originally developed for systematic reviews of patient-reported outcome measures (PROMs), it can also be used for other types of health-related measurement instruments, such as classifications, if some of the steps are adapted (Mokkink et al., 2018a; Prinsen et al., 2018). Since evidence on structural validity, internal consistency, cross-cultural validity, hypotheses testing for construct validity, and responsiveness was not available, we only reviewed content validity, criterion validity, reliability, and measurement error.

In total, fourteen studies describing five classification systems were included. There were no studies investigating the measurement properties of the Payne-Martin, Dunkin, and Lo classifications. Content validity was established for the STAR and ISTAP classifications through a consensus panel of wound care experts. Both the reliability (κ = 0.29 to 0.93) and criterion validity (43.3% to 53.3%) of the STAR classification were found to be insufficient when rated against the pre-defined criteria for good measurement properties (Prinsen et al., 2018). Using the modified GRADE approach (Mokkink et al., 2018a), the quality of evidence was rated very low due to risk of bias, inconsistency, and indirectness. There is moderate quality of evidence that the intrarater reliability (κ = 0.74 to 0.88), measurement error (p_o = 0.68 to 0.83), and criterion validity (72.5% to 92.0%) of the ISTAP classification are sufficient and the interrater reliability (κ = 0.46 to 0.69) insufficient. The quality of evidence was downgraded from high to moderate for all measurement properties of the ISTAP classification because of indirectness.

Indirectness refers to the fact that skin tear assessment was based on photographs in almost all studies, which may limit the generalisability of the findings to assessment in clinical practice. Results based on direct and indirect skin observation are hardly comparable because the use of photographs limits clinical information which is helpful for skin tear classification (Carville et al., 2007; Strazzieri-Pulido et al., 2015b). Assessment in clinical practice allows a more comprehensive evaluation involving three-dimensional measurement, palpation, and accurate flap visualisation (Carville et al., 2007; Skiveren et al., 2015). In the study of Strazzieri-Pulido et al. (2015b), higher reliability and diagnostic accuracy were obtained when skin tear assessment was based on direct

observation in clinical practice than when photographs were used. Variability in study results may in part be attributed to the different assessment methods used, but can also be explained by some other factors (Kottner et al., 2011). First, in some studies the raters were allowed to see the STAR or ISTAP classification when categorising the skin tears (Carville et al., 2007; Strazzieri-Pulido et al., 2015b; Chang et al., 2016; Bassola et al., 2019; Van Tiggelen et al., 2020), while in others they were not (LeBlanc et al., 2013c; Skiveren et al., 2015; Chaplain et al., 2018; Källman et al., 2019). Second, in five studies the raters received an education session prior to the test (Carville et al., 2007; Skiveren et al., 2015; Chang et al., 2016; Chaplain et al., 2018; Källman et al., 2019), in four studies they did not (LeBlanc et al., 2013c; Strazzieri-Pulido et al., 2015b; Bassola et al., 2019; Van Tiggelen et al., 2020). Third, there were large differences in sample sizes across the studies, ranging from 3 to 1601 raters, and different statistical approaches were applied. Finally, differences in sample characteristics of the raters, such as educational level and expertise in relation to the assessment of skin tears, may have contributed to diverging results among studies.

Findings of this systematic review indicate that three measurement properties of the ISTAP classification are supported by moderate quality of evidence. Its criterion validity and measurement error were rated sufficient, its interrater reliability was found to be ‘moderate’ to ‘substantial’ and its intrarater reliability ‘substantial’ to ‘almost perfect’ according to the interpretation by Landis & Koch (1977). However, it is unclear whether this is high enough for clinical decision-making, as one may expect an almost perfect agreement when assessing skin tears (Kottner et al., 2011). Further research based on direct skin observation is needed. Since the STAR classification has been psychometrically tested in only three studies of doubtful/ inadequate methodological quality and with small sample sizes, further research is required. It is also recommended to test the measurement properties of the Payne-Martin classification through direct skin observation, using adequate samples and appropriate statistical approaches as described by Prinsen et al. (2018) and Kottner et al. (2011). When conducting reliability and validity studies, the measurement setting and statistical approaches should be sufficiently described to allow interpretation and synthesis of study results (Kottner et al., 2011). Since information on interpretability and feasibility may also be helpful in selecting the most appropriate tool (Prinsen et al., 2018), further research on these aspects is recommended. As the Dunkin and Lo classifications have been developed for the purposes of surgical management, these tools seem less suitable for use by healthcare professionals in clinical practice.

Limitations

A quantitative meta-analysis could not be performed because of the methodological variation between studies, different statistical approaches used, and the lack of measures of precision, such as confidence intervals, in almost all studies.

CONCLUSION

Five skin tear classification systems exist, of which only two have been psychometrically tested. Evidence of very low to moderate quality exists on their measurement properties. Currently, the validity and reliability of the ISTAP classification are supported by moderate quality evidence. Downgrading of the evidence is associated with the use of photographs (indirect skin observation) in psychometric testing. More well-designed, rigorously conducted and adequately reported studies, using representative samples, appropriate statistical methods and direct skin observations, are needed to make confident conclusions.

Conflicts of interest

None to declare.

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Chapter 5

Development and psychometric property testing of a skin tear knowledge assessment instrument (OASES) in 37 countries

Chapter based on:

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ABSTRACT

Background: Prevention and treatment of skin tears are a challenge for healthcare professionals. The provision of adequate care is based on profound and up-to-date knowledge. A valid and reliable instrument is needed to assess the knowledge of healthcare professionals about skin tears to identify educational gaps and priorities.

Objectives: To develop and psychometrically evaluate a skin tear knowledge assessment instrument (OASES).

Design: Prospective psychometric instrument validation study.

Methods: The skin tear knowledge assessment instrument (OASES) was developed based on a literature review and expert input (n = 19). Face and content validity were assessed in a two-round Delphi procedure by 10 international experts affiliated with the International Skin Tear Advisory Panel (ISTAP). The instrument was psychometrically tested in a convenience sample of 387 nurses in 37 countries (April – May 2020). Validity of the multiple-choice test items (item difficulty, discriminating index, quality of the response alternatives), construct validity, and test-retest reliability (stability) were analysed and evaluated in light of international reference standards.

Results: A 20-item instrument, covering six knowledge domains most relevant to skin tears, was designed. Content validity was established (CVI = 0.90 – 1.00). Item difficulty varied between 0.24 and 0.94 and the quality of the response alternatives between 0.01 – 0.52. The discriminating index was acceptable (0.19 – 0.77). Participants with a theoretically expected higher knowledge level had a significantly higher total score than participants with theoretically expected lower knowledge ($p<0.001$). The 1-week test-retest intraclass correlation coefficient (ICC) was 0.83 (95% CI = 0.78 – 0.86) for the full instrument and varied between 0.72 (95% CI = 0.64 – 0.79) and 0.85 (95% CI = 0.81 – 0.89) for the domains. Cohen's Kappa coefficients of the individual items ranged between 0.21 and 0.74.

Conclusion: OASES is supported by acceptable psychometric properties and can be applied in nursing education, research, and practice to assess knowledge of healthcare professionals about skin tears.

Keywords: Instrument development, Knowledge, Nursing, Psychometrics, Reliability, Skin tear, Validity

SUMMARY STATEMENT

What's already known about this topic?

- Skin tears are under-recognised and frequently misdiagnosed, resulting in suboptimal prevention and delayed or inappropriate treatment.
- Adequate knowledge about skin tears is associated with assessment and documentation quality, appropriate management, and a reduction in skin tear incidence.
- None of the existing instruments to assess skin tear knowledge is psychometrically tested, nor up-to-date.

What does this study add?

- An instrument (OASES) supported by acceptable psychometric properties was developed to measure knowledge of healthcare professionals about skin tears.
- OASES can be used worldwide to identify education, practice, and research needs and priorities related to skin tears in clinical practice.

INTRODUCTION

Skin tears are prevalent acute wounds which constitute an important health issue, both in terms of human suffering and the exorbitant costs to the society (LeBlanc et al., 2018a). Based on previous research, skin tears do not always follow an expected healing trajectory and they may evolve into complex or difficult-to-heal wounds without appropriate care (LeBlanc et al., 2013b; Brown, 2019; Idensohn et al., 2019a). Patients suffering from slow-to-heal wounds are prone to experiencing frequent infection, prolonged hospitalisation, diminished quality of life, protracted pain, emotional distress, and high healthcare costs (LeBlanc et al., 2013a; Strazzieri-Pulido et al., 2015a; Serra et al., 2018).

The International Skin Tear Advisory Panel (ISTAP) advocates a universal taxonomy and best practices, and they define skin tears as *"traumatic wounds caused by mechanical forces, including removal of adhesives. Severity may vary by depth (not extending through the subcutaneous layer)"* (LeBlanc et al., 2018a). Although skin tears can occur on any anatomical location, they are particularly common on the extremities such as the arms and legs (LeBlanc et al., 2018a; Serra et al., 2018). According to recent epidemiological studies, skin tears are reported across all healthcare settings and mostly found in neonates, the elderly population, and people who are critically and chronically ill (LeBlanc & Baranoski, 2017). Skin tear prevalence has been shown to vary between 3.3 – 19.8% in acute care (McErlean et al., 2004; McLane et al., 2004; Santamaria et al., 2009; Hsu & Chang, 2010; Lopez et al., 2011; Amaral et al., 2012; Chang et al., 2016; Bermark et al., 2018), 14.3% in palliative care (Maida et al., 2012), 5.5 – 19.5% in the community (Carville & Lewin, 1998; Carville & Smith, 2004), and 3.0 – 26.0% in long-term care (LeBlanc et al., 2013b; Strazzieri-Pulido et al., 2015a; Koyano et al., 2016; Ayello, 2017; LeBlanc, 2017; Skiveren et al., 2017; Woo et al., 2017; LeBlanc et al., 2018a; LeBlanc & Baranoski, 2018; Woo & LeBlanc, 2018; Van Tiggelen et al., 2019a).

Despite their high prevalence and considerable impact, skin tears are often under-recognised and misdiagnosed, resulting in suboptimal prevention and delayed or inappropriate management (LeBlanc et al., 2014; LeBlanc et al., 2018a). A crucial requirement to be able to lower the occurrence of skin tears or reduce their severity is the integration of best practice recommendations for the prevention and management of skin tears into practice. Three new best practice guidelines have recently been developed to guide healthcare professionals in improving the assessment, classification, treatment, and prevention of skin tears (LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020). Best practice encompasses timely and accurate identification and classification, comprehensive documentation, and the application of an evidence-based protocol to guide treatment (LeBlanc et al., 2018a; LeBlanc et al., 2018b). Early treatment may improve wound

healing and reduce complications (Meuleneire, 2002; Brillhart, 2005). Experts agree that prevention is the best strategy for managing these largely avoidable wounds (LeBlanc & Baranoski, 2017). The focus should be on early recognition of patients at risk and controlling modifiable risk factors (LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020). Despite the availability of evidence-based guidelines and the need for evidence-based care, a gap between evidence and practice regarding skin tear prevention and management exists (White, 2001; Edwards et al., 2017).

A reason contributing to this evidence-practice gap is the lack of knowledge and a negative attitude towards skin tear prevention and management (Edwards et al., 2017). To raise awareness and improve the quality of care, healthcare professionals should possess in-depth and up-to-date knowledge (LeBlanc et al., 2018a). Lack of knowledge might lead to misconceptions about skin tears (Campbell et al., 2018a). Hsu et al. (2009) identified knowledge as an important predictor of skin tear management behaviour. Some studies have concluded that higher skin tear knowledge was significantly associated with better assessment and documentation, an increase in implementation of evidence-based prevention and management strategies, and a decrease in skin tear incidence and severity (McTigue et al., 2009; Edwards et al., 2017; Pagan & Harvey, 2019). To be able to assess skin tear knowledge adequately and to determine educational needs and priorities, a valid and reliable instrument is required.

Background

A literature review was performed to identify existing instruments assessing skin tear knowledge. The electronic databases MEDLINE (PubMed interface), Embase, CINAHL (EBSCO interface), CENTRAL, and Google Scholar were searched until May 2020. The keywords ‘skin tear’, ‘knowledge’, ‘instrument’, ‘tool’, and ‘questionnaire’ were combined. The search revealed four instruments. White (2001) developed a questionnaire to gain insight into the opinions, current practice, and knowledge base of nurses in relation to skin tears. The knowledge test was designed following a literature review and contained seven open-ended questions related to the Payne-Martin definition of a skin tear, ageing skin, risk factors, the Payne-Martin classification system, and prevention strategies (Payne & Martin, 1993; White, 2001). Baranoski & Ayello (2004) developed a skin tear knowledge assessment instrument consisting of seven multiple-choice items related to aetiology, assessment, risk factors, Payne-Martin classification, and treatment. As part of an educational intervention study, a skin tear knowledge test was designed by McTigue et al. (2009). The instrument included 12 multiple-choice items covering the domains ‘identification and assessment’, ‘Payne-Martin classification’, and ‘treatment of skin tears’. Following the development of the ISTAP tool kit to aid in the assessment, prevention, and treatment of skin tears (LeBlanc et al., 2013a), LeBlanc & Baranoski (2014) designed a knowledge test consisting of 35 multiple-choice

items related to skin tear aetiology, assessment, risk factors, ISTAP classification, prevention, and treatment.

None of the above-mentioned instruments have been psychometrically tested and no information about their developmental processes was provided. Additionally, the instruments are no longer up-to-date as several new best practice recommendations, with updated definitions, assessment, classification, prevention, and treatment strategies, have been published recently (LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020). Therefore, a new skin tear knowledge assessment instrument integrating the recent evidence-based guidelines had to be developed.

Aims

The aim of this study was to develop and psychometrically test an instrument to assess the knowledge of nurses on skin tear prevention and treatment.

METHODS

A prospective psychometric instrument validation study was conducted in three phases as described by Mishel (1998). Phase 1 entailed the development of instrument structure and content. Phase 2 included content validation through expert consultation in a two-round Delphi procedure and pretesting of the instrument. Phase 3 required the psychometric evaluation of the instrument in an international sample of nurses. Validity of the multiple-choice test items (item difficulty, discriminating index, quality of the response alternatives), construct validity, and test-retest reliability (stability) were assessed. Figure 1 provides an overview of the developmental process.

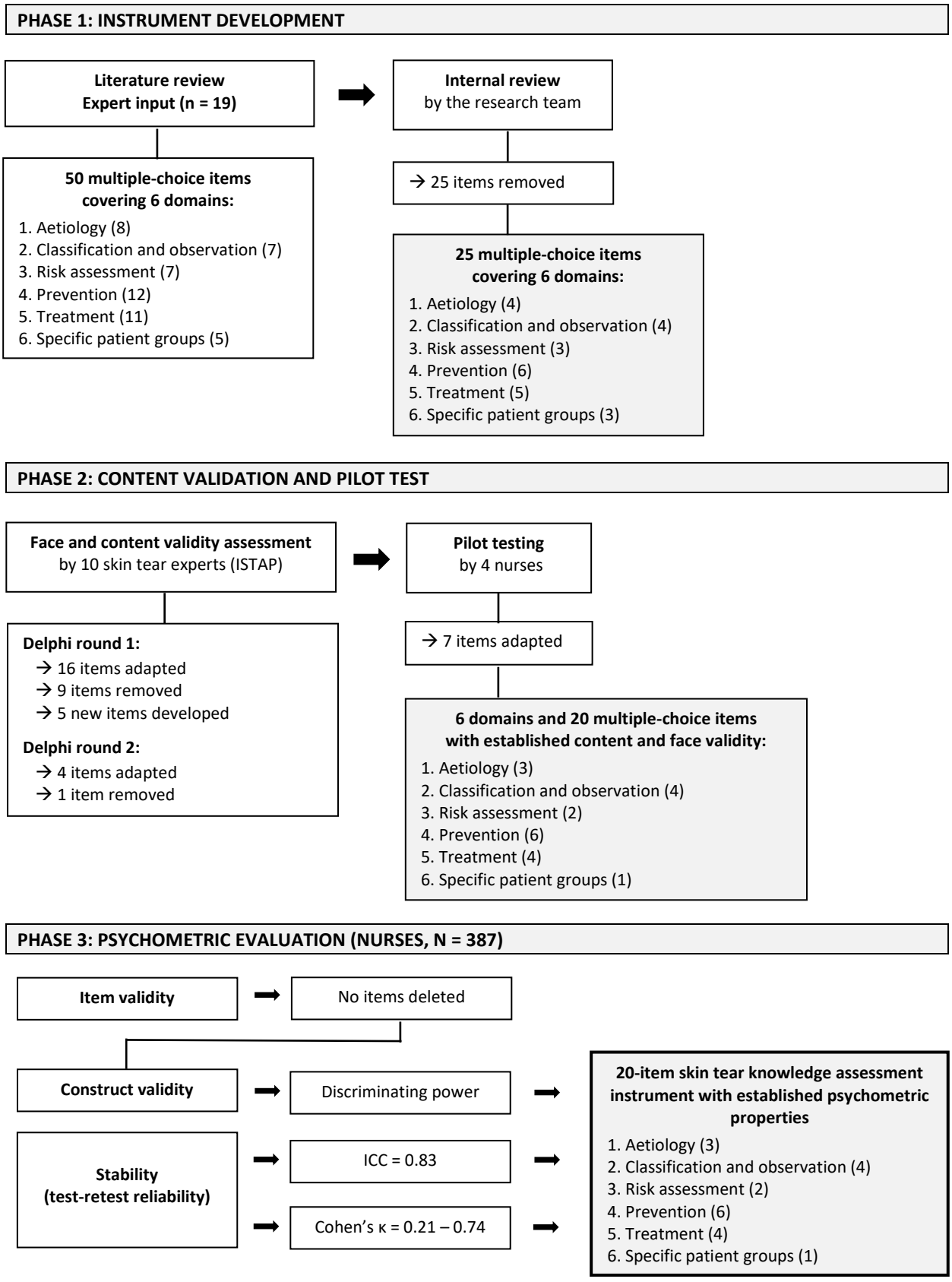

Figure 1. Process of instrument development

Phase 1: Instrument development

Based on expert input and a literature review using the ISTAP Best Practice Recommendations for the Prevention and Management of Skin Tears in Aged Skin (LeBlanc et al., 2018a), the Best Practice Recommendations for the Prevention and Management of Skin Tears (LeBlanc et al., 2018b) and the Best Practice Recommendations for Holistic Strategies to Promote and Maintain Skin Integrity (Beeckman et al., 2020), six knowledge domains covering the most relevant aspects of skin tear management were identified to construct the instrument and 50 multiple-choice items were designed. The expert panel was composed of 19 international key opinion leaders from 13 countries, of which 7 were executive board members of the International Skin Tear Advisory Panel (ISTAP). Two of the three best practice guidelines, developed by ISTAP and Wounds Canada in 2018, provide evidence-based and updated information on the aetiology, risk factors, identification, assessment, classification, treatment, and prevention of skin tears (LeBlanc et al., 2018a; LeBlanc et al., 2018b). The third best practice document, developed by ISTAP in 2020, focuses on the shared risk factors and preventative strategies for common skin conditions among individuals with increased skin vulnerability, including skin tears (Beeckman et al., 2020). The number of items per knowledge domain was based on the relevance of the domain. It is recommended to initially generate a large pool of items, which can then be refined and reduced through various review processes (Netemeyer et al., 2003; DeVon et al., 2007; Polit & Beck, 2008). After internal review by the research team, 25 items were retained for content validation (phase 2). Issues such as item redundancy, relevance, readability, and respondent cooperation were taken into account (Netemeyer et al., 2003; Polit & Beck, 2008).

The items were composed in the English language, according to the Multiple-Choice Item-Writing Guidelines of Haladyna et al. (2002). The central idea was included in the stem and both the stem and the response options were worded positively. The amount of reading was minimised in each item. Response options were logically arranged, of about equal length, and homogeneous in grammatical structure and content. The options ‘All-of-the-above’ and ‘None-of-the-above’ were avoided. Five response options were formulated for each item: one correct answer, three alternative response options, and one ‘I do not know the answer’ option to avoid the respondents guessing.

The instrument was designed to evaluate theoretical knowledge as well as more complex cognitive skills, for example, by the inclusion of pictures and cases. Cognitive skills range from lower-order thinking skills that require less cognitive processing to higher-order thinking skills that require deeper learning and a higher degree of cognitive processing (Adams, 2015). In 1956, Bloom created a classification of cognitive skills which was later revised by Anderson & Krathwohl (2001). The revised version of Bloom's taxonomy differentiates six hierarchical levels: remembering (level

1), understanding (level 2), applying (level 3), analysing (level 4), evaluating (level 5), and creating (level 6) (Anderson & Krathwohl, 2001). The preliminary skin tear knowledge assessment instrument included multiple-choice items of all levels except level 6.

Phase 2: Content validation and pilot test

The domains and items were reviewed by experts in a two-round Delphi procedure to determine face and content validity. The expert panel consisted of 10 executive board members of the International Skin Tear Advisory Panel (ISTAP) with extensive expertise in skin tear care and research. Using an online survey (LimeSurvey, version 2.05+), the experts were invited to evaluate whether the domains and items were relevant (not relevant at all – not relevant – relevant – very relevant), the items were clear (not clear – clear) and the items and response alternatives were correct (not correct – correct). They were also invited to provide additional feedback and suggestions. The Content Validity Index (CVI) was calculated to measure the experts' agreement on the relevance of the items and a cut-off value of ≥ 0.80 was determined based on the recommendations of Lynn (1986).

After the first Delphi round, the following six knowledge domains were found to be relevant and valid in measuring the construct of the instrument: (a) aetiology; (b) classification and observation; (c) risk assessment; (d) prevention; (e) treatment; and (f) specific patient groups. Based on the experts' feedback, 16 items were adapted, 9 items removed, and 5 new items developed. Of the deleted items, five were integrated into another item to reduce item redundancy and four had a CVI of 0.70 which was below the threshold for relevance. All other items had a CVI between 0.90 and 1.00. Besides scoring the items on relevance, clarity, and correctness, several experts suggested some new topics (e.g. skin moisturising, increased risk of neonates), items, and response options to be included in the instrument. Adaptations and development of new items were based on these suggestions and ratings. During the second Delphi round, the experts were asked for additional comments and/ or approval on the revised instrument. Four items were adapted, and one item removed. The changes mainly concerned the rewording of items and response options.

The knowledge assessment instrument was pilot tested by a sample of four nurses attending a Master of Science in Nursing and Midwifery educational program. They were asked to assess the clarity (not clear – clear) and the readability (hard to read – readable – easy to read) of the items and response alternatives. The participants were invited to give additional feedback and suggestions. Their feedback led to the adaptation of seven items. This resulted in an instrument consisting of 20 multiple-choice items covering six knowledge domains most relevant to skin tears (Appendix 5). Each item can be scored as correct (1 point) or incorrect (0 points), resulting in a maximum possible score of 20.

Phase 3: Psychometric evaluation

Sample

An online survey was set up in a convenience sample of nurses. A total of 200 participants were required to meet the widely cited 'rule of thumb' suggesting that 10 respondents per item are needed in psychometric evaluations (Polit & Beck, 2008). Participants were recruited in 37 countries via the network of the research team and wound care organisations, being the Brazilian Association of Enterostomal Therapy (SOBEST), European Pressure Ulcer Advisory Panel (EPUAP), European Wound Management Association (EWMA), International Skin Tear Advisory Panel (ISTAP), Nurses Specialized in Wound, Ostomy and Continence Canada (NSWOCC), Pan Pacific Pressure Injury Alliance (PPPIA, representing Hong Kong Enterostomal Therapists Association (HKETA), New Zealand Wound Care Society (NZWCS), Wounds Australia and Wound Healing Society Singapore (WHSS)), Society of Private Nurse Practitioners of South Africa (SPNP), Tissue Viability Society (TVS), World Council of Enterostomal Therapists (WCET), Wound Healing Association of Southern Africa (WHASA), Wound, Ostomy, and Incontinence Nurses Society of Turkey (YOİHD), and Wounds UK. The call to participate, including the link to the survey, was sent by e-mail to potential participants within the network of the research team. The wound care organisations disseminated the call by publishing an announcement on their websites or by e-mailing members.

Procedure

Data were collected over April and May 2020 using an online survey (LimeSurvey, version 2.05+). The survey included information on the procedure and confidentiality, demographic questions, and the English knowledge assessment instrument (OASES). Participants were asked to complete the instrument individually and without consulting any resources (e.g. books, internet). One week after completion of the survey, a second survey was sent to the participants to evaluate the stability of the instrument. This survey (retest) included the identical knowledge assessment instrument, but the order of the items was randomised to reduce potential bias. Participants were not informed in advance about this test-retest procedure and no feedback was given between the test and retest.

Data analysis

Statistical analyses were performed using the software package IBM® SPSS® (Version 24, IBM Corporation, New York, NY). The answers on the knowledge assessment instrument were recoded into dichotomous variables (not correct – correct). The 'I do not know the answer' option was considered as 'not correct'. The total score on the instrument was calculated as the sum of correct answers (maximum score = 20). The level of significance was set at 5%.

Validity of the multiple-choice test items

Item difficulty. The difficulty level of an item (p-value) refers to the proportion of respondents who answered the item correctly (McAlpine, 2002; Haladyna, 2004). An item difficulty of p = 0.70 is optimal for items with five answer options (Lord, 1952; Sabbe et al., 2007). Items with a p-value higher than 0.90 were considered too easy and items with a p-value lower than 0.10 were considered too difficult (Manderlier et al., 2017).

Discriminating index. To calculate the discriminating index (D-value) of the items, the respondents were divided into two extreme groups: the 27% best-performing respondents and the 27% worst-performing respondents (high total score vs. low total score) (Haladyna, 2004; Kline, 2005). For each item, the percentage of correct answers in the 27% worst-performing group was subtracted from the percentage of correct answers in the 27% best-performing group. The D-value can vary from +1 (where there is a perfect correlation between those who answered the item correctly and those who scored high marks on the test overall) to −1 (where there is a perfect inverse correlation between those answering correctly and those scoring high on the test). D-values between 0.20 and 0.40 are minimally recommended (McAlpine, 2002; Sabbe et al., 2007).

Quality of the response alternatives. The quality of a response alternative (a-value) was assessed by the proportion of respondents choosing the alternative. The ideal a-value for an item with five answer options is 0.10. The a-values had to be lower than the p-value for each item. Ideally, the a-values had to be about equal, indicating that all response alternatives function as equal distractors (Sabbe et al., 2007).

Construct validity

The known-groups technique was used to evaluate the ability of the instrument to differentiate between groups with theoretically expected different levels of knowledge regarding skin tears (DeVon et al., 2007; Polit & Beck, 2008). Ten groups of nurses hypothesised to differ in level of knowledge because of their role, education level, specialisation, expertise, and obtained skin tear training were predefined. Table 1 summarises the groups that were supposed to have a theoretically expected higher knowledge level on skin tears vs. groups with theoretically expected less knowledge. The independent sample *t*-test was used to compare the mean total scores of the predefined groups (Polit & Beck, 2008).

Test-retest reliability

The stability of the instrument was examined using the test-retest procedure. Two-way random, single-measure intraclass correlation coefficients (ICC) were calculated for the overall instrument and for each domain. Reliability coefficients ≥ 0.70 were considered acceptable and coefficients ≥ 0.80 were preferred (Polit & Beck, 2008). Cohen's Kappa was calculated for each item. The criteria

suggested by Landis & Koch were used to interpret the Kappa coefficients (< 0.00 = poor; 0.00–0.20 = slight; 0.21–0.40 = fair; 0.41–0.60 = moderate; 0.61–0.80 = substantial; 0.81–1.00 = almost perfect) (Landis & Koch, 1977).

Ethical considerations

This study was approved by the Ethics Committee of Ghent University Hospital (B670201941827). Participants received written information about the aim and procedure before the start of the study. Anonymity and confidentiality were ensured. Informed consent was obtained from all participants.

Table 1. Predefined groups based on the theoretically expected level of knowledge – known-groups technique

Groups	**n**	**Mean score (SD)** Max = 20	***t*** [a]	**df** [b]	**P value**
Nurse specialists in wound care [c] (A)	212	15.1 (2.8)	6.29	141.87	< 0.001
vs. bedside nurses [d] (B)	90	12.5 (3.4)			
Bachelor degree (A)	153	14.5 (2.9)	4.20	94.10	< 0.001
vs. undergraduate degree (B)	61	12.3 (3.6)			
Wound care nurses (A)	218	14.9 (2.9)	4.99	283	< 0.001
vs. general nurses (B)	67	12.8 (3.3)			
Experts in skin tears [e] (A)	112	15.4 (2.6)	6.88	128	< 0.001
vs. novice in skin tears [e] (B)	18	10.8 (2.8)			
Participants with ST training [f] (A)	133	14.8 (2.8)	3.75	312.09	< 0.001
vs. participants without ST training [g] (B)	254	13.6 (3.4)			

SD: standard deviation, ST: skin tear, (A): group with theoretically expected higher level of knowledge, (B): group with theoretically expected lower level of knowledge, [a]: independent sample *t*-test, [b]: degrees of freedom, [c]: qualified nurses specialised in wound care, [d]: qualified nurses responsible for the daily care of patients, [e]: self-estimated expertise in relation to the assessment and management of skin tears (based on the levels of proficiency defined by Benner (1982)), [f]: participants who completed a specialised training in skin tears, [g]: participants who never completed a specialised training in skin tears

RESULTS

Participant characteristics

A total of 387 participants (90.2% female, mean (SD) age: 45.9 (11.9) years) completed the first survey (test), of whom 230 (59.4%) also completed the second survey (retest). More than half of the participants were nurses specialised in wound care (54.8%) and 52.2% had more than 20 years of professional experience. Almost two-thirds of the participants (65.6%) had not completed any previous training focusing on skin tears, but more than 80% expressed the need to do so. An overview of the sample demographics is provided in Table 2.

Table 2. Demographics of the participants

	Test (n = 387) n (%) / Mean (SD)	**Retest (n = 230)** n (%) / Mean (SD)
Gender		
Female	349 (90.2)	204 (88.7)
Age (years) [Mean (SD)]	45.9 (11.9)	46.3 (11.4)
Age category		
< 30 years	36 (9.3)	20 (8.7)
30 – 39 years	93 (24.0)	50 (21.7)
40 – 49 years	96 (24.8)	58 (25.2)
≥ 50 years	162 (41.9)	102 (44.3)
Role		
Nurse	90 (23.3)	43 (18.7)
Head nurse	16 (4.1)	9 (3.9)
Nurse specialist in wound care	212 (54.8)	138 (60.0)
Nurse specialist (other field)	44 (11.4)	23 (10.0)
Lecturer	14 (3.6)	10 (4.3)
Researcher	2 (0.5)	2 (0.9)
Other	9 (2.3)	5 (2.2)
Education		
Undergraduate	61 (15.8)	33 (14.3)
Bachelor degree	153 (39.5)	91 (39.6)
Master degree	134 (34.6)	82 (35.7)
Doctoral degree	39 (10.1)	24 (10.4)
Specialisation		
General nursing	67 (17.3)	35 (15.2)
Geriatrics	10 (2.6)	9 (3.9)
Pediatrics	6 (1.6)	4 (1.7)

Emergency and intensive care	30 (7.8)	13 (5.7)
Operating room	16 (4.1)	12 (5.2)
Mental health	2 (0.5)	0 (0.0)
Community nursing	28 (7.2)	9 (3.9)
Rehabilitation	3 (0.8)	1 (0.4)
Wound care	218 (56.3)	142 (61.7)
Other	7 (1.8)	5 (2.2)
Work experience in healthcare		
< 5 years	33 (8.5)	14 (6.1)
5 – 10 years	58 (15.0)	37 (16.1)
11 – 20 years	94 (24.3)	55 (23.9)
> 20 years	202 (52.2)	124 (53.9)
Expertise in skin tears [a]		
Novice	18 (4.7)	5 (2.2)
Advanced beginner	38 (9.8)	26 (11.3)
Competent	94 (24.3)	57 (24.8)
Proficient	125 (32.3)	74 (32.2)
Expert	112 (28.9)	68 (29.6)
Wound care course [b]		
Completed	296 (76.5)	182 (79.1)
Skin tear training [c]		
Completed	133 (34.4)	82 (35.7)
Need skin tear training [d]		
Yes	313 (80.9)	184 (80.0)
Country of work		
Australia	45 (11.6)	30 (13.0)
Belgium	20 (5.2)	13 (5.7)
Brazil	24 (6.2)	8 (3.5)
Canada	26 (6.7)	23 (10.0)
Chile	7 (1.8)	2 (0.9)
China	16 (4.1)	7 (3.0)
Colombia	1 (0.3)	1 (0.4)
Croatia	1 (0.3)	1 (0.4)
Czech Republic	24 (6.2)	14 (6.1)
Denmark	2 (0.5)	0 (0.0)
France	1 (0.3)	1 (0.4)
Germany	1 (0.3)	1 (0.4)
India	2 (0.5)	2 (0.9)
Indonesia	4 (1.0)	3 (1.3)
Iran	1 (0.3)	0 (0.0)
Ireland	3 (0.8)	2 (0.9)

Italy	8 (2.1)	4 (1.7)
Japan	2 (0.5)	2 (0.9)
Jordan	1 (0.3)	0 (0.0)
Kenya	3 (0.8)	3 (1.3)
Mexico	1 (0.3)	1 (0.4)
Namibia	1 (0.3)	0 (0.0)
the Netherlands	1 (0.3)	0 (0.0)
New Zealand	1 (0.3)	1 (0.4)
Peru	1 (0.3)	0 (0.0)
Philippines	2 (0.5)	2 (0.9)
Portugal	19 (4.9)	12 (5.2)
Saudi Arabia	4 (1.0)	2 (0.9)
Singapore	3 (0.8)	2 (0.9)
South Africa	42 (10.9)	28 (12.2)
Sweden	1 (0.3)	0 (0.0)
Switzerland	2 (0.5)	1 (0.4)
Thailand	1 (0.3)	0 (0.0)
Turkey	13 (3.4)	7 (3.0)
United Arab Emirates	1 (0.3)	1 (0.4)
United Kingdom	62 (16.0)	33 (14.3)
United States of America	40 (10.3)	23 (10.0)

SD: standard deviation, [a]: self-estimated expertise in relation to the assessment and management of skin tears (based on the levels of proficiency defined by Benner (1982)), [b]: completion of a post-qualification wound care course, [c]: completion of a specialised training in skin tears, [d]: self-indicated need for a specialised training in skin tears

Validity of the multiple-choice test items

Item difficulty

The item difficulty (p-value) of 17 items ranged between 0.24 and 0.89, with a median value of 0.77. Three items were found to be too easy (0.92 – 0.94). None of the items had a difficulty index lower than 0.10 (Table 3).

Discriminating index

The discriminating index (D-value) of 19 items ranged between 0.23 and 0.77, with a median value of 0.42. One item had a D-value lower than 0.20. None of the items had a negative discriminating index (Table 3).

Quality of the response alternatives

The quality of the response alternatives (a-value) ranged between 0.01 and 0.52, with a median value of 0.05. For two items, one of the a-values was higher than the p-value (Table 3).

Construct validity

Known-groups technique. The mean total scores of the groups with a theoretically expected higher knowledge level were statistically significantly higher than those of the groups with theoretically expected less knowledge (Table 1). For example, the mean total score of the nurse specialists in wound care (15.1/20, SD = 2.8) was significantly higher than the mean total score of the bedside nurses (12.5/20, SD = 3.4; $t = 6.29$, $df = 141.87$, $p < 0.001$).

Test-retest reliability

A total of 230 nurses completed the instrument twice with a 1-week interval between administrations. During the first completion (test), the mean total score was 14.5/20 (SD = 3.1). A mean total score of 14.8/20 (SD = 3.2) was obtained during the second completion (retest). The overall intraclass correlation coefficient (ICC) was 0.83 (95% CI = 0.78 – 0.86). The ICCs for the domains varied between 0.72 (95% CI = 0.64 – 0.79) and 0.85 (95% CI = 0.81 – 0.89) (Table 3). The Kappa coefficients of the individual items ranged between 0.21 and 0.74. Cohen's κ values between 0.21 – 0.40 were found for four items, κ = 0.41 – 0.60 for eleven items, and κ = 0.61 – 0.80 for five items.

Table 3. Validity of the multiple-choice test items and test-retest reliability

Domains	Items	Proportion of respondents choosing each response option [a]				Do not know [c]	D-value [d]	ICC (95% CI) [e]	Cohen's κ
		a	b	c	d				
Aetiology	1	0.92 [b]	0.01	0.05	0.02	0.00	0.23	0.81 (0.75-0.85)	0.58
	2	0.02	0.04	0.02	0.92 [b]	0.05	0.42		0.53
	3	0.01	0.56 [b]	0.03	0.40	0.04	0.62		0.55
Classification and observation	4	0.07	0.02	0.02	0.89 [b]	0.01	0.25	0.72 (0.64-0.79)	0.24
	5	0.06	0.29	0.62 [b]	0.03	0.01	0.39		0.57
	6	0.05	0.03	0.87 [b]	0.05	0.01	0.25		0.21
	7	0.10	0.80 [b]	0.06	0.04	0.02	0.39		0.44
Risk assessment	8	0.02	0.86 [b]	0.08	0.04	0.22	0.53	0.79 (0.73-0.84)	0.49
	9	0.68 [b]	0.04	0.04	0.24	0.04	0.57		0.70
Prevention	10	0.94 [b]	0.01	0.02	0.03	0.03	0.28	0.85 (0.81-0.89)	0.61
	11	0.38	0.50 [b]	0.11	0.01	0.01	0.44		0.53
	12	0.02	0.24	0.70 [b]	0.04	0.02	0.64		0.48
	13	0.22	0.24 [b]	0.41	0.13	0.14	0.19		0.31
	14	0.79 [b]	0.07	0.05	0.09	0.03	0.55		0.62
	15	0.02	0.20	0.23	0.55 [b]	0.04	0.77		0.74
Treatment	16	0.05	0.80 [b]	0.04	0.11	0.05	0.54	0.77 (0.71-0.83)	0.46
	17	0.07	0.03	0.04	0.86 [b]	0.02	0.35		0.63
	18	0.06	0.05	0.12	0.77 [b]	0.01	0.47		0.36
	19	0.52	0.42 [b]	0.01	0.05	0.04	0.35		0.45
Specific patient groups	20	0.01	0.03	0.84 [b]	0.12	0.01	0.36	N/A	0.57

[a]: based on the proportion of respondents who did NOT choose the 'I do not know the answer' option (= a-value for incorrect response alternatives), [b]: correct answer (= p-value), [c]: proportion of respondents who choose the 'I do not know the answer' option, [d]: discriminating index, [e]: intraclass correlation coefficient (95% confidence interval)

DISCUSSION

The aim of this study was to develop and evaluate the psychometric properties of an instrument to assess nurses' knowledge of skin tears. The literature review conducted prior to the study identified the existence of four instruments to assess skin tear knowledge (White, 2001; Baranoski & Ayello, 2004; McTigue et al., 2009; LeBlanc & Baranoski, 2014). However, these instruments are not in line with the most recent guidelines and none of them had been psychometrically tested. In the current study, a rigorous process of instrument development and psychometric evaluation was followed. The resulting instrument consisted of 20 multiple-choice items reflecting six domains expressing the most relevant aspects of skin tear management. The results indicate that the newly developed skin tear knowledge assessment instrument (OASES) has acceptable validity and reliability properties.

OASES was developed based on the most recent evidence-based recommendations for skin tear prevention and management (LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020). As the body of evidence regarding skin tears continues to evolve, the instrument should be regularly updated when new evidence is available. Due to the broad coverage of different domains, a wide range of essential skin tear knowledge can be assessed. All items of the instrument were carefully constructed according to the Multiple-Choice Item-Writing Guideline (Haladyna et al., 2002). The inclusion of cases and pictures allows the evaluation of a variety of cognitive process levels (Adams, 2015). The exclusive use of multiple-choice items resulted in an instrument that is quick and easy to administer and score, and allows the questioning of a wide range of topics in a limited period of time (Polit & Beck, 2008).

Face and content validity of OASES were confirmed through intensive review by ten experts in a double Delphi procedure and four nurses in a pilot study. The review process strongly supported item relevance and comprehensiveness. The Content Validity Index (CVI) of all items exceeded 0.80 and, thus, fully achieved Lynn's criterion for content validity (Lynn, 1986).

The rigorous psychometric evaluation of OASES focused on item validity, construct validity, and test-retest reliability. Overall values for item difficulty were good, although three items were found to be too easy (items 1, 2, and 10). Nevertheless, the research team decided to retain the items because they assess fundamental knowledge concerning the aetiology and prevention of skin tears. In addition, it should be noted that more than half of the survey participants were nurse specialists in wound care who are supposed to possess this basic skin tear knowledge. When excluding the specialists from the analyses, lower p-values of respectively 0.83 (item 1), 0.77 (item 2), and 0.82 (item 10) were found. Analysis of the quality of the response alternatives revealed

several a-values less than 0.10, suggesting that these response options were less attractive and that reformulation should be considered. For items 13 and 19, the proportion of correct answers was lower than the proportion of incorrect answers. However, these items were retained because experts considered them to be essential. Furthermore, it was reasonable to assume that the lower p-values were mainly due to lack of knowledge as these items require a more in-depth knowledge and higher-order thinking skills (Anderson & Krathwohl, 2001). D-values (discriminating index) of the items were acceptable to very good, indicating that the items were able to differentiate between low- and high-scoring respondents (McAlpine, 2002).

Construct validity was assessed using the known-groups technique, in which mean total scores were compared between groups with theoretically expected different levels of knowledge. This technique provides a good indication of whether the instrument validly measures the construct it is intended to measure (DeVon et al., 2007; Polit & Beck, 2008). The results support the discriminating power of OASES as the scores of all predefined groups differed significantly in the expected direction.

Test-retest reliability was assessed to evaluate the stability of OASES over one week. The intraclass correlations (ICC) of the overall instrument and the domains ranged between 0.72 and 0.85 and were considered to be good (Polit & Beck, 2008). Since the domain 'specific patient groups' contained only one item (dichotomous), it was not appropriate to calculate the ICC. Therefore, only Cohen's Kappa was calculated for this item/ domain (Mandrekar, 2011). Kappa coefficients were fair for four items, moderate for eleven items, and substantial for five items according to the interpretation by Landis & Koch (1977). Lower Kappa values (< 0.50) were mainly observed in more practical items and cases, requiring profound knowledge and a greater degree of cognitive processing (Adams, 2015). This might be a possible explanation for the somewhat inconsistent answers on these items.

Although internal consistency is often assessed in instrument development studies, this reliability measure was not evaluated in our study. Internal consistency, usually expressed as Cronbach's α, refers to the degree of correlation among items in an instrument (Polit & Beck, 2008). Kottner & Streiner (2010) indicate that internal consistency should only be determined when items of an instrument measure one unidimensional construct. In this case, items are effects of the construct to be measured and are expected to be interrelated or homogenous (effect indicator model). In our knowledge assessment instrument, the items determine the construct (causal indicator model), which means that the items and domains should not necessarily be interrelated. For example, respondents who score low on the domain 'risk assessment' may perform well classifying skin

tears. Therefore, the concept of internal consistency was not applicable for our instrument (Kottner & Streiner, 2010).

The skin tear knowledge assessment instrument was psychometrically tested in an international sample of nurses with a wide variety of backgrounds and different levels of education and experience. This increases the generalisability of our findings and allows the instrument to be widely applicable. OASES can be applied in nursing practice, education, and research to assess factual knowledge and more complex cognitive skills regarding skin tear management. The instrument can be completed by individual healthcare professionals to determine their personal knowledge level and areas for improvement. Alternatively, OASES could be used to evaluate the effectiveness of skin tear educational programs on knowledge using a pretest-posttest design. Educational programs may play an important role in the dissemination of skin tear guidelines and research findings to healthcare professionals, narrowing the evidence-practice gap (White, 2001). OASES can be used to determine widespread knowledge gaps and misconceptions by identifying low-scoring items and domains. Insight in the educational needs and priorities may support the development of tailored educational programs and other strategies for improving the quality of skin tear care.

Limitations

The fact that the instrument is only available in the English language might be a limiting factor. In a next step, OASES should be translated into other languages according to the Process of Translation and Adaptation of Instruments recommended by the World Health Organization (WHO, 2021a) to encourage global dissemination and implementation.

The instrument was administered twice with a 1-week interval in order to evaluate its stability. Although the time between the test and retest was relatively short, potential changes in knowledge from one test period to the next could have influenced the results. Daily experiences and learning opportunities make that skin tear knowledge does not remain stable over time. However, the risk that participants purposefully searched for information on skin tears was small as they were not informed about the test-retest procedure. Furthermore, no feedback was provided between the test and retest. The fact that the mean total scores of both test moments only differed minimally (14.5/20 vs. 14.8/20) strengthens our assumption that potential changes in knowledge were minimal.

CONCLUSION

A skin tear knowledge assessment instrument (OASES), consisting of 20 items clustered into six relevant knowledge domains, was developed. The instrument allows to assess both factual knowledge and more complex cognitive skills regarding skin tears. A thorough validation and reliability process ensured good test-retest reliability, content, item, and construct validity. OASES can be used in nursing practice, education, and research to identify knowledge gaps and focus areas in order to optimise strategies aimed at improving the quality of skin tear care.

Conflicts of interest

None to declare.

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Chapter 6

General discussion

Although skin tears are a highly prevalent and clinically relevant condition among patients with increased skin vulnerability, their burden and impact on patients and the healthcare system are often underestimated (McTigue et al., 2009; LeBlanc et al., 2016a; Campbell et al., 2018a). They are frequently perceived as unavoidable and insignificant injuries, making them poorly reported and inadequately treated and prevented in clinical practice (Hardie & Wick, 2020). Education and training of (future) healthcare professionals are urgently needed to raise awareness and improve the translation of clinical guidelines into practice (Edwards et al., 2017; LeBlanc et al., 2018a). As skin tears are considered to be largely preventable, there should be primarily focused on accurate and early identification of patients at risk and implementation of targeted prevention strategies (Stephen-Haynes & Callaghan, 2017; LeBlanc et al., 2018b).

This dissertation aimed to contribute to the small but growing evidence base on the prevalence and associated factors of skin tears in the nursing home population. Additionally, tools were developed and validated to support a more systematic, accurate, and consistent assessment and reporting of skin tears and to inform the development of effective and tailored education programs. In this general discussion, the main findings and methodological issues of the studies included in this dissertation are discussed in three sections: (1) skin tear prevalence and associated factors, (2) standardised assessment and documentation, and (3) integration of evidence into practice. Finally, recommendations for future research, clinical practice, education, and policy are proposed.

SKIN TEAR PREVALENCE AND ASSOCIATED FACTORS

Key findings

Prevalence figures provide institutions and policy makers with useful information about the magnitude of skin tear problems at a certain point in time, allow benchmarking, enable goal setting, and may be an aid in planning for health resources and facilities (Defloor et al., 2005; Anderson et al., 2013; LeBlanc, 2017). In addition, knowledge of prevalence may lead to increased awareness of skin tears and may initiate the development of skin tear prevention and treatment strategies and education programs (Schoonhoven et al., 2007; Vanzi & LeBlanc, 2018). If prevalence studies also collect data on treatment and preventive measures taken, the compliance with prevention and treatment protocols at that specific moment can be examined (Defloor et al., 2005). Nevertheless, prevalence figures on skin tears are rather scarce and mainly obtained in Asia, Australia, Canada, and the United States (Strazzieri-Pulido et al., 2015a; Bermark et al., 2018). Reported prevalence figures vary widely from 1.1% to 41.2% and data comparisons are difficult due to the heterogeneity between studies in terms of study population, sample size, methodological design, skin tear definitions, and the use of different skin tear classification systems (LeBlanc, 2017). Several skin

tear prevalence studies are based on retrospective reviews of medical records and institutions' databases, which have a significant potential to contain incomplete, inaccurate, and inconsistent data (Song & Chung, 2010; Sanada et al., 2015). Since skin tears have historically been minimised and underreported by healthcare professionals, it is believed that retrospective reviews may provide an underrepresentation of the true prevalence of skin tears (LeBlanc, 2017).

The study described in chapter 2 was the first prevalence investigation of skin tears in Belgium and only the fourth in Europe. This study was performed as a cross-sectional observational study and revealed a skin tear prevalence of 3.0% in 1153 Belgian nursing home residents. The proportion of skin tears was highest on the lower arms (32.1%) and lower legs (42.9%), and most skin tears were classified as type 3 (42.9%) according to the ISTAP Classification System. Direct skin observations were conducted jointly by a trained study nurse and two researchers experienced in skin tear assessment, supporting the internal validity and reliability of the study results. The large sample in this multisite study was representative of the general Belgian nursing home population in terms of age, gender and mobility level, which increases the generalisability of our findings (Socialistische Mutualiteiten, 2017). The prevalence of skin tears in the present study (3.0%) is slightly lower than the 3.9%, 4.6% and 6.3% prevalence rates reported in previous studies from Japan (Koyano et al., 2016), Denmark (Skiveren et al., 2017) and Germany (Hahnel et al., 2017), and significantly lower than the 9.5%, 14.7%-26.0% and 23.5%-41.2% prevalence rates in long-term care facilities in the USA (Hawk & Shannon, 2018), Canada (LeBlanc et al., 2013b; LeBlanc, 2017; Woo et al., 2017; Woo & LeBlanc, 2018) and Australia (Edwards et al., 2017; Parker et al., 2020).

The lower prevalence in our study may indicate that Belgian long-term care facilities provide a higher quality of care compared to other countries, but could more likely be explained by methodological differences between studies. First of all, it should be noted that most of the previous studies have included relatively small sample sizes, which limits the relevance and generalisability of their results and makes that comparisons should be made with caution. The three studies with larger sample sizes (ranging from 678 to 1253 residents) from Canada and the USA were based on administrative data from health records and databases (Hawk & Shannon, 2018; Woo et al., 2017; Woo & LeBlanc, 2018). The use of administrative data for research purposes has limitations related to the process of data collection and the completeness, accuracy and reliability of the data (Song & Chung, 2010; Timofte et al., 2018). It is well known that healthcare professionals experience difficulties in distinguishing skin tears from other similar wounds, such as MARSI, pressure ulcers, or moisture-associated skin damage (MASD) (Gray et al., 2012; LeBlanc et al., 2018a; Rayner et al., 2019; Hardie & Wick, 2020). Proper identification and differential diagnosis of skin tears require in-depth training and experience (LeBlanc et al., 2016a). Therefore, there is a significant chance that other wound aetiologies have been incorrectly classified as skin tears, and

vice versa. In addition, no distinction was made between skin tears, lacerations, and abrasions in the Canadian studies. All wounds registered as ‘skin tears’, ‘lacerations’, and ‘abrasions’ were grouped together under the wound aetiology of skin tears, resulting in a potential overrepresentation of skin tear prevalence (Woo et al., 2017; Woo & LeBlanc, 2018).

A second reason why comparisons between studies are difficult is the fact that different skin tear definitions and data collection procedures were used. In our study, as well as in the studies by LeBlanc (2017) and Skiveren et al. (2017), skin tears were assessed and classified according to the ISTAP definition and classification system. In all other studies, the Payne-Martin, the STAR, a pressure ulcer, or no classification system were used (LeBlanc et al., 2013b; Koyano et al., 2016; Edwards et al., 2017; Hahnel et al., 2017; Woo et al., 2017; Hawk & Shannon, 2018; Woo & LeBlanc, 2018; Parker et al., 2020). The use of a standardised, globally accepted (ICD) definition and classification system for skin tears in future prevalence studies would be recommended to support accurate and consistent assessment (LeBlanc, 2017; LeBlanc et al., 2018a). The NPUAP, EPUAP, PPPIA and ISTAP state that, despite the similarities in wound appearances and challenges in diagnosis, skin tears should not be classified using the International NPUAP/EPUAP Pressure Ulcer Classification System (National Pressure Ulcer Advisory Panel et al., 2014; LeBlanc et al., 2016a). Regarding the process of data collection, variations can be found in the level of training and experience of the data collectors in skin tear assessment and differential diagnosis, which has an important impact on the validity and reliability of the obtained prevalence rates (LeBlanc et al., 2016a). Furthermore, there are differences in the body parts observed among studies. Although skin tears are particularly common on the extremities, they can occur on any area of the body (LeBlanc et al., 2018a; Serra et al., 2018). In almost all studies, a full body examination was performed (LeBlanc et al., 2013b; Edwards et al., 2017; Hahnel et al., 2017; LeBlanc, 2017; Woo et al., 2017; Hawk & Shannon, 2018; Woo & LeBlanc, 2018; Parker et al., 2020). The three studies with the lowest prevalence rates (3.0% (our study), 3.9% (Koyano et al., 2016), and 4.6% (Skiveren et al., 2017)) only examined the extremities, which might have led to omission and underreporting of skin tears.

A third reason is related to the heterogeneity in patient populations between studies. The highest skin tear prevalence (41.2%) was reported in the Australian study by Parker et al. (2020). This study exclusively included residents with dementia, which has previously been identified as an important risk factor for skin tears (McGough-Csarny & Kopac, 1998; LeBlanc et al., 2013b; Rayner et al., 2015; Strazzieri-Pulido et al., 2017). People with dementia are at increased risk of developing a skin tear because of impaired cognition resulting in a higher incidence of falls, other trauma, and altered mobility (Brimelow & Wollin, 2018; Parker et al., 2020). In contrast to the study of Parker et al. (2020), some other studies have excluded high-risk populations for skin tears, such as critically

ill and end-of-life patients (LeBlanc & Baranoski, 2011). This concerned the studies with lower skin tear prevalence rates (3.9% (Koyano et al., 2016) and 6.3% (Hahnel et al., 2017)). According to Koyano et al. (2016), the variety in skin tear prevalence rates may also be attributed to the geographical diversity of the study populations. Skin tear prevalence was studied in various ethnic/racial groups in which the degree of age-related skin fragility varies (Sanada et al., 2015; Koyano et al., 2016). Differences in sun exposure habits (and resulting photoageing), environmental influences and skin properties, such as dermal thickness, dryness or tolerance against ultraviolet exposure, make that some ethnic/racial groups are more prone to developing skin tears than others (Diridollou et al., 2007; Sanada et al., 2015; Koyano et al., 2016). In their study, for example, Diridollou et al. (2007) found that with age, skin dryness increases more in African-American and Caucasian women than in Chinese and Mexican women. Dry skin (xerosis cutis) is an important risk factor for skin tear development (LeBlanc et al., 2018a; Brown, 2019; Lichterfeld-Kottner et al., 2020). Besides the variations in ethnicity, seasonal differences may also affect skin tear prevalence (Sanada et al., 2015; LeBlanc, 2017). Further research is needed to ascertain the effect of ethnic/racial and seasonal variations on skin tear development in the long-term care population.

The above-mentioned differences between skin tear prevalence studies in terms of methodological design, sample size, diagnostic criteria, data collection procedures, and study population make that comparisons and interpretations should be made cautiously. More rigorous, well-sampled studies with consistent and standardised methodology are needed to obtain more comparable results and make more confident conclusions.

In addition to investigating skin tear prevalence, the first study of this dissertation (chapter 2) also aimed to explore factors independently associated with skin tear presence in Belgian nursing home residents. By identifying key risk factors for skin tears, targeted strategies can be customised to prevent these wounds in the most vulnerable populations (LeBlanc, 2017; Rayner et al., 2018b). Knowledge of skin tear risk factors can contribute to accurate and early identification of individuals at risk, which should be the first step of any prevention plan (Sanada et al., 2015; Serra et al., 2018). A good fitted multivariate binary logistic regression model was designed, which confirmed age, history of skin tears, chronic use of corticosteroids, dependency for transfers, and use of adhesives/dressings as independent risk factors for skin tears in the nursing home population. The factors identified are theoretically sound, consistent with findings from previous studies, and provide important guidance to identify high risk patients in need for specific skin tear prevention strategies (Payne & Martin, 1990; Malone et al., 1991; Everett & Powell, 1994; Carville & Lewin, 1998; McGough-Csarny & Kopac, 1998; Carville & Smith, 2004; Santamaria et al., 2009; Kennedy & Kerse, 2011; Amaral et al., 2012; Holmes et al., 2013; LeBlanc et al., 2013b; Rayner et al., 2015;

Sanada et al., 2015; Lewin et al., 2016; Koyano et al., 2017; LeBlanc, 2017; Newall et al., 2017; Skiveren et al., 2017; Bermark et al., 2018; Hawk & Shannon, 2018; Rayner et al., 2018a; Serra et al., 2018; Woo & LeBlanc, 2018).

Use of adhesives/dressings was the factor most strongly associated with skin tear presence. In residents with adhesives/dressings on the extremities, the odds of presenting with skin tears was 7.05 times as high as in residents without adhesives/dressings. This finding was supported by LeBlanc & Baranoski (2011), who identified adhesive/dressing removal as one of the top three causes of skin tears. In order to avoid injury in individuals with fragile skin, there should be preventively focused on this important modifiable factor (LeBlanc et al., 2018a). Careful selection of dressings with an atraumatic and non-adherent wound contact layer, such as silicone, can help reduce skin damage/ trauma and associated pain on dressing removal (Matsumura et al., 2013; Idensohn et al., 2019b). The dressing should be marked with an arrow to indicate the correct direction of removal and should be removed slowly (Stephen-Haynes & Callaghan, 2017; LeBlanc et al., 2018a). The use of a skin barrier product to protect the surrounding skin (e.g. from maceration if the wound has high exudate levels) should be considered (Stephen-Haynes, 2012; LeBlanc et al., 2018a). Dressings recommended by ISTAP include non-adherent mesh (e.g. silicone mesh), foam, hydrogel, calcium alginate, gelling fibre, and acrylic dressings (LeBlanc et al., 2018a). When local, spreading or systemic infection is a concern, dressings containing antimicrobials such as silver ions, methylene blue, gentian violet, Leptospermum honey, or polyhexamethylene biguanide (PHMB) should be considered (Blair & Carter, 2005; LeBlanc et al., 2016b; Idensohn et al., 2019b; Bain et al., 2020). It should however be noted that gentian violet is hardly available. Adhesive skin closure strips, gauze, film/hydrocolloid, and iodine-based dressings should be avoided (LeBlanc et al., 2018a; Idensohn et al., 2019b).

Another modifiable associated factor identified was dependency for transfers. When assistance is required for daily activities, such as transferring, there is an increased risk of mechanical trauma caused by medical devices (e.g. wheelchairs, bed rails, lifters) or assistance from others (Vanzi & Toma, 2017). The study of Carville et al. (2014) revealed that shearing and friction forces associated with residents' transfer activities accounted for nearly 12% of all skin tears. The use of glide sheets, padding on equipment (e.g. wheelchair arm and leg supports, bed rails, transfer aids), and protective clothing (e.g. long sleeves/ trousers, knee-high socks, gloves, shin pads, elbow guards) may be possible solutions for reducing the risk of skin tears during transfers (Sussman & Golding, 2011; LeBlanc et al., 2018b; Idensohn et al., 2019b). Sharp fingernails and jewellery should be avoided (Campbell et al., 2018b). Patients should be encouraged and trained to participate as actively as possible during transfers (Idensohn et al., 2019b; Beeckman et al., 2020). Occupational and physical therapists could educate patients, their families, and caregivers about

proper transferring/ positioning techniques, assistive devices, and skin-friendly equipment (Campbell et al., 2018b; LeBlanc et al., 2018a; Vanzi & LeBlanc, 2018). Advanced age, having a history of skin tears, and the chronic use of corticosteroids can be considered as non-modifiable associated factors. Although these factors can not be changed, they can be controlled to minimise their effects (e.g. by twice-daily application of moisturisers and more frequent skin inspection) (LeBlanc et al., 2018a).

Although we identified five independent associated factors for skin tears, several other factors reported in previous studies, such as the presence of haematoma, senile purpura, ecchymosis, and oedema, were not confirmed (Payne & Martin, 1990; McGough-Csarny & Kopac, 1998; Rayner et al., 2015; Lewin et al., 2016; Newall et al., 2017; Skiveren et al., 2017; Bermark et al., 2018; Rayner et al., 2018a). Haematoma and oedema, as well as some other factors, such as thin skin and dry skin, were found to be significantly associated with skin tears in the univariate analyses, but were not statistically significant in the multivariate analyses. No distinction was made between haematoma, senile purpura, and ecchymosis because these skin conditions are difficult to distinguish from each other due to their similar clinical and pathophysiological characteristics (Rayner et al., 2015; LeBlanc, 2017; Newall et al., 2017; Campbell et al., 2018b). Together with stellate pseudoscars, xerosis cutis, and skin atrophy, they have been previously identified as intrinsic skin changes that occur with advanced ageing (Woo & LeBlanc, 2018). These changes lead to a loss of the protective mechanical function of the skin and extreme fragility, increasing the risk of skin injury from mechanical trauma (Kaya & Saurat, 2007; Campbell et al., 2018b; Vanzi & Toma, 2018). Given their interconnectedness and the difficulties in differentiating between them, Kaya & Saurat (2007) proposed to group the different clinical manifestations of age-related skin fragility under the umbrella term of ‘dermatoporosis’. By incorporating all of the skin changes associated with ageing under one umbrella term in future studies, assessment and documentation will be simplified and the development of valid and easy-to-use skin tear risk assessment tools supported (LeBlanc, 2017).

Another factor that has frequently been identified as being associated with skin tear occurrence is a low Braden Scale score, and thus an increased risk of developing pressure ulcers (Amaral et al., 2012; Sanada et al., 2015; Strazzieri-Pulido et al., 2015a; Feng et al., 2018; Woo & LeBlanc, 2018). This can be explained by the fact that skin tears and pressure ulcers share common risk factors (e.g. limited mobility/ activity), which means that individuals may simultaneously be at risk for both conditions (LeBlanc et al., 2016a; LeBlanc & Baranoski, 2017; Brimelow & Wollin, 2018). Nevertheless, the Braden Scale or other pressure ulcer risk assessment tools should not be used to assess the risk of developing skin tears as they are not designed for skin tear risk assessment and do not adequately predict skin tear development (Sanada et al., 2015; Leisman et al., 2020).

Methodological considerations

Our study (chapter 2) was conducted using a cross-sectional observational design, including the performance of direct skin assessments and collection of data on potential risk factors at one point in time. This prevented us to establish the temporal cause-and-effect relationship between exposure and the occurrence of skin tears (Song & Chung, 2010; Flannelly & Jankowski, 2014; Kestenbaum, 2019). Future longitudinal studies (e.g. cohort studies) are needed to clarify the causal associations between potential risk factors and skin tear occurrence, to confirm the already identified risk factors, to identify additional (unknown) risk factors, and to examine their influence and interconnectedness across various healthcare settings and patient populations. In addition, longitudinal studies will allow to estimate incidence rates, which are generally more accurate and stable compared to prevalence rates, and should be used to evaluate the quality of preventive care and the effectiveness of quality improvement programs (Schoonhoven et al., 2007; Noordzij et al., 2010; Anderson et al., 2013; Agency for Healthcare Research and Quality, 2014). However, the conduct of longitudinal studies may pose practical challenges such as the need for large sample sizes, long follow-up periods with repeated observations, the possible loss of study participants to follow-up, considerable time investment, and high costs (Schmidt & Teti, 2005; Song & Chung, 2010; Antay-Bedregal et al., 2015).

Furthermore, it is important to note that our study had a relatively low event rate (28 skin tears), resulting in wide confidence intervals of the factors associated with skin tear presence and potentially inadequate statistical power of the regression model (Gibbons & Hodge, 2012; Hosmer et al., 2013; Steyerberg, 2019). As a rule of thumb, a minimum of ten events (skin tears) per predictor variable (EPV) in the model is recommended when performing a logistic regression analysis (Concato et al., 1995; Peduzzi et al., 1995). Our multivariate model included five variables (age, history of skin tears, chronic use of corticosteroids, dependency for transfers, and use of adhesives/dressings), accounting for 5.6 EPV (28/5). A relatively low number of events compared to the number of variables in the model may increase the risk of overfitting and limit the generalisability of the results (Hansen et al., 2014; Ogundimu et al., 2016). However, the large simulation study of Vittinghoff & McCulloch (2007) showed that problematic confidence interval coverage (< 93%), type I error (> 7%), and relative bias (> 15%) were fairly frequent with 2-4 EPV, uncommon and not severe with 5-9 EPV, and still observed with 10-16 EPV. Problems with model performance were similar for 5-9 EPV and 10-16 EPV and were also dependant on other factors that were equally or more influential than EPV, such as the number of variables in the model, predictor prevalence, and sample size. Therefore, Vittinghoff & McCulloch (2007) stated that the 10 EPV rule can be relaxed to 5-9 EPV and that systematic discounting of results, in particular statistically significant and biologically plausible associations, from any model with 5-9 EPV does not appear to be justified.

Similar to previous skin tear risk factor studies (see chapter 1), our study was restricted to patient-related risk factors. In future studies, there should also be focused on factors related to the situation (e.g. acute illness, surgery), the physical environment (e.g. padding on equipment, adequate lighting), the healthcare professional (e.g. knowledge, attitude), the ward (e.g. staffing level, skill-mix), and the healthcare setting (e.g. availability of prevention protocols, education/ audit programs) as potential risk factors for skin tears (Campbell et al., 2016a; LeBlanc et al., 2018a).

STANDARDISED ASSESSMENT AND DOCUMENTATION

Key findings

Skin tears are often trivialised and not recognised as a unique condition distinct from other wound aetiologies, making them frequently misdiagnosed and underreported (Chang et al., 2016; Ellis, 2018; LeBlanc et al., 2018a; Idensohn et al., 2019a). The lack of diagnostic accuracy results in inappropriate or delayed treatment, increased pain and suffering, delayed wound healing, infection, raised healthcare costs, and incorrect and incomparable epidemiological data (Benbow, 2017; Campbell et al., 2018; Vanzi & LeBlanc, 2018). The adoption of a specific ICD code for skin tears and the international use of a standardised, valid and reliable skin tear classification system are fundamentally needed to increase awareness, provide a common description, and support a more consistent and accurate assessment and reporting (LeBlanc et al., 2018a). Consequently, more accurate skin tear prevalence and incidence rates will be obtained, benchmarking will be facilitated, goal setting, making appropriate treatment decisions and outcome evaluation will be supported, and meaningful medical, nursing and scientific communication will be enabled (Gibb et al., 2015; Chang et al., 2016; Kottner et al., 2020b).

Classification is defined as ‘a systematic arrangement in groups or categories according to established criteria’ (Merriam-Webster, 2021). Classification systems provide common language, terms and concepts for diagnosing and describing disorders and can aid in monitoring how much they improve or do not improve after some intervention (Streiner & Kottner, 2014; Kottner et al., 2020b). In contrast to skin tears, classification of other wounds such as pressure ulcers became an accepted and integral part of daily nursing practice to ensure that patients receive the appropriate treatment and that documentation is accurate (Dealey & Lindholm, 2006; Defloor et al., 2006). The use of a universal definition and classification system (NPUAP/EPUAP) has facilitated best practice and research within this domain (Carville et al., 2007). Furthermore, since pressure ulcers have been recognised as an indicator of the quality of care, correct pressure ulcer classification is of utmost importance in the light of quality measurements, legal purposes, and reimbursement (Lyder & Ayello, 2008; Kruger et al., 2013; Krupp & Monfre, 2015).

While pressure ulcer classification has been well embedded in clinical practice and research for decades, the systematic assessment and reporting of skin tears using a universally accepted and profoundly tested classification system remains in its infancy. In the descriptive studies of White (2001) and LeBlanc et al. (2014), about 90% of the 1647 participating healthcare professionals indicated the need and willingness to use a common, user-friendly tool to assess and document skin tears. To find out which of the existing skin tear classifications can be recommended for use in daily practice and research, a systematic review, according to the COSMIN guideline, was performed (chapter 4). This was the first systematic review to critically appraise, compare, and summarise the evidence on the measurement properties of skin tear classifications. The review revealed that five skin tear classifications exist (Payne-Martin, Dunkin, Lo, STAR, and ISTAP), of which only two have been psychometrically tested (STAR and ISTAP). The Dunkin and Lo classifications were found to be less suitable for use by healthcare professionals in clinical practice since they have been developed for the purposes of surgical management. The Payne-Martin and STAR classifications have previously been criticised for their complexity, subjectivity, and poor widespread acceptance (Chaplain et al., 2018; LeBlanc et al., 2018a). The ISTAP classification was developed as a simplified and easy-to-use tool, categorising skin tears into three types (LeBlanc et al., 2013c). Content validity of the STAR and ISTAP classifications was established by an expert consensus panel. Both the reliability and criterion validity of the STAR Classification System were found to be insufficient when compared against the criteria for good measurement properties (Prinsen et al., 2018). It should however be noted that this rating was based on the findings of only three studies of very low methodological quality due to risk of bias, inconsistency, and indirectness (Mokkink et al., 2018a). The ISTAP classification was the most commonly evaluated system with moderate-quality evidence to support its reliability, measurement error and criterion validity. Downgrading of the evidence from high to moderate was associated with the use of photographs in psychometric testing (indirect skin observation). Further psychometric testing of the Payne-Martin, STAR, and ISTAP classifications is required.

Due to the methodological heterogeneity between studies (e.g. study design, procedures, sample characteristics), differences in statistical analyses, the lack of confidence intervals, and inadequate reporting, it was impossible to conduct a quantitative meta-analysis and draw a meaningful comparison. There is a need for rigorously conducted, well-designed reliability and validity studies, in which representative samples of raters apply different skin tear classifications to comparable samples of patients. Results should be computed using adequate and comparable statistical methods. When instruments are to be used in daily practice, their measurement properties should also be investigated under conditions as close as possible to the clinical daily routine (Kottner et al., 2011). Only one study conducted a real skin assessment in a clinical setting (direct skin observation). In studies using samples of skin tear experts/ specialists to examine reliability and

validity, it is questionable whether the results are generalisable to the population of healthcare professionals working in daily practice using skin tear classifications (e.g. ward nurses). During our review process, it became clear that considerable confusion exists regarding the concepts of reliability, agreement, and diagnostic accuracy and the selection of appropriate methods of data analysis. In the studies of Carville et al. (2007) and Chang et al. (2016), for example, the authors indicated that interrater reliability of the STAR classification was analysed using Cohen's kappa, but the results reported are percentages (proportions of agreement). Furthermore, information about study design, sample selection, and statistical analysis was often incomplete, complicating the interpretation and synthesis of study results. The thorough investigation of reliability and validity and the adequate reporting of the measurement process and all relevant information are essential in every study to estimate the amount of error inherent in the obtained results (Kottner et al., 2009; Kottner et al., 2011; de Souza et al., 2017). Reliability and validity studies that are conducted as part of a larger study (e.g. clinical trial, epidemiological study), usually as a quality control, should also provide sufficient information to understand how the study was designed and conducted and how the results were obtained (Kottner et al., 2011). To improve the quality of reporting, support study design, and reduce conceptual and statistical confusion, authors of future studies are strongly encouraged to follow the Standards for Reporting Studies of Diagnostic Accuracy (STARD) (Bossuyt et al., 2003) and the Guidelines for Reporting Reliability and Agreement Studies (GRRAS) (Kottner et al., 2011).

Although the ISTAP Classification System has been psychometrically tested in multiple studies since its development in 2013, further rigorous testing with larger samples of healthcare professionals across various settings and countries was required. Previous studies were relatively small-scale, often of doubtful methodological quality, and mainly focused on the evaluation of interrater reliability. Furthermore, in order to avoid terminology confusion, there was a need for a standardised, internationally agreed definition for the concept of a 'skin flap' in the area of skin tears to be added to the ISTAP Classification System (LeBlanc et al., 2018a). Therefore, a two-phase international project was set up to (1) develop and content validate a 'skin flap' definition through expert consultation in a two-round Delphi procedure involving 17 experts from 11 countries, and (2) to measure interrater and intrarater reliability, agreement, and diagnostic accuracy of the ISTAP classification in a convenience sample of 1601 healthcare professionals from 44 countries (chapter 3). The results showed that photographs of skin tears could be assessed in a valid and reliable way using the ISTAP classification. The large, heterogeneous sample of healthcare professionals allowed the comparison of results between groups. Higher reliability and agreement coefficients were found in more experienced and higher educated healthcare professionals. This indicates that sufficient and adequate education and training will be important for improving the classification of skin tears. For the purpose of the psychometric evaluation, the ISTAP Classification System

including the newly developed definition of a ‘skin flap’ was translated into 15 languages (Arabic, Chinese, Czech, Danish, Dutch, English, French, German, Hebrew, Italian, Japanese, Portuguese, Spanish, Swedish, and Turkish) of the 44 participating countries. This will enhance global dissemination and implementation of the ISTAP classification in research and clinical practice.

However, although being statistically acceptable, it should be questioned whether the obtained reliability and agreement coefficients are high enough for individual clinical decision-making as one may expect an almost perfect agreement when assessing skin tears. Even if one obtains high reliability and agreement estimates, disagreements may have occurred which are clinically unacceptable (Kottner et al., 2011; Elban et al., 2020). Furthermore, it should be remembered that reliability and validity are not fixed, immutable properties of a scale that, once established, apply in all situations and for all people (Streiner & Kottner, 2014). They are affected by various sources of variability in the measurement setting (e.g. rater and sample characteristics, type of instrument, administration process) and the statistical approach (Kottner et al., 2009; Kottner et al., 2011; de Souza et al., 2017). A scale that may be valid or reliable for one group assessed under certain circumstances may not be valid or reliable with other groups or testing situations (Streiner & Kottner, 2014; Mendes-Ribeiro et al., 2020). Therefore, study results are only interpretable when the assessment conditions and the statistical methods are clearly described (Kottner et al., 2011; de Souza et al., 2017). Further studies investigating reliability and validity, but also other factors such as feasibility and acceptability of the ISTAP classification in clinical practice are needed. It should hereby be emphasised that empirical evidence supporting the psychometric properties of an instrument in the target population does not necessarily justify its routine use in clinical practice. The implementation of a classification tool must lead to better care processes and improved patient outcomes. Randomised controlled trials are recommended to estimate the impact of the ISTAP classification on clinical practice improvement and patient-related benefits (Streiner & Kottner, 2014).

Methodological considerations

The psychometric evaluation of skin tear classifications (STAR and ISTAP) was based on the assessment of photographs of skin tears in almost all studies, including ours (chapter 3). This limits the generalisability of the study results to skin tear assessment in real nursing practice. Actual skin assessment in a clinical setting was conducted in only one study to date (Strazzieri-Pulido et al., 2015b). Whether skin assessment in clinical practice is easier and more accurate than using photographs is still to be investigated. It is assumed that the abundance of clinical information when conducting a real skin examination may be harder to extract and interpret than that of photographs (Kottner et al., 2009). On the other hand, the use of photographs limits clinical information which is useful for skin tear classification. In order to be able to classify a skin tear correctly, the wound must

be cleansed, any residual debris or haematoma removed, necrotic tissue debrided, and the skin flap, if viable, re-approximated (LeBlanc et al., 2018b; Fletcher et al., 2020). This might be difficult to observe in static, two-dimensional photographs. Examination of a patient's skin in clinical practice allows a more comprehensive evaluation involving three-dimensional measurement, palpation, and accurate flap visualisation (Carville et al., 2007; Baranoski et al., 2012; Skiveren et al., 2015). However, assessment in clinical practice would be more small-scale, time-consuming, and harder to organise. The use of patient cases, including information about the patient's background and high quality (three-dimensional) photographs or videos in which the skin flap has been re-approximated where possible, might be a valuable and feasible alternative. It is important to consider that the characteristics of the set of photographs and the completeness of clinical information about an individual's health status, age, wound history, dependency for ADLs, medications, and the cause of the wound may influence the diagnostic process and, thus, the assessment results (Kottner et al., 2011).

Translations of the English ISTAP classification were carried out by native speakers with extensive content expertise in the field of skin tears, but back-translation was not performed. The WHO states that, in order to achieve different language versions of an English instrument that are conceptually equivalent in each of the target countries, forward-translations and back-translations should be conducted (WHO, 2021a). The availability of the ISTAP classification in additional languages should be extended in the future. Any translation or adaptation should be carried out in accordance with the proposed guidelines of the WHO (2021a) and Sousa & Rojjanasrirat (2011).

INTEGRATION OF EVIDENCE INTO PRACTICE

Key findings

High-quality, evidence-informed and up-to-date clinical practice guidelines offer a way of bridging the gap between policy, best practice, local contexts, and patient choice and have the potential to improve health outcomes (Kredo et al., 2016; Young et al., 2020). They aim to support healthcare professionals with evidence-based decision-making, enhance the effectiveness and quality of care, decrease variations in clinical practice, and reduce costly and preventable adverse events (Fischer et al., 2016; Kredo et al., 2016; Correa et al., 2020; Gibson et al., 2021). Clinical practice guidelines for the prevention and management of skin tears are available, however, compliance with these guidelines in clinical practice is lacking. A number of reasons have been identified as contributing to this evidence-practice gap, including limited access to evidence, poor communication, lack of knowledge and skills, and a negative attitude towards skin tear prevention and management (LeBlanc, 2014; Edwards et al., 2017). The systematic meta-review of Correa et al. (2020) identified

the absence of a leader/ champion for implementation processes, lack of time of healthcare professionals, additional workloads, limited financial resources, lack of specialised personnel, little support from superiors, lack of education and training, difficulties with interdisciplinary teamwork, and lack of agreement with and clarity of guidelines (including language problems) as additional common barriers for the implementation of research evidence in clinical practice.

Implementation of skin tear guidelines is imperative to reduce the occurrence of skin tears and optimise their management (LeBlanc et al., 2018a; LeBlanc et al., 2018b; Beeckman et al., 2020). However, disseminating and integrating evidence into practice is a complex and challenging process as it involves making changes at the individual, organisational and health system levels (Grol & Grimshaw, 2003; Correa et al., 2020). Multifaceted interventions that combine staff education, skills training, developing appropriate patient/ family education materials, creating a supportive environment, management and resource support, and the provision of evidence in a readily accessible form for use in practical situations are suggested to facilitate transfer of evidence into practice (Davies et al., 2008; Edwards et al., 2017; Karlberg-Traav et al., 2021). Guidelines should be translated into local protocols, which are more explicit about the sequence, timing, and provision of interventions and can be directly incorporated into routine patient care (Manns, 2015; Kredo et al., 2016). Other effective strategies include local champion support, use of reminder systems, clinical decision-making support systems, and audit and feedback cycles that include modification or refining of strategies (National Health and Medical Research Council, 2000; Ploeg et al., 2010; Edwards et al., 2017).

Continuous education and training will play a central role in improving (future) healthcare professionals' awareness, attitudes, skills, knowledge, understanding and acceptance of skin tear guidelines and may contribute to a positive change in their behaviour (Woolhouse & Moola, 2014; LeBlanc et al., 2018a; Tamai et al., 2020). Only one-third of the 387 participating nurses (of which 54.8% were nurses specialised in wound care) in our study (chapter 5) had ever completed a course focusing on skin tears, while more than 80% expressed the need to complete one. Several studies have identified significant positive associations between education and nurses' use of research evidence to guide their clinical practice (Rodgers, 2000; Squires et al., 2011; Florin et al., 2012; Wang et al., 2013; Edwards et al., 2017; Ferreira et al., 2021; Karlberg-Traav et al., 2021).

Insights into widespread knowledge gaps, educational needs, and priority areas are needed to support the development of effective and tailored educational programs (White, 2001; Pagan & Harvey, 2019). In this context, the fourth study of this dissertation (chapter 5) included the design and psychometric property testing of an instrument measuring nurses' knowledge on skin tears (OASES). Previously developed skin tear knowledge assessment instruments have never been

psychometrically tested and are no longer up-to-date (White, 2001; Baranoski & Ayello, 2004; McTigue et al., 2009; LeBlanc & Baranoski, 2014). OASES has been rigorously developed based on the most recent evidence-based skin tear guidelines and consists of 20 multiple-choice items covering six relevant domains: (1) aetiology, (2) classification and observation, (3) risk assessment, (4) prevention, (5) treatment, and (6) specific patient groups. A thorough psychometric evaluation ensured good test-retest reliability, content, item, and construct validity. OASES allows to assess both factual knowledge and more complex cognitive skills regarding skin tears in basic nursing education, post-graduate training, and nursing practice (Adams, 2015). In addition to informing the development of educational programs by identifying low-scoring items and domains, OASES can also be used to evaluate their effectiveness on knowledge using a pretest-posttest design. Further research is needed to determine the relationship between improved skin tear knowledge and long-term changes in clinical practice and patient outcomes.

The Theory of Planned Behaviour (Ajzen, 1991) states that, besides knowledge, attitude is also an important factor in predicting, changing and maintaining behaviour. Actual performance of the intended behaviour is directly affected by behavioural intentions, which are derived from attitudes, subjective norms, and perceived behavioural control. The latter are results of behavioural, normative and control beliefs, which are in turn affected by background factors such as education, knowledge and experience. Education, knowledge and individual skills are important factors that lead to favourable intentions by affecting both behavioural beliefs and control beliefs (Ajzen, 1991; Ajzen & Fishbein 2005; Ajzen & Gilbert Cote, 2008). It would be useful to develop and psychometrically test an instrument measuring nurses' attitude towards skin tear prevention and management that includes statements of belief, behaviour, and/or behavioural intentions. Such an instrument can be used in research and practice to inform the development or optimisation of strategies aimed at improving skin tear care (e.g. educating healthcare professionals about the burden and impact of skin tears, demonstrating the feasibility and positive/ meaningful outcomes of adequate skin tear prevention and management) (Grol & Wensing, 2004). In the field of pressure ulcers and IAD, two rigorously validated instruments measuring nurses' attitude towards PU and IAD prevention have been developed. The Attitude towards Pressure ulcer Prevention instrument (APuP) consists of 13 statements, divided into five subscales: (1) personal competency to prevent pressure ulcers, (2) priority of pressure ulcer prevention, (3) impact of pressure ulcers, (4) responsibility in pressure ulcer prevention, and (5) confidence in the effectiveness of prevention (Beeckman et al., 2010a). The Attitude towards the Prevention of IAD instrument (APrIAD) consists of 14 statements, clustered into four subscales: (1) beliefs about the impact of IAD on patients, (2) beliefs about team responsibility to prevent IAD, (3) beliefs about personal responsibility to prevent IAD, and (4) beliefs about the effectiveness of IAD prevention products and procedures (Van Damme et al., 2019). Supporting Ajzen's theory (1991), the studies of Beeckman et al. (2011) and

Demarré et al. (2012) revealed that nurses' attitudes towards PU prevention were significantly associated with the application of adequate prevention according to the guidelines. Increased knowledge was significantly associated with a more positive attitude towards PU prevention (Beeckman et al., 2011).

Methodological considerations

Although OASES was psychometrically tested in a large international sample of nurses from 37 countries, the instrument was administered only in English. The possible language barrier may have influenced the results of the validation process, participation rates and representativeness (Lavrakas, 2008; Wong & Wang, 2008; Ngwakongnwi, 2017). In a next step, OASES should be translated and validated into other languages to allow global use. As the provision of adequate skin tear prevention and management is not only the responsibility of nurses, one must also be able to assess skin tear knowledge of other multidisciplinary team members (e.g. occupational therapists, physical therapists, pharmacists) in a valid and reliable way. Therefore, it is recommended to adapt and validate OASES for use in other professions, taking into account each discipline's specific responsibilities. Tailored instruments to assess the knowledge of patients and their caregivers about skin tears can also be developed and validated. Future translations (including forward and back translations), adaptations, and validations of OASES should be carefully conducted according to the guidelines of the WHO (2021a) and Sousa & Rojjanasrirat (2011). Efforts are currently being made to translate and validate OASES into Dutch, Italian, and Spanish and to adapt the instrument for use in other target populations. Cross-sectional studies are being conducted to assess the knowledge of Belgian, Chilean, Italian, and UK hospital nurses, community nurses, nursing students, nurse specialists in wound care, and general practitioners about skin tears using (a translated/ adapted version of) OASES.

Instrument adaptation and validation is an ongoing process, which makes that OASES in its current form can only be used for a limited time period (DeVellis, 2003; Streiner et al., 2015). As evidence and insights regarding skin tears continue to evolve, it will be important to re-evaluate and update the content of OASES whenever fundamental aspects within the body of evidence change.

RECOMMENDATIONS

Recommendations for research

Developing a minimum data set for skin tear prevalence and incidence measurements

Internationally comparable skin tear prevalence and incidence data are missing due to wide variations in methodological design, sample size, study population, skin tear definitions, and the use of different classification systems (Strazzieri-Pulido et al., 2015a; LeBlanc, 2017). The complexity of correctly diagnosing a skin tear and differentiating it from other skin lesions may also contribute to this variation (LeBlanc et al., 2016a). To promote the quality, interpretability, and comparability of epidemiological data across different healthcare settings and countries, the development of a standardised data collection procedure using a valid and reliable minimum data set (MDS) is recommended. Such a uniform method will allow repeated reliable collection of skin tear prevalence and incidence data for meaningful use within the facility and for local and international benchmarking (Baharestani et al., 2009; Anderson et al., 2013; Haesler et al., 2017).

In line with the EPUAP MDS for pressure ulcers (Vanderwee et al., 2007) and the MDS for IAD (Van den Bussche et al., 2018), a MDS for skin tears could include administrative data (e.g. date, country, setting, discipline), patient data (e.g. sex, year of birth), risk assessment, skin observation to assess the anatomical location and severity (using the ISTAP Classification System) of skin tears, and data about current prevention and treatment practices. The registration of preventive and therapeutic measures during prevalence and incidence studies is useful to be able to evaluate their effectiveness and to examine the compliance with prevention and treatment protocols (Defloor et al., 2005). Knowledge about when (e.g. before or after admission to the facility, during ADL support/ a fall) and where (unit/ discipline) a skin tear is acquired can aid in developing targeted interventions to improve the quality of care (Anderson et al., 2013). The assessment of each patient's skin by two independent observers is recommended. Unannounced visits from a third party (e.g. a specialist nurse), who observes a random sample of patients, allow the calculation of interrater reliability coefficients (Bours et al., 1999; Defloor et al., 2005). Prior to the prevalence/ incidence measurements, all data collectors should be trained in the identification, classification, and differential diagnosis of skin tears, the completion of the data collection instrument (MDS), and study procedures (Defloor et al., 2005; Anderson et al., 2013).

Towards a structured risk assessment

Together with the findings from previous risk factor studies, our multivariate binary logistic regression model (chapter 2) could inform the development of a reliable and easy-to-use skin tear risk assessment tool with adequate predictive validity for use in research and practice, which is

currently lacking. Such a tool will provide a standardised way of assessing and documenting risk of skin tears and should be part of a comprehensive prevention program to complement healthcare professionals' clinical judgement and routine skin assessment (Newall et al., 2017; LeBlanc et al., 2018b). Risk assessment tools are used to estimate or predict a patient's likelihood of developing a particular outcome or health condition, such as skin tears (Janssen et al., 2009). When evaluating the clinical utility of a risk assessment tool, the strength of predictors, parsimony, and the ease and practicality of measuring variables are important determinants to take into account (Rayner et al., 2018a). As skin tear risk factors, and thus the predictive performance of a skin tear risk assessment tool, are likely to differ across healthcare settings and patient populations, the development and validation of different tools or adjustments to the original tool (e.g. changing the weights of predictors or adding a predictor) may be necessary (Janssen et al., 2009; Moons et al., 2015; LeBlanc, 2017; Newall et al., 2017). When implementing a skin tear risk assessment tool to support clinical reasoning and decision making, care should be taken not to ignore relevant clinical information that has not been included in the tool (Moons et al., 2015). Accurate and early identification of patients at risk for skin tears will allow targeted and timely initiation of appropriate preventive measures in order to reduce skin tear incidence, optimise quality of life, and better utilise healthcare resources (Rayner et al., 2018b; Serra et al., 2018).

Recommendations for practice

Integrating the ISTAP Classification System into the electronic health record

Correct and early identification and classification of skin tears are crucial to optimise their management (LeBlanc et al., 2018a). Inadequate or delayed treatment can cause increased pain and suffering, delayed wound healing, infection, prolonged hospitalisation, and increased healthcare costs (Stephen-Haynes, 2012; Campbell et al., 2018b; Idensohn, 2019a). The ISTAP Classification System was developed as a simple, straightforward, and time-saving instrument that can be easily implemented in research and clinical practice to support the assessment and documentation of skin tears (LeBlanc et al., 2013c). The tool contains concise descriptions and photographs illustrating each of the three severity levels. Large-scale psychometric testing showed that skin tears can be assessed in a valid and reliable way using the ISTAP classification (chapter 3). It is strongly recommended to incorporate the ISTAP Classification System within the electronic health record. By doing so, awareness will be increased, a common description provided, and a more systematic, accurate, and consistent assessment and reporting of skin tears supported. As a result, the provision of early treatment will be incentivised, meaningful communication enabled, and the quality and comparability of epidemiological data enhanced (Chang et al., 2016; LeBlanc & Baranoski, 2017; Chaplain et al., 2018; Bassola et al., 2019).

Additionally, it should be considered to develop a clinical decision support system that can be linked to the ISTAP Classification System within the electronic health record to guide clinical treatment. Such a system, providing the best treatment options for each skin tear type, can support the integration of clinical guidelines into practice (Bates et al., 2003; Van de Velde et al., 2015; Edwards et al., 2017). Skin tears are classified based on the amount of skin flap loss. The different level of loss is important and should indicate the care to be provided to preserve the skin flap as much as possible (Stephen-Haynes, 2012). Future randomised controlled trials are, however, needed to examine the efficacy of different treatment modalities and dressings on the different skin tear types, including outcomes of healing times, complications, and cost-effectiveness (White, 2001; LeBlanc et al., 2017; Woo & LeBlanc, 2018).

Towards a bundled prevention approach for maintaining skin integrity

As skin tears are considered to be largely avoidable, a primary focus should be placed on the implementation of effective prevention strategies in order to minimise their occurrence and maintain skin integrity (Stephen-Haynes, 2013; LeBlanc et al., 2018b). Current skin tear prevention strategies are, however, primarily based on expert opinion (LeBlanc, 2017; Newall et al., 2017; LeBlanc et al., 2018b). The risk factors identified in chapter 2 may contribute to the development of evidence-based, specific preventive interventions being effective in patients at risk of skin tears. Besides designing preventive interventions specifically targeted at risk factors for skin tears (e.g. the use of non-adhesive dressings, padding on equipment), the adoption of a bundled prevention approach focusing on shared risk factors for a range of different skin injuries should be considered (Lichterfeld et al., 2015; LeBlanc et al., 2016a; Brimelow & Wollin, 2018; Woo & LeBlanc, 2018).

Individuals at risk for skin tears may at the same time be at risk for developing various other skin conditions, such as pressure ulcers (PUs), medical adhesive-related skin injuries (MARSI), incontinence-associated dermatitis (IAD), intertriginous dermatitis (ITD), and peristomal or periwound moisture-associated skin damage (MASD) (Campbell et al., 2016a; Beeckman et al., 2020). Although the causes of these skin injuries differ, several risk factors (e.g. age-related skin changes, multiple comorbidities, polypharmacy, impaired mobility, functional and cognitive impairments) and potential adverse outcomes (e.g. infection, pain, impaired quality of life, increased costs and burden of care) are common (Lichterfeld et al., 2014; Campbell et al., 2016a; Campbell & Samolyk, 2020). The Skin Safety Model (SSM), proposed by Campbell et al. (2016a), provides a unified perspective on the diverse yet interconnected patient, system and causative factors that may contribute to the spectrum of skin injuries faced by older individuals with increased skin vulnerability. The SSM advocates a paradigm shift from focus on specific skin injury prevention towards a holistic patient-centered goal of maintaining skin integrity and skin barrier function. This comprehensive, overarching model can guide healthcare professionals in the recognition and

consideration of the complexity of skin injury etiology and offers a theoretical foundation for innovative and holistic skin injury prevention (Campbell et al., 2016a).

Building further on the framework of Campbell et al. (2016a), Beeckman et al. (2020) developed a best practice document that provides guidance in identifying shared risk factors and a synergistic prevention approach to maintain and promote skin integrity that will break down barriers in practice. Preventive strategies include, but are not limited to, maximising ADL performance, promoting and facilitating mobility (including repositioning and use of appropriate equipment), promoting and maintaining continence and appropriate continence care, optimising nutrition, hydration and medication use, and implementing a full individualised skin care regimen (Beeckman et al., 2020). Adequate daily topical skin care is a key preventive measure as it directly acts on the skin barrier function and should consist of gentle skin cleansing using low-irritating cleansing products and application of leave-on products, such as humectant-containing moisturisers and skin protectants (Lichterfeld et al., 2015; Beeckman et al., 2020; Lichterfeld-Kottner et al., 2020). Previous studies have shown large variations in skin care practices and product use between clinical settings, wards, and healthcare professionals, which may indicate room for quality improvement (Kottner et al., 2013; Brimelow & Wollin, 2018). High-quality clinical trials using clinically relevant and comparable outcomes are needed to further investigate the specific effects of different skin care strategies and products on the incidence of various skin conditions (Lichterfeld-Kottner et al., 2020).

As falls are a significant cause of skin injury in older individuals, it should be examined how fall prevention can be incorporated into holistic skin injury prevention programs (LeBlanc & Baranoski, 2017; Campbell & Samolyk, 2020). Risk of falling increases with age and is particularly present in patients with unsteady gait and balance, poor vision, and dementia (Gillespie et al., 2012; LeBlanc & Baranoski, 2014). Appropriate fall prevention has been shown to decrease injurious falls through mobility exercises, balance and strength training, environmental modifications (e.g. removing carpets/ loose wires), use of anti-slip shoe devices, cataract surgery, vitamin D supplementation, gradual withdrawal of psychotropic medication, and educational interventions for healthcare staff, patients and families (Cameron et al., 2012; Gillespie et al., 2012; Burland et al., 2013; Brimelow & Wollin, 2018).

Comprehensive and holistic skin injury prevention focusing on skin safety, rather than addressing a single skin injury, is strongly recommended based on both clinical and economic considerations. Integrating the prevention of various skin injuries in one program can save money and time, enhance patient comfort, and improve skin integrity outcomes, overall health, function, and well-being (Meraviglia et al., 2002; LeBlanc et al., 2016a; Beeckman et al., 2020; Campbell & Samolyk, 2020). Multiple narrow condition-focused prevention programs can result in fragmented,

inconsistent, duplicated or even omitted care, which is neither sustainable nor desirable in the modern healthcare environment (Kalisch et al., 2009; Campbell et al., 2016a). However, care should be taken that such integrated programs are flexible to allow for specific and individualised prevention, taking into account patients' needs and preferences (LeBlanc et al., 2016a). The multidisciplinary team, patients, and their families/ caregivers should be educated and actively involved in the development and implementation of skin injury prevention strategies (LeBlanc et al., 2018b; Serra et al., 2018; Beeckman et al., 2020; Campbell & Samolyk, 2020).

Recommendations for education

Strengthening knowledge and skills on the identification and classification of skin tears

The psychometric evaluation of the ISTAP Classification System revealed that healthcare professionals with a higher educational level and more experience with the assessment of skin tears and use of the ISTAP tool classified the skin tear photographs in a more correct and reliable way. Accurate identification and classification of skin tears, as well as the differentiation from other wound types, require training and insights into aetiological mechanisms, causality, and wound-related characteristics (LeBlanc et al., 2016a; Zulkowski, 2017). A correct differential diagnosis between skin tears and other wounds, such as moisture-associated skin damage (MASD) or pressure ulcers, is important because the treatment and specific preventive measures to be taken are different (Vanzi & LeBlanc, 2018). Furthermore, confusion between skin tears and other wound aetiologies might result in inaccurate record keeping and benchmark data, incorrect reporting on quality of care, and inadequate use of limited resources (Mahoney et al., 2011; Gray et al., 2012; Chang et al., 2016).

The studies of Black et al. (2016) and LeBlanc et al. (2016a) have highlighted the clinical challenges of differentiating skin tears from stage two pressure ulcers (partial thickness skin loss) and deep tissue injuries (DTI) at the blistering stage because of their similar clinical appearances and multiple co-existing risk factors. DTI pressure ulcers present as purple or maroon localised areas of discolored intact skin or blood-filled blisters due to damage of underlying soft tissue from pressure and/or shear (National Pressure Ulcer Advisory Panel et al., 2014). About 24-48 hours after the ischaemic tissue has turned purple, the epidermis may appear dry and start to lift off, creating a thin blistered appearance. Portions of the dermis may also lift, leaving a wet, bright red wound bed as seen in a deep open blister (Black et al., 2016; Fletcher et al., 2017). The blistering phase of DTI is commonly confused with skin tears due to the presence of lifted skin flaps on the wound bed. However, the timing and location should be cues to the true aetiology of the wound. Traumatic wounds such as skin tears have a known time of occurrence, whereas DTI starts deep at the bone-muscle interface and may not become apparent for 24–72 hours after the pressure event that

caused the tissue damage. In addition, DTI are uncommon on the extremities (Black et al., 2016). In the study of LeBlanc et al. (2016a), three cases of skin tear lesions in long-term care and hospitalised patients were presented. In all three cases, the skin tears were misdiagnosed as stage two pressure ulcers, which resulted in delayed implementation of skin tear prevention and treatment strategies and subsequent evolution into complex wounds.

Education and training of (future) healthcare professionals will be important for improving skin tear identification and classification skills. The development of effective methods to teach skin tear identification, classification, and differential assessment that can be easily implemented in basic nursing education, post-qualification training, and as an educational strategy in implementation or quality improvement projects, is recommended. In the field of pressure ulcers, the Pressure Ulcer Classification education tool (PuClas, currently version 4) has been developed to teach and learn about pressure ulcer classification and IAD differentiation (Beeckman & European Pressure Ulcer Advisory Panel, 2017). PuClas can be used as a stand-alone teaching module or as an e-learning module and provides information on pressure ulcer and IAD aetiology, causative factors, classification, differentiation, and typical wound-related characteristics (location, shape, edges, depth, colour, and necrosis). Case-based exercises including high quality photographs of pressure ulcers and IAD lesions and a self-assessment module are included. The PuClas tool, either administered in a traditional lecture or in e-learning format, was found to be effective in significantly improving the classification and differentiation skills of qualified nurses and nursing students (Beeckman et al., 2008; Beeckman et al., 2010b). In line with PuClas, the development of an (e-learning) education tool for skin tear identification, classification and differentiation might facilitate learning and improve skills. Critical revisions of the content of this tool will be necessary whenever the latest evidence on this topic changes. An e-learning program is probably preferable as it allows time and location flexibility, unlimited access and retrieval of learning material, repetition of training, lower time commitment, and improved cost-effectiveness compared to traditional classroom-based teaching (Zhang & Nunamaker, 2003; Mackay & Stockport, 2006; Ruggeri et al., 2013; Lahti et al., 2014). It can be used as a stand-alone module or as a supporting online educational package for blended learning (Masie, 2006; Beeckman et al., 2008). Further research will be needed to evaluate whether such an education tool might improve skin tear identification, classification and differentiation skills of (future) healthcare professionals and to what extent better skills would improve skin tear care.

Education as a core strategy to increase awareness

Several studies have revealed substantial deficits in current skin tear practices. The study of White (2001) indicated that more than half of the 520 nurses participating in their survey did not fully assess and document skin tears (e.g. shape/ depth of the wound, amount of skin loss, condition of

surrounding skin). This finding was confirmed by the study of LeBlanc et al. (2014), in which 70% of the 1127 participating nurses and physicians reported problems with current assessment and documentation of skin tears in their practice settings. Even more worrying, 40% of the participants admitted to ignoring and not documenting anything for these wounds. About 80% indicated not using any tool or classification system for assessing and documenting skin tears, with 90% favouring a simplified method (LeBlanc et al., 2014). The study of Beechey et al. (2015) showed that only 38% of the participating community nurses used a skin tear classification system. In their prevalence study, Chang et al. (2016) reported that 71% of the skin tears were not documented. Similarly, an audit in 52 nursing homes identified a lack of documentation in relation to the assessment and classification of skin tears, which negatively affected the setting of appropriate treatment goals and the delivery of adequate care (Stephen-Haynes et al., 2011). Various terms other than 'skin tears' were used to document these wounds: partial-thickness/ superficial wound, scrape, abrasion, loss of epidermis, (tape) stripping, flap, full-thickness wound, laceration, tear, avulsion, pressure ulcer-related terminology, and open wound (LeBlanc et al., 2014). The use of a standardised skin tear definition and classification system is essential to increase awareness, provide a common description, and support accurate and consistent assessment and documentation (LeBlanc & Baranoski, 2017; LeBlanc et al., 2018a). Comprehensive assessment and documentation, including both wound-related and patient-related factors, are key to setting appropriate treatment goals and optimising management (LeBlanc et al., 2018a).

In the study of White (2001), only 24% of the participating nurses from 104 different nursing homes indicated that their facility had standard protocols for the prevention (including risk assessment) and treatment of skin tears. More than half of the nurses stated that soap was routinely used to wash and bath residents (White, 2001). The use of soap as a skin cleanser should be avoided since it acts as an irritant which has been shown to cause skin dryness and increased skin pH and TEWL (Kottner et al., 2013; Lichterfeld et al., 2015; Beeckman et al., 2020). The study of LeBlanc et al. (2014) showed that only 18% of the participating nurses conducted skin tear risk assessments, 31% used moisturisers, and 8% applied padding on side rails/ wheelchairs/ equipment to prevent skin tears. Regarding the treatment of skin tears, only one-third of the participants used non-adhesive dressings and 23% reported using skin closure strips (LeBlanc et al., 2014). Almost 70% of the nurses in the study of White (2001) used skin closure strips (Steristrips) covered with a polyurethane film, Steristrips alone, or no dressing. Woo & LeBlanc (2018) reported that only 4% of the observed skin tears in their prevalence study were treated with non-adhesive dressings and that 28% had no topical dressing. In the prevalence study of Chang et al. (2016), 93% of the skin tears did not have any wound dressing. Beechey et al. (2015) found that only in 43% of the skin tears the dressing was marked with an arrow to indicate the correct direction of removal in order to prevent damage to the skin flap. In the study of Stephen-Haynes et

al. (2011), 42 out of 52 nursing homes stated that dressings to treat skin tears were changed daily. However, frequent dressing changes create avoidable costs and can cause further skin damage (Stephen-Haynes et al., 2011; LeBlanc et al., 2018a). Adequate and early skin tear treatment are imperative to improve healing and prevent complications such as infection, risk of contamination, skin flap dryness, and devitalised tissue (Meuleneire, 2002; McTigue et al., 2009). The use of non-adherent and non-traumatic low tack dressings (e.g. silicone mesh) that allow extended wear time (minimum 5 days) to avoid disturbing the skin flap is strongly recommended (Stephen-Haynes, 2012; LeBlanc et al., 2018a; Fletcher et al., 2020). Best practice guidelines discourage the use of skin closure strips because of their strong adhesive properties which may increase the risk of further skin injury upon removal (LeBlanc et al., 2018a; LeBlanc et al., 2018b).

The abovementioned study findings show a considerable gap between what is done in clinical practice and what evidence supports. It is assumed that lack of awareness, knowledge deficits, insufficient skills, common misperceptions, and negative attitudes towards skin tear assessment, reporting, prevention and treatment contribute significantly to this evidence-practice gap (McTigue, 2009; Edwards et al., 2017; LeBlanc et al., 2018b; Woo & LeBlanc, 2018). Continuing professional education programs are urgently needed to support the diffusion and implementation of best practice guidelines (LeBlanc et al., 2018a; Fletcher et al., 2020). Our newly developed and validated skin tear knowledge assessment instrument (OASES) can be used to identify widespread knowledge gaps and themes needing more focus in education programs. (Future) healthcare professionals should be convinced of the significant burden and impact of skin tears on patients' quality of life, of the importance of accurate, consistent, and comprehensive skin tear (risk) assessment and documentation, and of the need, effectiveness, and feasibility of adequate and timely prevention and treatment (LeBlanc et al., 2018b). It should be emphasised that skin tears are largely preventable and that they, although beginning as acute wounds, have a high risk to encounter complications and evolve into complex chronic wounds if not properly managed (LeBlanc et al., 2014; Idensohn et al., 2019a; Fletcher et al., 2020).

The Education Committee of the European Wound Management Association (EWMA) has developed a curricular framework that incorporates various aspects of wound management in a number of education models, including the module descriptor ‘Assessment and Management of Skin Tears’ (EWMA, 2017). This module descriptor, which specifies learning outcomes for knowledge and practical skill acquisition, provides a solid basis for the design of skin tear education programs. According to the EWMA, a skin tear education module should include following topics: epidemiology, anatomy, pathophysiology, principles of patient care assessment, assessment, risk factors, prevention, management of skin tears, psychosocial aspects of care, education, and documentation. The use of varying education methods (e.g. traditional lectures, e-learning

modules, workshops, real patient cases/ stories) is recommended in order to meet diverse learning needs (EWMA, 2017). More holistic, injury-overarching education programs may also be useful to learn about preserving skin health in general and the importance of daily routine skin care for the prevention of various skin integrity impairments (Kottner et al., 2013; Beeckman et al., 2020). As part of the Coloplast HEAL educational program, which has been endorsed by EWMA, an e-learning module focusing on the maintenance of skin integrity is available (Coloplast, 2021). Additionally, the Skin Safety Model (SSM) can be used to teach (future) healthcare professionals about the shared and interacting risk factors that contribute to a multitude of skin injuries and potential adverse outcomes (e.g. pain, infection) (Campbell et al., 2016a). Healthcare institutions are strongly encouraged to incorporate evidence-based education on skin tears and general skin health into annual mandatory training programs for healthcare staff. Current education curricula for nurses, physicians, and other involved healthcare professionals (e.g. occupational and physical therapists) need to be reconsidered to ensure that knowledge gaps regarding skin tears and skin health are covered.

Multidisciplinary education should also involve tailored patient/ family education (Idensohn et al., 2019a). Educating patients and their families on skin frailty risk and injury prevention through adequate skin care (e.g. use of appropriate skin cleansers, application of moisturisers), optimising nutrition/ hydration, creating a safe environment, proper transferring techniques, mobility exercises, and active involvement in ADLs can empower them to engage in their own care and improve experiences and outcomes (Beechey et al., 2015; LeBlanc et al., 2018b; Beeckman et al., 2020; Fletcher et al., 2020).

Recommendations for policy

Towards an international language for skin tears

A variety of terms and definitions have been used to describe and document skin tears (LeBlanc et al., 2014; Rayner et al., 2015; LeBlanc et al., 2018a). The lack of standardised, universally adopted terminology contributes to confusion, misdiagnosis, subsequent inadequate treatment and prevention, inaccurate record-keeping, and wide variations in epidemiological data (LeBlanc et al., 2018a). In 2011, an international expert panel (ISTAP) obtained consensus on the term ‘skin tear’ and defined skin tears as *“wounds caused by shear, friction, and/or blunt force resulting in separation of skin layers. They can be partial-thickness (separation of the epidermis from the dermis) or full-thickness (separation of both the epidermis and dermis from underlying structures)”* (LeBlanc & Baranoski, 2011). This definition was updated by the ISTAP panel in 2018 as part of their best practice document for the prevention and management of skin tears (see chapter 1) (LeBlanc et al., 2018a). The current version of the WHO International Classification of Diseases

(ICD-11) contains codes for several wound aetiologies such as pressure ulcers (EH90) and incontinence-associated dermatitis (EK02.22), but does not contain separate coding for skin tears (World Health Organization, 2018). In the ICD-11, skin tears are subsumed under the general term 'laceration' (which is in turn subsumed under the parent terms 'open wound' and 'perineal laceration during delivery') and labelled according to their anatomical site of injury. However, a skin tear is a specific injury that is very different from a general laceration, which is defined as a jagged and irregular cut or tearing of soft body tissue (LeBlanc et al., 2018a; National Library of Medicine, 2019). In the ICD-10, skin tears are not even mentioned (World Health Organization, 2016).

The absence of a specific ICD-code for skin tears may in part explain the perceived insignificance, frequent misdiagnosis, and potential for underreporting of these wounds by healthcare professionals (Rayner et al., 2015). Skin tears must be recognised as a unique condition distinct from other wound aetiologies and should be included as an index term in the ICD (LeBlanc et al., 2018a). An ICD-code for skin tears will provide a common language, increase global awareness, and permit the systematic recording, analysis, interpretation and comparison of skin tear data collected in different healthcare settings or countries and at different times (World Health Organization, 2021b). These statistics can be used to track quality of care, support data-driven decision making, and allocate healthcare spending and investment (Kottner et al., 2020b). Furthermore, the use of consistent terminology for skin tears will improve prevention and management practices and facilitate the comparability of research globally (LeBlanc, 2017; LeBlanc et al., 2018a).

Integrating skin tears in quality measurements

Pressure ulcers are nationally and internationally accepted as an important indicator of the quality of care in hospitals, nursing homes, and community care settings (Agency for Healthcare Research and Quality, 2014; Beeckman et al., 2018a; Kottner et al., 2018; Li et al., 2020; Vlaams Instituut voor Kwaliteit van Zorg, 2021; Zorg en Gezondheid, 2021). Ongoing measurement and monitoring of pressure ulcer prevalence, incidence, and care practices have enabled benchmarking performance (over time and across units/ healthcare settings/ countries), initiated the development and implementation of quality improvement initiatives, and improved the quality of preventive care (Bours et al., 2004; Krupp & Monfre, 2015). Similar to pressure ulcers, skin tears are considered to be largely preventable adverse events that are sensitive to the quality of (nursing) care (LeBlanc, 2017). Therefore, it is recommended to include skin tears in current wound audit programs as part of a multifaceted strategy to improve skin tear care (LeBlanc & Baranoski, 2014; LeBlanc et al., 2018b). By combining the observation of various wound types such as pressure ulcers, IAD, and skin tears in one prevalence survey, valuable and much-needed data can be obtained without increased financial or staff resources, nor increased survey participation burden for patients

(Santamaria et al., 2009; Campbell et al., 2016b). Quality data are needed to estimate the burden of skin tears, to gain insight into resource requirements, to allow data-driven decision making, and to support the design, implementation, evaluation and adjustment of quality improvement strategies (Anderson et al., 2013). Conducting routine skin tear prevalence and/or incidence studies may raise staff and patient awareness of the problem of skin tears, allow benchmarking and monitoring performance, influence resource allocation, and ultimately improve patient care and outcomes (Gallagher et al., 2008; Anderson et al., 2013).

In order to be able to measure the quality of skin tear care and allow the development of targeted improvement interventions, skin tear-related quality indicators at structural (attributes of the care setting: material and human resources, organisational structure), process (activities of the care-giving practitioners), and outcome (effects of care on the health status of the patient) level should be defined (Donabedian, 1988; Agency for Healthcare Research and Quality, 2014). Quality indicators are standardised quantitative measures of practice performance for which there is evidence or consensus that they can be used to assess the quality of care (Campbell et al., 2002). They should be based on agreed definitions, described exhaustively and exclusively, relate to clearly identifiable events for the user, permit useful comparisons, be specific and sensitive, valid and reliable, and based on the best available evidence (Mainz, 2003; Kötter et al., 2012). Suggestions for possible structural indicators could be the availability of an evidence-based skin care protocol in the healthcare setting, the presence of appropriate non-adhesive dressings, the presence of a reference nurse, the presence of a multidisciplinary skin tear committee, the provision of regular mandatory training for healthcare professionals, the performance of regular audits of skin tear prevalence/ incidence/ practices, and the dissemination of audit results to key stakeholders and staff. Process indicators could include the performance and documentation of comprehensive skin assessments/ regular reassessments, the performance and documentation of standardised risk assessments/ regular reassessments, the implementation of an individualised prevention plan, the systematic reporting and evaluation of skin tears, and the use of adequate prevention and treatment strategies. Possible outcome indicators could be skin tear prevalence, incidence, prevalence of hospital-acquired skin tears, number of skin tears that transition to complex/ chronic wounds, average healing time, and patient satisfaction. The aforementioned suggestions can only serve as a starting point since the design of high-quality indicators requires a rigorous development and validation process (Kötter et al., 2012).

CONCLUSION

Skin tears represent a significant problem for patients and the multidisciplinary team across the continuum of healthcare settings. Despite their high prevalence, substantial impact on the well-being of patients and considerable financial burden to healthcare systems, skin tears remain an under-recognised injury in clinical practice and research. In the last few years, international best practice guidelines for the prevention and management of skin tears have been developed to support healthcare professionals with evidence-based decision-making, decrease variations in care, improve patient outcomes, and reduce costs. However, compliance with these guidelines in clinical practice is lacking. This thesis contributes to the small but growing body of evidence on skin tear epidemiology and provides tools to facilitate the translation of best practice guidelines into practice in order to improve skin tear care. Furthermore, this thesis provides necessary foundations for future research on the development and evaluation of preventive, therapeutic, and educational interventions.

Skin tears are mostly avoidable through the early identification of patients at risk and the timely application of targeted preventive measures. A structured and comprehensive risk assessment should be the first step of any prevention plan. Our research indicated that nursing home residents with advanced age, a history of skin tears, chronic use of corticosteroids, dependency for transfers, and use of adhesives/dressings have a higher risk of developing skin tears. The development of a valid, reliable, and easy-to-use skin tear risk assessment tool integrating the key risk factors is strongly recommended. Furthermore, the adoption of a bundled prevention approach focusing on shared risk factors for a range of different skin injuries should be considered.

When a skin tear occurs, it needs to be correctly identified and fully documented in order to optimise management from the earliest possible stage of care and prevent it from transitioning into a complex chronic wound. The use of a standardised and internationally accepted skin tear classification system, providing a common description, is recommended to support systematic, accurate, and consistent assessment and reporting. Consequently, meaningful clinical and scientific communication will be enabled, the quality and comparability of skin tear prevalence and incidence data enhanced, and benchmarking and clinical audits facilitated. Our global psychometric study showed that skin tears can be assessed in a valid and reliable way using the ISTAP Classification System, which is available in 15 languages. Integration of the ISTAP Classification System into the electronic health record should be considered. Additionally, since there is a clear need for standardisation in terminology, a specific ICD-code for skin tears should be created.

Continued education of (future) healthcare professionals on skin tears and skin health in general will be of key importance to increase awareness, improve knowledge, skills and attitudes, and bridge the gap between evidence and practice. Our newly developed and validated skin tear knowledge assessment instrument (OASES) can be used to identify widespread knowledge gaps and focus areas. Insights into the educational needs and priorities may support the development of tailored educational programs and other strategies aimed at improving the quality of skin tear care.

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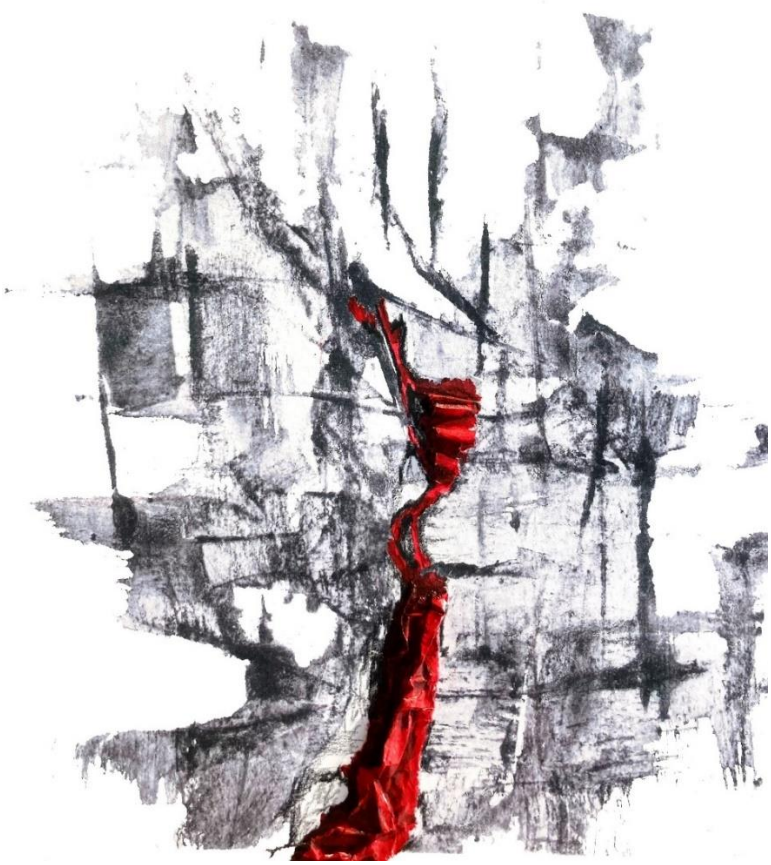

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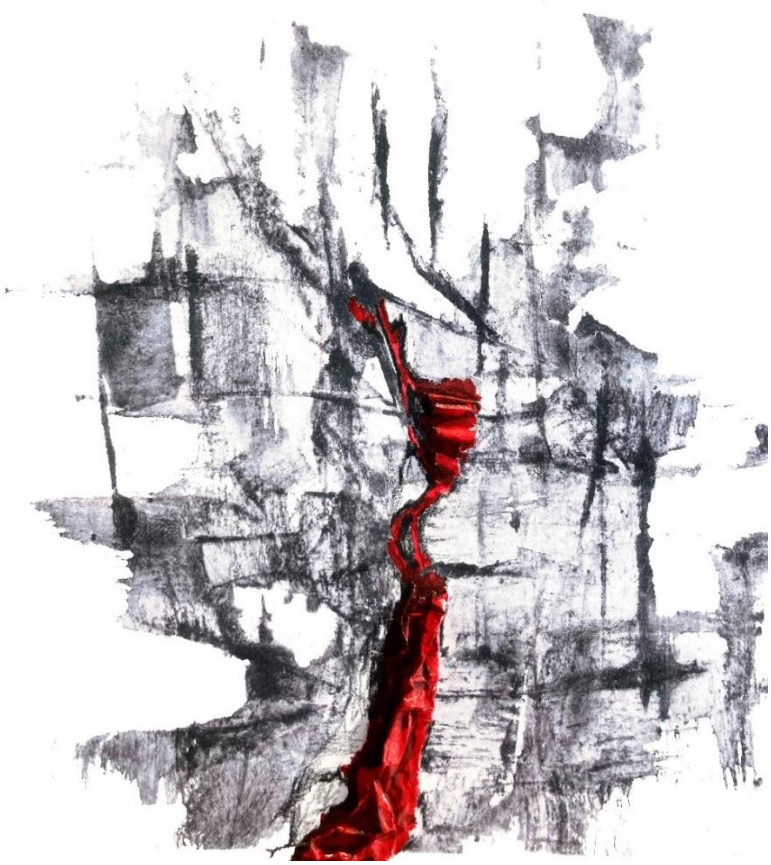
Appendix



Appendix 1. Supplementary demographics of the participants (chapter 3)

	Test (n = 1601) n (%) / Mean (SD)	**Retest (n = 952)** n (%) / Mean (SD)	**P value** [a]
Age			0.131
< 30 years	361 (22.5)	177 (18.6)	
30 – 39 years	387 (24.2)	244 (25.6)	
40 – 49 years	383 (23.9)	238 (25.0)	
≥ 50 years	470 (29.4)	293 (30.8)	
Work experience in healthcare			0.092
< 5 years	306 (19.1)	147 (15.4)	
5 – 10 years	287 (17.9)	171 (18.0)	
11 – 20 years	360 (22.5)	239 (25.1)	
> 20 years	648 (40.5)	395 (41.5)	
Current work setting			0.769
Local hospital	546 (34.1)	323 (33.9)	
Teaching / university hospital	425 (26.5)	251 (26.4)	
Magnet hospital	55 (3.4)	21 (2.2)	
Nursing home	116 (7.2)	68 (7.1)	
Community care	243 (15.2)	162 (17.0)	
Education	93 (5.8)	59 (6.2)	
Clinical research	20 (1.2)	15 (1.6)	
Industry / commercial	9 (0.6)	5 (0.5)	
No work / student	41 (2.6)	24 (2.5)	
Other	50 (3.1)	24 (2.5)	
Missing	3 (0.2)	0 (0.0)	
Observation of STs in practice [b]			0.876
None	216 (13.5)	127 (13.3)	
< 5 times a week	989 (61.8)	602 (63.2)	
5 – 10 times a week	322 (20.1)	183 (19.2)	
> 10 times a week	74 (4.6)	40 (4.2)	
Country of work			0.438
Australia	82 (5.1)	50 (5.3)	
Austria	5 (0.3)	4 (0.4)	
Belgium	175 (10.9)	128 (13.4)	
Botswana	2 (0.1)	1 (0.1)	
Brazil	3 (0.2)	1 (0.1)	
Canada	122 (7.6)	89 (9.3)	
Chile	69 (4.3)	45 (4.7)	
China	148 (9.2)	74 (7.8)	

Colombia	1 (0.1)	0 (0.0)
Costa Rica	2 (0.1)	0 (0.0)
Cyprus	1 (0.1)	1 (0.1)
Czech Republic	105 (6.6)	58 (6.1)
Denmark	19 (1.2)	12 (1.3)
Germany	105 (6.6)	58 (6.1)
India	1 (0.1)	0 (0.0)
Indonesia	3 (0.2)	1 (0.1)
Iran	2 (0.1)	0 (0.0)
Ireland	2 (0.1)	2 (0.2)
Israel	62 (3.9)	35 (3.7)
Italy	31 (1.9)	15 (1.6)
Japan	54 (3.4)	46 (4.8)
Jersey	1 (0.1)	0 (0.0)
Kenya	2 (0.1)	1 (0.1)
Malaysia	1 (0.1)	0 (0.0)
Malta	3 (0.2)	2 (0.2)
Mauritius	1 (0.1)	0 (0.0)
Namibia	2 (0.1)	1 (0.1)
the Netherlands	125 (7.8)	89 (9.3)
Norway	1 (0.1)	1 (0.1)
Philippines	3 (0.2)	3 (0.3)
Portugal	50 (3.1)	39 (4.1)
Saudi Arabia	1 (0.1)	1 (0.1)
Singapore	2 (0.1)	1 (0.1)
Slovakia	6 (0.4)	3 (0.3)
South Africa	56 (3.5)	24 (2.5)
Sri Lanka	1 (0.1)	0 (0.0)
Sweden	56 (3.5)	35 (3.7)
Switzerland	2 (0.1)	1 (0.1)
Taiwan	2 (0.1)	2 (0.2)
Thailand	1 (0.1)	0 (0.0)
Turkey	141 (8.8)	63 (6.6)
United Arab Emirates	9 (0.6)	3 (0.3)
United Kingdom	33 (2.1)	10 (1.1)
United States of America	108 (6.7)	53 (5.6)

STs: skin tears, [a]: chi-square (χ^2) test ($p < 0.05$ considered statistically significant), [b]: estimated number of observed skin tears in practice (average a week)

Appendix 2. Search strategy MEDLINE (PubMed interface) (chapter 4)

	Concept	Search terms
# 1	Skin tears	skin tear*[Title/Abstract] OR “Lacerations”[MeSH] OR skin laceration*[Title/Abstract] OR pre-tibial laceration*[Title/Abstract] OR abrasion*[Title/Abstract] OR skin rupture*[Title/Abstract] OR tear wound*[Title/Abstract] OR geri tear*[Title/Abstract] OR epidermal tear*[Title/Abstract]
# 2	Classification	“Classification”[MeSH] OR classification[MeSH Subheading] OR classif*[Title/Abstract] OR categor*[Title/Abstract] OR grad*[Title/Abstract] OR stag*[Title/Abstract] OR hierarch*[Title/Abstract] OR taxonom*[Title/Abstract]
# 3	Measurement properties	(instrumentation[sh] OR methods[sh] OR “Validation Studies”[pt] OR “Comparative Study”[pt] OR “psychometrics”[MeSH] OR psychometr*[tiab] OR clinimetr*[tw] OR clinometr*[tw] OR “outcome assessment (health care)”[MeSH] OR “outcome assessment”[tiab] OR “outcome measure*”[tw] OR “observer variation”[MeSH] OR “observer variation”[tiab] OR “Health Status Indicators”[Mesh] OR “reproducibility of results”[MeSH] OR reproducib*[tiab] OR “discriminant analysis”[MeSH] OR reliab*[tiab] OR unreliab*[tiab] OR valid*[tiab] OR “coefficient of variation”[tiab] OR coefficient[tiab] OR homogeneity[tiab] OR homogeneous[tiab] OR “internal consistency”[tiab] OR (cronbach*[tiab] AND (alpha[tiab] OR alphas[tiab])) OR (item[tiab] AND (correlation*[tiab] OR selection*[tiab] OR reduction*[tiab])) OR agreement[tw] OR precision[tw] OR imprecision[tw] OR “precise values”[tw] OR test-retest[tiab] OR (test[tiab] AND retest[tiab]) OR (reliab*[tiab] AND (test[tiab] OR retest[tiab])) OR stability[tiab] OR interrater[tiab] OR inter-rater[tiab] OR intrarater[tiab] OR intra-rater[tiab] OR intertester[tiab] OR inter-tester[tiab] OR intratester[tiab] OR intra-tester[tiab] OR interobserver[tiab] OR inter-observer[tiab] OR intraobserver[tiab] OR intra-observer[tiab] OR intertechnician[tiab] OR inter-technician[tiab] OR intratechnician[tiab] OR intra-technician[tiab] OR interexaminer[tiab] OR inter-examiner[tiab] OR intraexaminer[tiab] OR intra-examiner[tiab] OR interassay[tiab] OR inter-assay[tiab] OR intraassay[tiab] OR intra-assay[tiab] OR interindividual[tiab] OR inter-individual[tiab] OR intraindividual[tiab] OR intra-individual[tiab] OR interparticipant[tiab] OR inter-participant[tiab] OR intraparticipant[tiab] OR intra-participant[tiab] OR kappa[tiab] OR kappa’s[tiab] OR kappas[tiab] OR repeatab*[tw] OR ((replicab*[tw] OR repeated[tw]) AND (measure[tw] OR measures[tw] OR findings[tw] OR result[tw] OR results[tw] OR test[tw] OR tests[tw])) OR generaliza*[tiab] OR generalisa*[tiab] OR concordance[tiab] OR (intraclass[tiab] AND correlation*[tiab]) OR discriminative[tiab] OR “known group”[tiab] OR “factor analysis”[tiab] OR “factor analyses”[tiab] OR “factor structure”[tiab] OR “factor structures”[tiab] OR dimension*[tiab] OR subscale*[tiab] OR (multitrait[tiab] AND scaling[tiab] AND (analysis[tiab] OR analyses[tiab])) OR “item discriminant”[tiab] OR “interscale correlation*”[tiab] OR error[tiab] OR errors[tiab] OR “individual variability”[tiab] OR “interval variability”[tiab] OR “rate variability”[tiab] OR (variability[tiab] AND (analysis[tiab] OR values[tiab])) OR (uncertainty[tiab] AND

		(measurement[tiab] OR measuring[tiab])) OR “standard error of measurement”[tiab] OR sensitiv*[tiab] OR responsive*[tiab] OR (limit[tiab] AND detection[tiab]) OR “minimal detectable concentration”[tiab] OR interpretab*[tiab] OR ((minimal[tiab] OR minimally[tiab] OR clinical[tiab] OR clinically[tiab]) AND (important[tiab] OR significant[tiab] OR detectable[tiab]) AND (change[tiab] OR difference[tiab])) OR (small*[tiab] AND (real[tiab] OR detectable[tiab]) AND (change[tiab] OR difference[tiab])) OR “meaningful change”[tiab] OR “ceiling effect”[tiab] OR “floor effect”[tiab] OR “Item response model”[tiab] OR IRT[tiab] OR Rasch[tiab] OR “Differential item functioning”[tiab] OR DIF[tiab] OR “computer adaptive testing”[tiab] OR “item bank”[tiab] OR “cross-cultural equivalence”[tiab])
# 4	**Complete search**	**# 1 AND # 2 AND # 3**

Appendix 3. Description of the included classification systems (chapter 4)

Classification system	User group	Instrument description	Original language	Available translations
Payne-Martin Classification System for Skin Tears (Payne & Martin, 1990)	Healthcare professionals and researchers	3 categories and 4 subcategories (images and descriptions) *slightly revised in 1993:* • Category I: Skin tears without tissue loss ○ A. Linear type *A full thickness wound which occurs in a wrinkle or furrow of the skin. Both the epidermis and the dermis are pulled apart as if an incision has been made, exposing the tissue below.* ○ B. Flap type *A partial thickness wound in which the epidermal flap can be completely approximated or approximated so that no more than one millimeter of the dermis is exposed.* • Category II: Skin tears with partial tissue loss ○ A. Scant tissue loss type *A partial thickness wound in which ≤ 25% of the epidermal flap is lost and ≥ 75% of the dermis is covered by the flap.* ○ B. Moderate-to-large tissue loss type *A partial thickness wound in which > 25% of the epidermal flap is lost and > 25% of the dermis is exposed.* • Category III: Skin tears with complete tissue loss *A partial thickness wound in which the epidermal flap is absent.*	English	No data or information
Dunkin Classification of Pretibial Injuries (Dunkin et al., 2003)	Healthcare professionals and surgeons who manage pretibial injuries	4 types (+ management algorithm that defines options according to the type of injury): • Type 1: Laceration • Type 2: Laceration or flap with minimal haematoma and/or skin-edge necrosis	English	No data or information

		• Type 3: Laceration or flap with moderate to severe haematoma and/or necrosis • Type 4: Major degloving injury		
Lo Classification of Pretibial Lacerations (Lo et al., 2012)	Surgeons who manage pretibial lacerations	5 types (+ management algorithm that defines options according to the type of injury): • Type 1: Linear laceration without skin loss • Type 2: Flap laceration viable • Type 3: Flap laceration non-viable • Type 4: Skin loss • Type 5: Laceration with haematoma	English	No data or information
Skin Tear Audit Research (STAR) Skin Tear Classification System (Carville et al., 2007)	Healthcare professionals and researchers	5 categories (images and descriptions): • Category 1a *A skin tear where the edges **can** be realigned to the normal anatomical position (without undue stretching) and the skin or flap colour **is not** pale, dusky or darkened.* • Category 1b *A skin tear where the edges **can** be realigned to the normal anatomical position (without undue stretching) and the skin or flap colour **is** pale, dusky or darkened.* • Category 2a *A skin tear where the edges **cannot** be realigned to the normal anatomical position and the skin or flap colour **is not** pale, dusky or darkened.* • Category 2b *A skin tear where the edges **cannot** be realigned to the normal anatomical position and the skin or flap colour **is** pale, dusky or darkened.* • Category 3 *A skin tear where the skin flap is completely absent.*	English	Portuguese

International Skin Tear Advisory Panel (ISTAP) Skin Tear Classification System (LeBlanc et al., 2013c)	Healthcare professionals and researchers	3 types (images and descriptions): • Type 1: No skin loss *Linear or flap tear that can be repositioned to cover the wound bed.* • Type 2: Partial flap loss *Partial flap loss that cannot be repositioned to cover the wound bed.* • Type 3: Total flap loss *Total flap loss exposing the entire wound bed.* A definition of a "skin flap" was developed (Delphi study) and added to the ISTAP Classification System in 2020: *"A flap in skin tears is defined as a portion of the skin (epidermis/dermis) that is unintentionally separated (partially or fully) from its original place due to shear, friction, and/or blunt force. This concept is not to be confused with tissue that is intentionally detached from its place of origin for therapeutic use, e.g. surgical skin grafting."* (Van Tiggelen et al., 2020)	English	Arabic, Chinese, Czech, Danish, Dutch, French, German, Hebrew, Italian, Japanese, Portuguese, Spanish, Swedish, Turkish

Appendix 4. Reasons for downgrading the quality of evidence per measurement property per classification system (chapter 4)

Measurement property	Classification system	Summary result	Overall rating	Quality of evidence
Reliability	STAR	κ = 0.29 to 0.93	Insufficient (-)	Very low: risk of bias -1 (multiple studies of doubtful quality), inconsistency -2 (summarised result is rated insufficient based on the majority of results, the reported results are very inconsistent)
	ISTAP	Interrater reliability: κ = 0.46 to 0.69	Insufficient (-)	Moderate: indirectness -1 (indirect skin observation based on photographs)
		Intrarater reliability: κ = 0.74 to 0.88	Sufficient (+)	
Measurement error	STAR	No info available	No info available	No info available
	ISTAP	p_o = 0.68 to 0.83	Sufficient (+)	Moderate: indirectness -1 (indirect skin observation based on photographs)
Criterion validity	STAR	43.3% to 53.3%	Insufficient (-)	Very low: risk of bias -2 (multiple studies of inadequate quality), indirectness -1 (indirect skin observation based on photographs)
	ISTAP	72.5% to 92.0%	Sufficient (+)	Moderate: indirectness -1 (indirect skin observation based on photographs)

Appendix 5. Final skin tear knowledge assessment instrument (OASES) (chapter 5)

DOMAIN 1: AETIOLOGY

1. What is a skin tear?

a. A traumatic wound caused by mechanical forces, including removal of adhesives. *
b. A traumatic wound caused by chemical/biological irritants.
c. A chronic wound caused by moisture, friction and shear.
d. A chronic wound caused by pressure or pressure in combination with shear.

2. How does the ageing process affect the physiology of the skin?

a. Increased sweat gland function.
b. Increased skin elasticity.
c. Increased amount of subcutaneous fat.
d. Flattening of the dermo-epidermal junction. *

3. Which factor is associated with dry skin in an elderly population?

a. Increased activity of sweat glands.
b. Decreased activity of sebaceous glands. *
c. Increased collagen synthesis.
d. Decreased production of elastin.

DOMAIN 2: CLASSIFICATION AND OBSERVATION

4. Which information should be documented when doing the assessment of skin tears?

1. Cause, length, width, depth, and pain.
2. Type and amount of exudate, integrity of surrounding skin, and medication.
3. General health status, nutrition, and mental health status.

a. 1 & 2
b. 2 & 3
c. 1 & 3
d. 1, 2 & 3 *

5. Classify this skin tear using the International Skin Tear Advisory Panel (ISTAP) Classification System (2019).

a. Type 1 skin tear – No skin loss.
b. Type 2 skin tear – Partial flap loss.
c. Type 3 skin tear – Total flap loss. *
d. Unstageable.

6. Which picture is a type 1 skin tear according to the ISTAP Classification System (2019)?

a.

b.

c. *

d.

7. Classify this skin tear using the ISTAP Classification System (2019).

a. Type 1 skin tear – No skin loss.
b. Type 2 skin tear – Partial flap loss. *
c. Type 3 skin tear – Total flap loss.
d. Unstageable.

DOMAIN 3: RISK ASSESSMENT

8. Why are neonates at risk of developing a skin tear?

a. They have a limited blood supply to the extremities.
b. They have a decreased cohesion between the epidermis and the dermis. *
c. They have an increased number of anchoring fibrils at the dermo-epidermal junction.
d. They have an increased number of elastic fibers in the dermis.

9. Why is the long-term use of corticosteroids a risk factor for developing a skin tear?

a. They are associated with skin atrophy. *
b. They are associated with an increase in collagen production.
c. They are associated with an increased risk of bleeding.
d. They are associated with a reduced immune system.

DOMAIN 4: PREVENTION

10. Which of the following preventive measures is appropriate for a patient in a wheelchair with a skin tear on the lower limb?

a. Pad the wheelchair leg supports. *
b. Clean the skin with a detergent soap.
c. Rub the skin dry to increase circulation.
d. Apply an iodine-based dressing.

11. Why are skin moisturisers applied to prevent skin tears?

a. They prevent the skin from cracking and fissuring.
b. They replenish natural skin moisture. *
c. They act as a barrier against microbial invasion and physical injuries.
d. They accelerate skin cell turnover.

12. CASE: Mr. Scott, 85 years old, nursing home resident. Medical history: Incontinence, dementia, multiple falls, dependence for activities of daily living (ADLs). Multiple small skin tears on both legs and senile purpura on both arms are observed. Which of the following interventions should be part of his care plan to prevent occurrence of new skin tears?

a. Encouraging active involvement in ADLs, daily bathing using soap, moisturising the skin.
b. Ensuring a safe environment (e.g. adequate lighting), daily bathing, non-adherent dressings with silicone coating on skin tears.
c. Wearing protective clothing, moisturising the skin, non-adherent dressings with silicone coating on skin tears. *
d. Applying padding on furniture (e.g. table edges), daily bathing, hydrocolloid dressings on skin tears.

13. A humectant (e.g. urea) supports skin hydration. Why?

a. It draws water from the epidermis to the dermis to increase the levels of moisturisation in the dermo-epidermal junction.
b. It draws water from the dermis to the epidermis and compensates for the reduced levels of natural moisturisers in the skin. *
c. It traps moisture into the skin and reduces water loss by evaporation.
d. It softens the skin to aid absorption of moisture.

14. What is NOT an effective intervention to prevent skin tears?

a. The use of soap to cleanse the skin. *
b. The use of long sleeves and trousers to add a layer of protection to the extremities.
c. The use of padding on bed rails, wheelchair arm/leg supports and other equipment to minimise the risk of potential trauma.
d. The use of pillows and blankets to support dangling arms and legs.

15. What is effective to reduce the risk of developing a skin tear?

a. Rub the patient's skin to ensure it is dry after bathing.
b. Bath the patient every day and pat the patient's skin dry.
c. Bath the patient every day and use soft cloths and towels.
d. Minimise the frequency of bathing, if possible. *

DOMAIN 5: TREATMENT

16. CASE: A nurse removes an intravenous catheter. A skin tear is caused as a result of this action. What do you consider to be appropriate care for this patient?

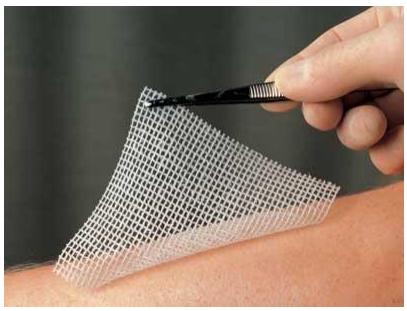
a. Control bleeding, cleanse the wound, re-approximate the skin edges with adhesive strips, manage infection/inflammation and exudate, and apply a gauze dressing and re-assess in 24 hours.
b. Control bleeding, cleanse the wound, re-approximate the remaining viable flap using a dampened cotton tip, manage infection/inflammation and exudate, and apply a non-adhesive dressing. *
c. Control bleeding by applying pressure firmly, cleanse the wound, debride the skin flap, manage infection/inflammation and exudate, and apply a film dressing.
d. Control bleeding by applying pressure firmly, cleanse the wound, re-approximate the remaining viable flap using a gloved finger, manage infection/inflammation and exudate, and apply an iodine-based dressing.

17. Which of the following products is recommended for use in skin tears?

a. Hydrocolloid dressings

b. Skin closure strips

c. Paraffin gauze



d. Non-adherent dressings with silicone coating *

18. The ideal dressing for managing skin tears has to:

1. Create a moist wound healing environment.
2. Afford extended wear time.
3. Be flexible and mould to contours.

a. 1 & 2
b. 2 & 3
c. 1 & 3
d. 1, 2 & 3 *

19. CASE: Type 2 skin tear (partial flap loss). After cleansing the wound bed, the following observations can be made:

T: Thin fibrin layer
I: No signs of local infection
M: Dry wound, no exudate
E: Fragile surrounding skin

Which treatment do you recommend after cleansing the wound bed?

a. Apply a non-adherent dressing with silicone coating and cover with a secondary dressing. Replace the dressings every 2-3 days and cleanse the wound thoroughly during dressing changes.
b. Apply a silicone mesh dressing and keep in place for 6-7 days. Cover with a secondary dressing. Cleanse the wound daily without removing the silicone mesh dressing and apply a hydrogel. *
c. Apply a gauze dressing and use paper tape to secure in place. Replace the dressing every 6-7 days. Cleanse the wound thoroughly during dressing changes and apply a hydrogel.
d. Apply wound strips to approximate the wound edges. Cover with a secondary dressing and replace the secondary dressing every 2-3 days.

DOMAIN 6: SPECIFIC PATIENT GROUPS

20. Who has the highest risk of developing a skin tear?

a. Preschool obese children.
b. Female adults.
c. Premature new-borns and elderly. *
d. Age is not associated with risk of skin tears.

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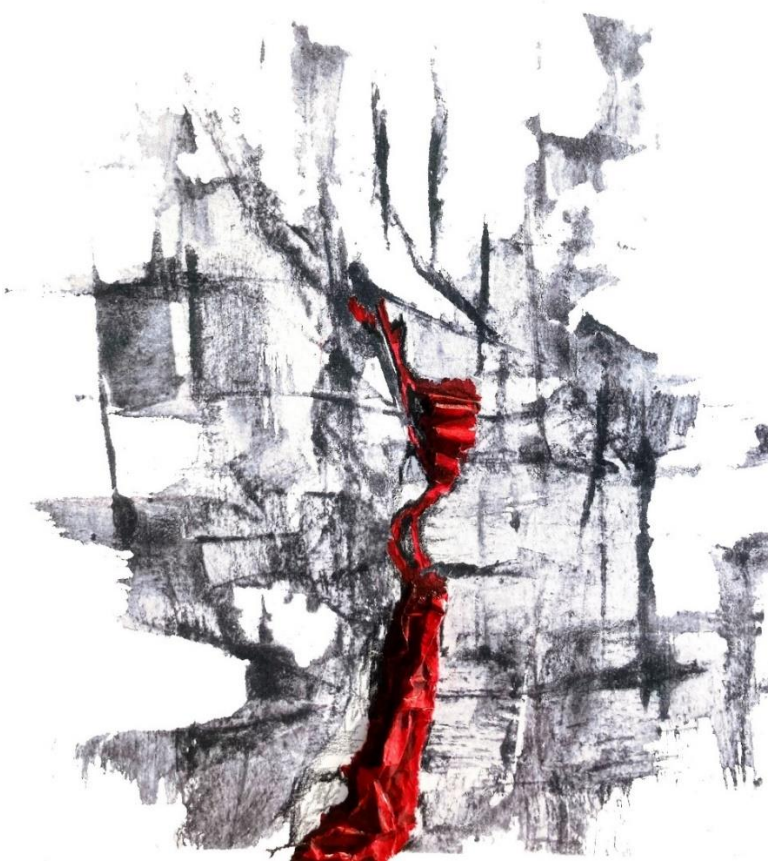
* indicates the correct answer.

The response alternative “e. I do not know the answer.” should be added to every item.

Summary



With an ageing population and increasing prevalence of chronic diseases, more patients will be at risk of developing various skin integrity impairments, such as skin tears. Skin tears are defined as *"traumatic wounds caused by mechanical forces, including removal of adhesives. Severity may vary by depth (not extending through the subcutaneous layer)"*. Although skin tears are acute wounds with the potential to heal by primary intention, they have a high probability of evolving into complex chronic wounds if not properly managed. Difficult-to-heal wounds can seriously affect patients' quality of life and impose a significant economic burden on the healthcare system. Despite their clinical relevance, skin tears remain an under-recognised and under-reported injury, which often results in suboptimal prevention and delayed or inappropriate treatment. In this context, this dissertation aimed to develop and validate tools to (1) standardise the assessment and documentation of skin tears for clinical practice and research purposes, and (2) support the development of tailored education programs for (future) healthcare professionals. Furthermore, skin tear prevalence and associated factors were examined in the Belgian nursing home population to determine the true extent of the problem and to inform the development of effective preventive strategies.

The first study of this dissertation (**chapter 2**) represents the first prevalence investigation of skin tears in Belgium and only the fourth in Europe. This cross-sectional observational study revealed a skin tear prevalence of 3.0% in 1153 Belgian nursing home residents. Knowledge of skin tear prevalence is essential to gain insight into the magnitude of the problem and may aid in resource allocation, allow benchmarking, enable goal setting, and support the implementation of evidence-based prevention, treatment, and educational strategies. Since skin tears are largely preventable adverse events that are sensitive to the quality of care provided by the multidisciplinary team, it is recommended to include them in current wound audit programs as part of a multifaceted strategy to improve skin tear care. To enhance the quality, interpretability, and comparability of epidemiological skin tear data across different healthcare settings and countries, the development of a standardised data collection procedure using a valid and reliable minimum data set (MDS) is required. Policymakers should discuss the importance, possible consequences, and feasibility of the development and implementation of skin tear-related quality indicators at structural, process, and outcome level.

In addition to investigating skin tear prevalence, this study also aimed to identify factors independently associated with skin tear presence. Such knowledge permits early identification of patients at risk, timely initiation of prevention, and targeting of preventive measures at specific associated factors. Multivariate binary logistic regression analyses showed that nursing home residents with advanced age, a history of skin tears, chronic use of corticosteroids, dependency for transfers, and use of adhesives/dressings have a higher risk of developing skin tears. Future

research should examine how the current knowledge on a wide range of skin tear risk factors can be integrated into a reliable and easy-to-use skin tear risk assessment tool with adequate predictive validity for use in research and practice. Additionally, the adoption of a bundled prevention approach focusing on shared risk factors for a range of different skin injuries should be considered.

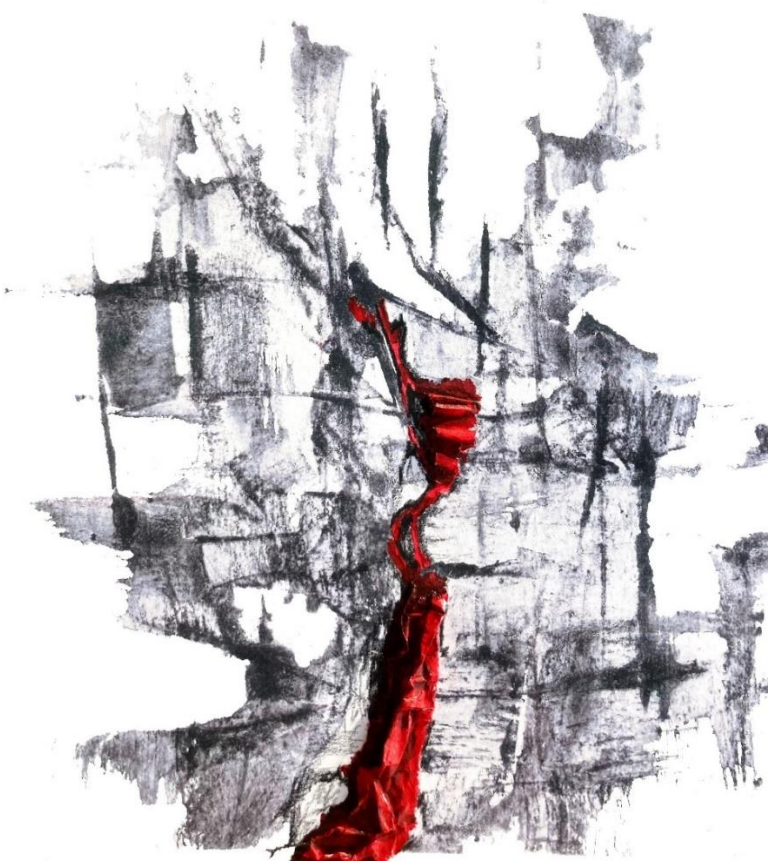
Skin tears are frequently misdiagnosed and poorly reported, resulting in incorrect and incomparable prevalence and incidence data, inadequate treatment, and avoidable complications. The common use of a standardised, globally accepted (ICD) definition and classification system for skin tears may support a more systematic, consistent, and accurate assessment and reporting. Therefore, the second study of this dissertation (**chapter 3**) aimed to psychometrically validate the ISTAP Classification System internationally. The ISTAP Classification System was developed as a simple and easy-to-use tool, categorising skin tears as type 1 (no skin/flap loss), type 2 (partial skin/flap loss), or type 3 (total skin/flap loss). After a two-round Delphi procedure with 17 experts from 11 countries, the following definition of a 'skin flap' was added to the tool: *"A flap in skin tears is defined as a portion of the skin (epidermis/ dermis) that is unintentionally separated (partially or fully) from its original place due to shear, friction, and/or blunt force. This concept is not to be confused with tissue that is intentionally detached from its place of origin for therapeutic use, e.g. surgical skin grafting"*. The results of the psychometric testing in a sample of 1601 healthcare professionals from 44 countries showed that skin tears can be assessed in a valid and reliable way using the ISTAP Classification System. Higher accuracy, reliability and agreement estimates were found in more experienced and higher educated healthcare professionals, implying that sufficient and adequate education and training will be important for optimising skin tear identification and classification skills. It should be considered to integrate the ISTAP tool into the electronic health record and to use it in future skin tear research to enhance the accuracy and comparability of study results. In the context of our study, the tool was translated into 15 languages, encouraging global awareness and implementation.

Besides the ISTAP classification, some other skin tear classifications exist. To find out which classification can be recommended for use in research and practice, the third study of this dissertation (**chapter 4**) aimed to critically appraise, compare, and summarise the quality of their measurement properties. This systematic review, which included 14 studies in a qualitative synthesis, revealed that five skin tear classifications exist (Payne-Martin, Dunkin, Lo, STAR, and ISTAP), of which only two have been psychometrically tested (STAR and ISTAP). Due to the methodological heterogeneity between studies (e.g. study design, procedures, sample characteristics), differences in statistical analyses, the lack of confidence intervals, and inadequate reporting, a meta-analysis could not be performed. Three studies of very low methodological quality showed insufficient reliability and criterion validity of the STAR classification. To date, the ISTAP

classification is the most commonly evaluated system with moderate-quality evidence to support its reliability, measurement error, and criterion validity. Downgrading of the evidence from high to moderate was associated with the use of photographs in psychometric testing (indirect skin observation). More well-designed, rigorously conducted and adequately reported studies, using representative samples, appropriate statistical methods and direct skin observations, are needed to draw confident conclusions.

The provision of adequate skin tear prevention and treatment relies on in-depth and up-to-date knowledge among healthcare professionals. Tailored and continuing education programs on skin tears and skin health in general will be essential to increase awareness, improve knowledge, skills and attitudes, and narrow the evidence-practice gap. In order to be able to assess skin tear knowledge adequately and to determine educational needs and priorities, a valid and reliable instrument is needed. In this context, the fourth and final study of this dissertation (**chapter 5**) included the design and psychometric testing of a skin tear knowledge assessment instrument (OASES). OASES was rigorously developed based on the most recent evidence-based guidelines for skin tear prevention and management. Content validity was established in a two-round Delphi procedure by a panel of 10 international experts. Psychometric testing in a sample of 387 nurses from 37 countries indicated adequate validity and reliability of the English version. The final instrument consists of 20 multiple-choice items covering six domains most relevant to skin tears: (1) aetiology, (2) classification and observation, (3) risk assessment, (4) prevention, (5) treatment, and (6) specific patient groups. OASES can be applied in basic nursing education, post-graduate training, research, and practice to assess both factual knowledge and more complex cognitive skills regarding skin tears. In a next step, OASES should be translated and validated into other languages to allow global use.

Samenvatting



Als gevolg van de toenemende vergrijzing van de bevolking en de stijgende prevalentie van chronische ziekten wordt verwacht dat het aantal patiënten dat risico loopt op het ontwikkelen van diverse huidaandoeningen, zoals skin tears, zal stijgen. Skin tears worden gedefinieerd als *"traumatische wonden veroorzaakt door mechanische krachten, inclusief het verwijderen van kleefverbanden. De ernst kan variëren naargelang de diepte van het letsel (niet doorheen de hypodermis/ subcutis)"*. Hoewel skin tears acute wonden zijn die primair gesloten kunnen worden, bestaat er een grote kans dat ze evolueren tot gecompliceerde chronische wonden als ze niet adequaat behandeld worden. Moeilijk helende wonden kunnen de kwaliteit van leven van patiënten ernstig aantasten en leggen een aanzienlijke economische last op het gezondheidszorgsysteem. Ondanks hun klinische relevantie blijven skin tears onvoldoende (h)erkende en ondergerapporteerde wonden, wat vaak resulteert in suboptimale preventie en vertraagde of ongeschikte behandeling. In deze context was dit doctoraatsonderzoek gericht op het ontwikkelen en valideren van instrumenten om (1) de beoordeling en documentatie van skin tears te standaardiseren voor klinische praktijk en onderzoek, en (2) de ontwikkeling van op maat gemaakte opleidingsprogramma's voor (toekomstige) zorgprofessionals te ondersteunen. Daarnaast werden de prevalentie en geassocieerde factoren van skin tears bestudeerd in Belgische woonzorgcentra om de ware omvang van het probleem te achterhalen en de ontwikkeling van effectieve preventiestrategieën te ondersteunen.

De eerste studie van dit proefschrift (**hoofdstuk 2**) geeft het eerste prevalentieonderzoek naar skin tears in België weer en slechts het vierde in Europa. Deze cross-sectionele observationele studie toonde een skin tear prevalentie van 3.0% bij 1153 bewoners van Belgische woonzorgcentra. Kennis over de prevalentie van skin tears is van essentieel belang om inzicht te krijgen in de grootte van het probleem en kan helpen bij de toewijzing van middelen, benchmarking mogelijk maken, het stellen van doelen vergemakkelijken, en de implementatie van evidence-based preventie-, behandelings-, en educatieve strategieën ondersteunen. Aangezien skin tears grotendeels te voorkomen wonden zijn die gevoelig zijn aan de kwaliteit van multidisciplinaire zorg, wordt aanbevolen om hen op te nemen in huidige wondaudits als onderdeel van een veelzijdige strategie om skin tear zorg te verbeteren. Om de kwaliteit, interpreteerbaarheid en vergelijkbaarheid van epidemiologische skin tear data over verschillende zorginstellingen en landen heen te bevorderen, is de ontwikkeling van een gestandaardiseerde datacollectieprocedure die gebruik maakt van een valide en betrouwbare minimum dataset (MDS) noodzakelijk. Beleidsmakers zouden het belang, de mogelijke gevolgen en de haalbaarheid van de ontwikkeling en implementatie van skin tear gerelateerde kwaliteitsindicatoren op structureel, proces- en resultaatsniveau moeten bespreken.

Naast het in kaart brengen van de prevalentie van skin tears, beoogde deze studie ook om factoren te identificeren die onafhankelijk geassocieerd zijn met de aanwezigheid van skin tears. Dergelijke

kennis maakt het mogelijk om risicopatiënten vroegtijdig te identificeren, tijdig aangepaste preventie op te starten, en preventieve maatregelen te richten op specifieke geassocieerde factoren. Multivariate binaire logistische regressieanalyses toonden aan dat bewoners van woonzorgcentra met een hogere leeftijd, een voorgeschiedenis van skin tears, chronisch gebruik van corticosteroïden, afhankelijkheid voor transfers, en verbanden of pleisters ter hoogte van de extremiteiten een verhoogd risico hebben op het ontwikkelen van skin tears. Vervolgonderzoek moet bestuderen hoe de huidige kennis over skin tear risicofactoren geïntegreerd kan worden in een valide, betrouwbaar en gebruiksvriendelijk risicobeoordelingsinstrument dat gebruikt kan worden in de klinische praktijk en onderzoek. Daarnaast moet de implementatie van gebundelde preventieprogramma's die focussen op gemeenschappelijke risicofactoren voor verschillende huidaandoeningen overwogen worden.

Skin tears worden vaak verkeerd gediagnosticeerd en ondergerapporteerd, wat resulteert in onjuiste en onvergelijkbare prevalentie- en incidentiecijfers, inadequate behandeling en vermijdbare complicaties. Het gemeenschappelijk gebruik van een gestandaardiseerde internationaal geaccepteerde (ICD) definitie en classificatiesysteem voor skin tears zou een meer systematische, consistente en accurate beoordeling en rapportering kunnen ondersteunen. Daarom was de tweede studie van dit proefschrift (**hoofdstuk 3**) gericht op de psychometrische validering van het ISTAP Classificatiesysteem op internationaal niveau. Het ISTAP Classificatiesysteem werd ontwikkeld als een eenvoudig te gebruiken en tijdbesparend instrument dat skin tears onderverdeelt in drie categorieën: type 1 (geen verlies van de huidflap), type 2 (gedeeltelijk verlies van de huidflap), en type 3 (volledig verlies van de huidflap). Na een dubbele Delphi procedure met 17 experten uit 11 landen werd de volgende definitie van een 'huidflap' aan het instrument toegevoegd: *"Een huidflap bij skin tears wordt gedefinieerd als een deel van de huid (epidermis/ dermis) dat onopzettelijk (gedeeltelijk of volledig) gescheiden wordt van zijn oorspronkelijke plaats door de inwerking van schuif-, wrijvings- en/of mechanische krachten. Dit concept mag niet verward worden met weefsel dat opzettelijk weggehaald wordt van zijn oorspronkelijke plaats voor therapeutische doeleinden, bv. huidtransplantaties"*. De psychometrische eigenschappen werden geëvalueerd in een steekproef van 1601 zorgprofessionals uit 44 landen. De resultaten toonden aan dat skin tears op een valide en betrouwbare manier beoordeeld kunnen worden aan de hand van het ISTAP Classificatiesysteem. Een hogere diagnostische nauwkeurigheid, overeenstemming en betrouwbaarheid werden vastgesteld bij meer ervaren en hoger opgeleide zorgprofessionals, wat impliceert dat voldoende en adequate opleiding en training belangrijk zullen zijn voor het optimaliseren van vaardigheden omtrent het identificeren en classificeren van skin tears. Er moet overwogen worden om het ISTAP Classificatiesysteem te integreren in het elektronisch patiëntendossier en het te gebruiken in toekomstig skin tear onderzoek om de accuraatheid en vergelijkbaarheid van onderzoeksresultaten

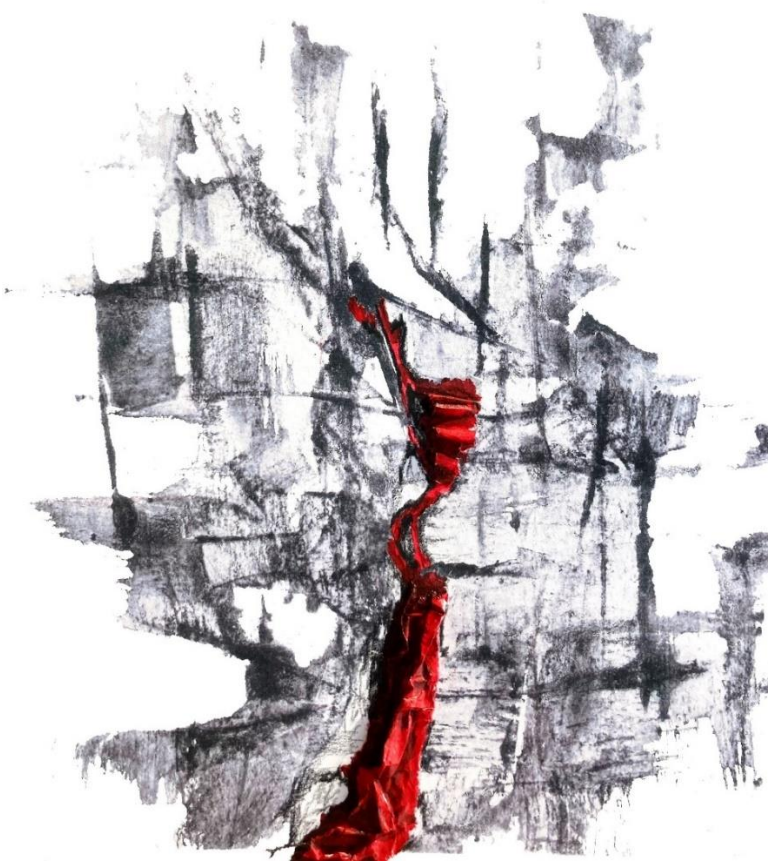
te verbeteren. In het kader van onze studie werd het instrument vertaald in 15 talen, wat wereldwijde bewustwording en implementatie bevordert.

Naast de ISTAP classificatie bestaan er nog een aantal andere skin tear classificaties. Om te achterhalen welke classificatie aanbevolen kan worden voor gebruik in onderzoek en praktijk, beoogde de derde studie van dit proefschrift (**hoofdstuk 4**) om de kwaliteit van hun psychometrische eigenschappen kritisch te beoordelen, te vergelijken en samen te vatten. Deze systematische review, die de resultaten van 14 studies in een kwalitatieve synthese samenbracht, onthulde dat er vijf skin tear classificaties bestaan (Payne-Martin, Dunkin, Lo, STAR en ISTAP), waarvan er slechts twee psychometrisch getest zijn (STAR en ISTAP). Het uitvoeren van een meta-analyse was niet mogelijk omwille van de methodologische heterogeniteit tussen de studies (bv. onderzoeksopzet, procedures, steekproefkenmerken), verschillende statistische methoden, het ontbreken van betrouwbaarheidsintervallen en onvolledige rapportering. Drie studies van zeer lage methodologische kwaliteit toonden onvoldoende betrouwbaarheid en criteriumvaliditeit van de STAR classificatie. Tot op heden is de ISTAP classificatie het meest geëvalueerde instrument. Evidentie van matige methodologische kwaliteit toonde aan dat de ISTAP classificatie een adequate betrouwbaarheid en criteriumvaliditeit heeft. Het downgraden van de kwaliteit van evidentie (van hoog naar matig) was te wijten aan het gebruik van foto's in psychometrische evaluaties (indirecte huidobservatie). Er is nood aan methodologisch goed opgezette, grondig uitgevoerde en adequaat gerapporteerde studies, die gebruik maken van representatieve steekproeven, geschikte statistische methoden en directe huidobservaties, om sterke conclusies te kunnen trekken.

Het toepassen van adequate skin tear preventie en behandeling berust op een grondige en actuele kennis van zorgprofessionals over skin tears en bescherming van de huidintegriteit in het algemeen. Op maat gemaakte en permanente opleidingsprogramma's zullen van essentieel belang zijn om bewustwording te creëren, kennis, vaardigheden en attitudes te verbeteren, en de kloof tussen evidentie en praktijk te overbruggen. Om kennis over skin tears adequaat te kunnen meten en opleidingsbehoeften en prioriteiten te kunnen bepalen, is een valide en betrouwbaar meetinstrument noodzakelijk. In dit kader omvatte de vierde en laatste studie van dit proefschrift (**hoofdstuk 5**) de ontwikkeling en psychometrische evaluatie van een skin tear kennistest (OASES). Het instrument werd rigoureus ontwikkeld op basis van de meest recente evidence-based richtlijnen voor skin tear preventie en behandeling. De inhoud werd gevalideerd door een internationaal panel van 10 experten via een dubbele Delphi procedure. De resultaten van de psychometrische testen, in een steekproef van 387 verpleegkundigen uit 37 landen, toonden aan dat de Engelstalige versie van OASES een adequate validiteit en betrouwbaarheid heeft. De kennistest bestaat uit 20 meerkeuzevragen, onderverdeeld in 6 relevante thema's: (1) etiologie,

(2) classificatie en observatie, (3) risicobeoordeling, (4) preventie, (5) behandeling, en (6) specifieke patiëntengroepen. OASES kan toegepast worden in het verpleegkundig onderwijs, postacademische opleidingen, onderzoek en klinische praktijk om zowel feitelijke kennis als meer complexe cognitieve vaardigheden met betrekking tot skin tears te meten. In een volgende stap moet OASES vertaald en gevalideerd worden in andere talen om wereldwijd gebruik mogelijk te maken.

Curriculum vitae



PERSONALIA

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2014 – 2016	Master of Science in Health Care Management and Policy *Faculty of Medicine and Health Sciences, Ghent University*
2011 – 2014	Bachelor of Occupational Therapy *Faculty of Health and Social Care, Artesis Plantijn (AP) University of Applied Sciences and Arts Antwerp*
2005 – 2011	Secondary education, Economics - Modern Languages *Klein Seminarie Hoogstraten*

WORK EXPERIENCE

2020 – present	Study coordinator, Clinical Trial Center (CTC), University Hospital Antwerp (UZA)
2016 – present	PhD student, University Centre for Nursing and Midwifery, Department of Public Health and Primary Care, Faculty of Medicine and Health Sciences, Ghent University
2010 – 2016	Interim and summer jobs ▪ Occupational therapist, RevArte Rehabilitation Hospital Edegem ▪ Occupational therapist, General Hospital (AZ) Klina Brasschaat ▪ Patient transport associate, Rehabilitation Hospital De Mick (AZ Klina) Brasschaat

ADDITIONAL TRAINING

2022	The Science and Practice of Skin Tears (January 2022, March 2022, EWMA – ISTAP)
2021	Global Skin Tear Summit – Current Practice (April 2021, ISTAP)
2020 – 2021	International Council of Harmonization – Good Clinical Practices (ICH-GCP) E6R2 (November 2020, July 2021, University of Antwerp, UZA)
2020	IATA Dangerous Goods Regulations & ADR Regulations (November 2020, KVS & Partners - Dangerous Goods Consulting)

2018 2nd Occupational Therapy Research Symposium: Creating Connections – Building Bridges in Occupational Therapy Research (September 2018, Catholic University (KU) of Leuven)

2016 – 2019 Doctoral Schools Training Program, Life Sciences and Medicine, Ghent University

- Knowledge 2 Connect: Privacy and (bio)medical research (November 2016, Knowledge Centre for Health Ghent (KCGG))
- Knowledge 2 Connect: How can I turn my manuscript into an article (February 2017, KCGG)
- European Pressure Ulcer Prevention and Treatment Masterclass (March 2017, EPUAP)
- Summer School 'Let's Talk Science': Argumentation and debating techniques (July 2017, Ghent University)
- Summer School 'Let's Talk Science': Presentation performance: about body language and anxiety on stage (July 2017, Ghent University)
- Knowledge 2 Connect: How effectively search for nursing and allied health literature in CINAHL (September 2018, KCGG)
- Knowledge 2 Connect: Give your research a real life: introduction to TechTransfer (November 2018, KCGG)
- Conducting and publishing a systematic review and meta-analysis (February - April 2019, KCGG, Biostatistics Unit Ghent University)

PUBLICATIONS

International peer-reviewed articles included in the Science Citation Index (A1)

Van Tiggelen, H., & Beeckman, D. (2022). Skin tears anno 2022: an update on definition, epidemiology, classification, aetiology, prevention, and treatment. *Journal of Wound Management* [Under Review]

Cools, D., Franck, C., Spinhoven, M., Op de Beeck, B., El Addouli, H., Nicolay, S., Carpentier, K., Van Hoyweghen, A., van Ierssel, S., Peeters, K., **Van Tiggelen, H.**, Janssens, H., & Snoeckx, A. (2022). Differences in correlation of chest CT and clinical diagnosis of coronavirus disease 2019 (COVID-19) in severe ill patients during the first and second wave of the pandemic. *European Radiology* [Under Review]

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Anrys, C., **Van Tiggelen, H.**, Verhaeghe, S., Van Hecke, A., & Beeckman, D. (2019). Independent risk factors for pressure ulcer development in a high-risk nursing home population receiving evidence-based pressure ulcer prevention: Results from a study in 26 nursing homes in Belgium. *International Wound Journal, 16*(2), 325-333. doi:10.1111/iwj.13032

Vermeir, P., Degroote, S., **Van Tiggelen, H.**, Vandijck, D., Peleman, R., Verhaeghe, R., Mariman, A., Vermeersch, H., & Vogelaers, D. (2018). Patient perspectives on electronic health record accessibility and patient participation: a questionnaire survey. *Acta Clinica Belgica, 73*(4), 292-297. doi:10.1080/17843286.2018.1436233

Vermeir, P., Degroote, S., Vandijck, D., **Van Tiggelen, H.**, Peleman, R., Verhaeghe, R., Mariman, A., & Vogelaers, D. (2017). The patient perspective on the effects of medical record accessibility: a systematic review. *Acta Clinica Belgica, 72*(3), 186-194. doi:10.1080/17843286.2016.1275375

PRESENTATIONS

Oral presentations

Van Tiggelen, H., Van Damme, N., Theys, S., Vanheyste, E., Verhaeghe, S., Van Hecke, A., LeBlanc, K., Campbell, K., Woo, K., & Beeckman, D. (2019). The prevalence of skin tears and associated risk factors in Belgian nursing homes : a cross-sectional observational study. Presented at the CARE4: 3rd International Scientific Nursing and Midwifery Congress, Leuven, Belgium, 5 February 2019.

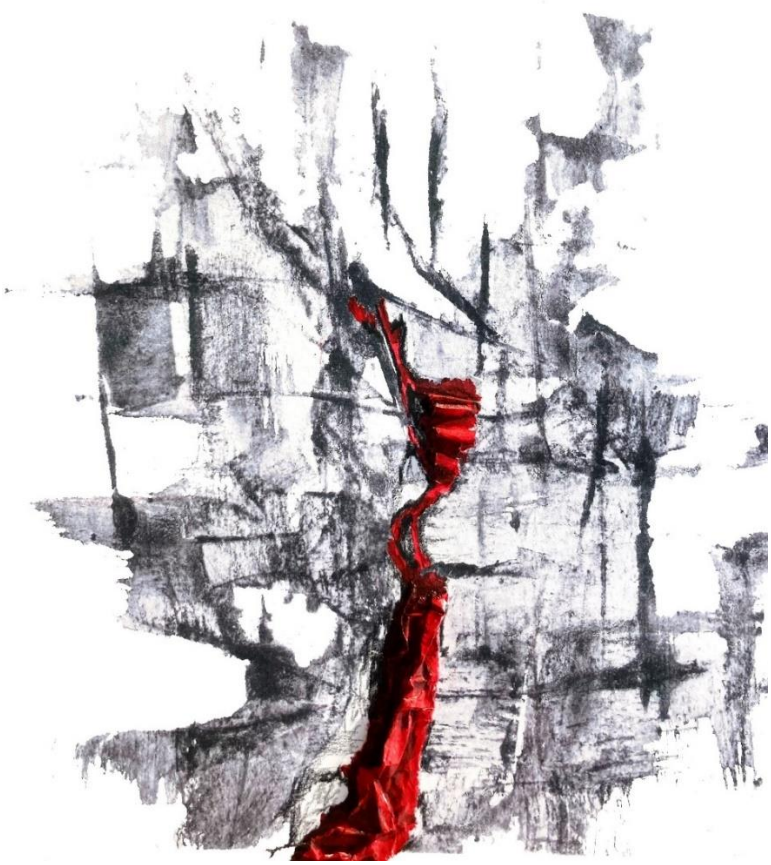
Serraes, B., Beeckman, D., Anrys, C., **Van Tiggelen, H.**, Van Hecke, A., & Verhaeghe, S. (2019). A RCT in high risk nursing home residents to compare cost-effectiveness of a static air mattress and alternating mattress to prevent pressure ulcers. Presented at the CARE4: 3rd International Scientific Nursing and Midwifery Congress, Leuven, Belgium, 5 February 2019.

Anrys, C., **Van Tiggelen, H.**, Verhaeghe, S., Van Hecke, A., & Beeckman, D. (2019). Independent risk factors for pressure ulcer development in a high-risk nursing home population receiving pressure ulcer prevention. Presented at the CARE4: 3rd International Scientific Nursing and Midwifery Congress, Leuven, Belgium, 5 February 2019.

Poster presentations

Vanheyste, E., Theys, S., Van Damme, N., **Van Tiggelen, H.**, & Beeckman, D. (2018). The prevalence of skin tears in long-term care facilities in Belgium. Poster presentation at Research Day & Student Research Symposium, Ghent University, Ghent, Belgium, 19 April 2018.

Dankwoord



Met veel trots en voldoening kijk ik terug op het traject dat ik de voorbije jaren heb afgelegd. Een traject van vallen en opstaan, van bergen en dalen. Aan het einde van dit intensief maar zeer leerrijk traject neem ik graag even de tijd om een aantal mensen te bedanken die mij elk op hun eigen unieke manier ondersteund hebben. Zonder jullie had ik hier vandaag niet gestaan. Ik ben blij dat jullie mijn tochtgenoten waren.

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