NOTES ON BURN NURSING

aspects of pain management

Alette de Jong

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Pijnmeting en pijninterventies in de brandwondenzorg
vanuit verpleegkundig perspectief

(met een samenvatting in het Nederlands)

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Co-promotor:	Dr. N.E.E. van Loey

Aan Eva en Aimée

Contents

'What you want are facts, not opinions, for who can have any opinion of any value as to whether the patient is better or worse, excepting the constant medical attendant, or the really observing nurse? The most important practical lesson that can be given to nurses is to teach them what to observe, how to observe, what symptoms indicate improvement, what the reverse, which are of importance, which are of none, which are the evidence of neglect and of what kind of neglect. (…) The vagueness and looseness of the information one receives in answer to that much abused question, 'Is he better?' would be ludicrous, if it were not painful. The only sensible answer (in the present state of knowledge about sickness) would be 'How can I know? I cannot tell how he was when I was not with him'.'

Florence Nightingale (1859) [1].

Chapter 1

Introduction and outline of the thesis

1. Introduction

'The right of all people with pain is to have access to appropriate assessment and treatment of their pain by adequately trained health-care professionals' [2]. Burns are often associated with pain. Many research reports start with the statement that pain is even one of the major problems in burn care. Burn care nurses are health care professionals that are confronted with pain on a daily basis and therefore have an important role in pain management: they are responsible for the assessment of pain and play a central role in the multidisciplinary approach of the treatment of pain by providing pharmacological and non-pharmacological interventions. The studies presented in this thesis aim at improvement of pain measurement and pain treatment by nurses.

1.1 Pain

Two definitions of pain are frequently used in health-care. The first is a theoretical definition: 'An unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage' [3]. The second is a practical definition: 'Whatever the experiencing person says it is, existing whenever he says it does' [4]. Both definitions have not been adjusted since their publication, meaning that they are solid fundamental definitions accepted by pain experts, and that they best describe what pain is.

Pain is as old as mankind itself, but one of the first pain theories that may have influenced the development of current theories is the theory of Descartes (1596-1650). Descartes hypothesized that tissue damage generates a pain signal by pain receptors in the skin that is directly forwarded to a pain centre in the brain, which is a one-way process [5]. However, we now know that pain can continue after wound healing and that pain can be experienced without wounds, meaning that the pain process is more complex than supposed by Descartes, as is explained below.

The gate control theory [6] suggests that pain is the result of the integration of a neurophysiological, an affective and a cognitive system. Influencing these systems can alter pain sensation. The neurophysiological processes form the base of pain perception. Pain receptors are connected to fibers that transport the pain impulses to the spinal cord. These sensory fibers are of various diameters and can transmit various stimuli. The three types of sensory fibers are the large myelinated A-beta fibers (transmission of touch and pressure), the small myelinated A-delta fibers (quick transmission of severe pain) and the small non-myelinated C fibers (transmission of less severe pain). Located in the substantia gelatinosa of the dorsal horn of the spinal cord are cells that form a control mechanism, the 'gate'. These cells regulate the transmission of pain impulses from periphery cells to transmission cells in the dorsal horn. Once this has occurred, certain processes in the brain are activated, which cause pain to be registered and perceived. Pain impulses are transmitted to the substantia gelatinosa by the small A-delta and C fibers. Activating the small fibers can open the gate, which transmits the pain stimulus further to the

brain. Activating the large A-beta fibers, for example by massaging the painful area, can close the gate. Factors influencing the patients' perception of pain in this neurophysiological system are for example the burn itself, wound care, dressing type, infection, movement and donor sites [7].

Affective processes can also alter pain sensation. An affective state influencing pain that is frequently observed in patients with burns is anxiety. Pain anxiety is considered an integral part of burn pain [8]. Impulses sent from the brain reach the gate via the descending nerve fibers and open the gate, increasing pain perception. The gate can thus be influenced by not only the peripheral nervous system, but also by the central nervous system. For many patients, the experience of pain is reduced when anxiety is controlled [9]. Relaxation, attention or distraction for example can close the gate. Other emotional factors that can influence the gate are depression, anger, catastrophizing, frustration and hopelessness [7].

The third system that influences pain is the cognitive system, in which memory has a central position. Pain is often evaluated in terms of previous experiences. When a person perceives pain, previous pain experiences play a large role in the expectation of pain perception. Past painful experiences can cause anxiety of pain in a future painful procedure. Factors influencing the patients' perception of pain from a cognitive perspective through the gate are a positive attitude, control, stress management, environment and relation with staff [7].

The aforementioned factors play a crucial role in the experience of burn pain, in particular during acute care when high levels of pain are experienced. Acute pain in patients with burns is divided into background and procedural pain. Pain associated with burns is caused by stimulation of pain receptors in the dermis and epidermis. Intact or partial intact nerve ends generate pain impulses. Immediately after the burn, an inflammatory response is initiated which sensitizes the pain receptors in and around the burn. This causes background pain, which is experienced continuously. Every manipulation (wound care, movement) involving the burn leads to additional stimulation of the pain receptors, which explains the development of procedural pain [10]. Other characteristics of burn pain are the long-lasting and fluctuating course between and within patients, the dependence on daily repetitive wound care procedures and a decrease of pain only toward the end of admission. These characteristics make burn pain difficult to treat [11].

1.2 Importance of adequate pain management

Adequate management of burn pain is important for many reasons. Inadequate pain management decreases pain resistance, increases analgesic requirements and can trigger mechanisms that may lead to increased sensitivity to pain over time [11]. These mechanisms involve sensitization of peripheral receptors, increased excitability at the dorsal horn and activation of pathways descending from higher centres. With time, these changes may become irreversible and neuropathic pain is risked as a result [7].

Inadequate pain treatment may also delay wound healing [12, 13], predicts suicidal ideation after discharge [14] and may increase the development of delirium in ICU patients [15]. Besides, procedural anxiety seems to predict posttraumatic stress symptoms one year after the burn event [16]. Adequate pain treatment is therefore a prerequisite for optimal wound healing and quality of life during admission and after discharge. Furthermore, inadequate pain treatment for an initial painful procedure in children conditions anxiety, heightens arousal for subsequent procedures and reduces the effectiveness of analgesia for subsequent procedures [17, 18]. Inadequate pain management in children also has long-term consequences. It has been demonstrated that infants and children who experienced pain in early life, show long-term changes in pain perception and related behaviours [19], while major surgery in early infancy, in combination with appropriate pain management, did not result in an altered pain response to subsequent pain exposure in childhood [20]. Wollgarten-Hadamek et al. [21, 22] suggested that severe burn injuries at 6-24 months of age may cause long-term alterations in sensory and pain processing later in childhood and adolescence.

1.3 Pain measurement

To evaluate the status of pain management in daily burn care practice, but also for research purposes, pain should be adequately measured. But pain is a subjective concept, influenced by many factors. Many health-care professionals, but also patients, do not believe that pain can be correctly measured, since there are no devices as there is a thermometer to measure body temperature or a monitor to display the heart rate. Still, pain should be measured in order to evaluate pain treatment.

Pain often provokes pain behaviour. In adults, many aspects might influence pain behaviour, like social environment or pain experiences in the past. Observation of pain behaviour in adults is therefore a less appropriate measure to assess pain and self-reports of pain are preferred. Recording the occurrence of pain behaviour however is helpful in situations where children are unable to provide self-reports [23]. Mills [24] identified three pain behavioural categories in children from 0 to 3 years old, namely motor movement, communication and facial expression, that should all be included in a pain behavioural measure. Henry and Foster [25] stated that several behavioural observation instruments have been developed in the past two decades to measure pain in infants and children, but none are specific for burn pain. In addition, Martin-Herz et al. [26] recommend specific investigation of pain assessment for children with burn injuries.

Irrespectively of the type of pain measurement, be it self-reported or observational, an essential requirement of all outcome measures is that they are reliable and valid [27, 28]. Reliability is the degree to which an instrument measures a construct in a reproducible fashion, validity represents the degree to which an instrument measures what it is intended to measure in a specific patient population. It is, for example, not self-evident that an instrument that measures chronic low back

pain can also be used in the burn population. Another criterion is that the instrument serves both daily practice, in order to evaluate pain management, and research, to investigate effects of pain interventions. Furthermore, the clinical usability, i.e. the speed and ease of use, are important criteria. Much effort has been given to the development and testing of pain measurement instruments for adult patients with burns. This is, however, not the case for young children with burns who are unable to provide self-reports of pain.

1.4 Nursing and pain management

Burn care nurses are confronted daily with the phenomenon of pain. They find themselves in a paradoxical position because they are often the cause of pain during wound care procedures as they remove bandages, clean and debride the wound area, yet at the same time they are also the providers of pain relief [29, 30]. The state of pain management is not satisfactory to nurses working in burn care, and research into pain management has a high priority [31]. The recognition of pain falls within the nursing domain and nurses play a central role in the multidisciplinary approach of the treatment of pain [28, 32-34].

Nurses contribute to pain management by measuring and evaluating pain and by treating pain by administering pharmacological and non-pharmacological interventions. Besides focusing on appropriate pain measurement, this thesis examines the use of non-pharmacological interventions because, as Patterson [35] reported, patients experience pain in spite of the use of medication. When non-pharmacological methods are used in combination with pharmacological interventions, a positive effect on pain relief can be seen [36]. In addition, nurses can independently implement many non-pharmacological interventions.

There are various non-pharmacological interventions. Important considerations when selecting a non-pharmacological intervention for patients with burns are: simplicity, easy to learn, immediate usability and minimal expenditure of time and effort during use. Simple relaxation techniques meet these criteria. Patients with burns are often too tired and ill to take the time and exert the discipline to learn complex techniques [35].

2. Outline of the thesis

This thesis consists of two parts: one on pain measurement and one on non-pharmacological interventions. Although a pain measurement instrument with good clinimetric properties for adults, the visual analogue thermometer (VAT) [37]), is available, this was not yet the case for young children with burns, who unable to provide self-reports of pain. Chapter 2 describes reliability testing of the pain observation scale for young children (POCIS) and the nurse observational visual analogue scale (VAS obs) to measure procedural and background pain in burned children aged 0-4 years [38]. Chapter 3 illustrates whether the POCIS, the COMFORT behaviour scale

(COMFORT-B) and the VAS obs are reliable, valid and clinically useful instruments to measure pain in young children with burns [39]. Chapter 4 exhibits construct validity research of the POCIS and COMFORT-B by using Rasch analysis [40]. In chapter 5, cutpoints of COMFORT-B are presented, as well as the extent and course of pain in young children with burns and factors that may influence procedural pain. Chapter 6 describes the comparison between VAT and the graphic numeric rating scale (GNRS). To legitimate their interchangeable use, the aim was to compare self-reports obtained with both scales, to compare their ability to differentiate background from procedural pain, and to compare cutpoints of both scales. Finally, a literature review on the use of a simple relaxation technique to reduce pain during wound care is presented in chapter 7 [41] and a review on non-pharmacological procedural pain interventions is described in chapter 8 [42]. In chapter 9, discussion and future perspectives are presented.

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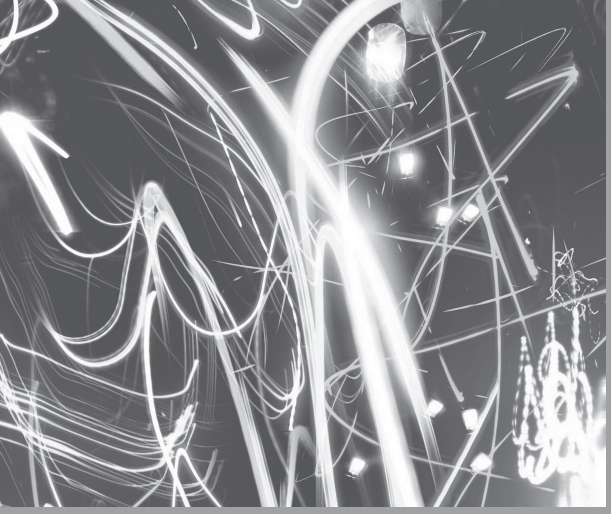

Part I

Pain measurement instruments

‘If you don’t measure it, then you can’t prove it or manage it.’

Carl Granger (2007) [40].

Chapter 2

Reliability and validity of the pain observation scale for young children and the visual analogue scale in children with burns

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Burns 2005; 31(2): 198-204.

Abstract

Burn care nurses (n = 73) rated pain from 24 fragments of videotaped children during wound care procedures and during periods of rest using the POCIS and the VAS. Intraclass correlations were used to assess inter-rater and intra-rater reliability for the POCIS and the VAS. Internal consistency for the POCIS was assessed by Cronbach's alpha. The POCIS has shown poor to moderate inter-rater reliability, moderate to good intra-rater reliability and an acceptable internal consistency. The VAS turned out to have poor inter-rater reliability and poor to moderate intra-rater reliability. Due to poor results of inter-rater reliability in both scales, construct validation is left undone until more acceptable results are obtained. Factors explaining the results are the large number of raters, the manner they were trained and a lack of variation between pain classes in video fragments. Although not all results were satisfying, an easy to use scale as the POCIS has promising qualities and deserves further reliability research.

1. Introduction

Every year approximately 500 patients with severe burns are admitted to Dutch burn centres [1]. According to Dutch burn centre charts, approximately 30% of these patients are children younger than 4 years old [2]. Burns in young children are mostly caused by hot liquids. Children get, due to their development stage of motor and cognitive skills, hold of cups filled with coffee or tea or pull down hot liquid containers with the tablecloth [3].

Pain caused by severe burns is considered the worst form of pain [4]. Melzack and Wall [5] maintain that pain is such a complex concept with various determining factors that it defies definition. Nevertheless, a definition proposed by the International Association for the Study of Pain, comes up repeatedly in the literature: 'Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage' [6]. McCaffery and Beebe [7] recognize two categories of pain, namely chronic and acute pain. Acute pain, like burn pain, has a predictable and limited duration and has a tendency to diminish. Acute pain in burn patients can be divided in background pain and procedural pain.

Adequate management of procedural and background pain is essential to the relationship between the burn patient and the multidisciplinary team. It aids in increasing comfort of the patient and prevents an elevated metabolism, thereby reducing the chance of malnutrition and deterioration of the immune system [8]. Furthermore, adequate pain management correlates highly with reduction of acute stress symptoms during admission in the hospital [9].

Nurses are one group of health-care professionals responsible for the recognition and treatment of pain [10]. Because of their frequent and direct contact with the patient, and through their direct involvement in the phenomenon of pain, burn care nurses have a special responsibility to improve pain management. The ultimate goal is to optimise nursing care in order to achieve good patient results in the burn unit.

Nurses can contribute to pain management by measuring pain. However, there is a need for more clarification regarding instruments to measure background and procedural pain in burned infants, toddlers and preschoolers. This instrument should preferably meet the following criteria. In the first place, the instrument should be reliable and valid for this specific patient population. Secondly, the instrument should be easy and quickly to use and be available in Dutch language. Finally, the instrument should be appropriate for nurses to measure pain, since parents are not present in the burn unit all day.

1.1 Literature

A literature review was conducted to assess what is known about pain measurement instruments in burned children in the age of 0-4 years. The databases CINAHL and Medline were used. Combinations of the keywords burns and pain measurement, pain assessment or pain scoring and children, non-verbal children, pediatrics, toddlers, preschoolers, infants or preverbal children were used. Consequently, on the base of titles and abstracts a selection was made. Publications without abstracts or names of authors, case studies, studies in other than clinical settings and publications in other than English or Dutch language were excluded.

Relevant literature shows that cognitive, physiological and behavioural components are frequently used to measure pain [11]. Cognitive components can be measured by self-reports, but are only appropriate for children above the age of four [12]. Physiologic parameters such as heart rate, respiratory rate and blood pressure are useful with patients who are not able to interact with their environment, like artificially ventilated children [13], who are however not part of the target group. In addition, measurement of these parameters, when manually assessed, can cause pain and anxiety and can distort data [14]. Behavioural measures are helpful in situations where children are unable to provide self-report. Mills [15] identified three pain behavioural categories in children from 0 to 3 years old, namely motor movement, communication and facial expression. Children with burns where included in this qualitative study. The following behavioural observation instruments are suggested in the burns literature and are examined on the presence of the aspects as described by Mills [15], on age group, easiness of use, validity and reliability and the users group: the observer pain scale [16, 17], the children's hospital of eastern Ontario pain scale (CHEOPS) [8, 13, 16], the objective pain scale [16], the observational scale of behavioural distress, the infant pain behaviour scale, the postoperative pain measure for parents and the face leg activity cry consolability pain assessment tool [13], a discomfort 5-point scale [18] and the visual analogue scale (VAS) [19].

However, none of these scales are ready to use because they do not meet all before mentioned criteria. Although the majority of the scales, especially the VAS, is easy to use, based on the necessary time to observe and rate and on the simplicity (the number of scale items and the number of options per item), reliability and validity of the scales are not assessed for our target group. Besides, most of the scales do not cover the age group of our patients. Finally, the scales are not available in Dutch and are not always developed for nurses' use. These findings correspond with the statement of Henry and Foster [20], namely that several behavioural observation instruments have been developed in the past two decades to measure pain in infants and children, but none are specific for burn pain. In addition, Martin-Herz et al. [21] recommend specific investigation of pain assessment for children with burn injuries.

The similarity between the suggested scales is that they are developed to measure acute pain. Given the fact that procedural and background pain are types of acute pain, the literature was screened on Dutch behavioural scales to measure acute pain in this age group. Two instruments were found, namely the pain observation scale for young children (POCIS) [22], measuring postoperative pain after ear, nose and throat surgery and the COMFORT scale [23], measuring postoperative pain on the ICU. The POCIS, derived from the CHEOPS, which includes the three behavioural aspects according to Mills [15], seemed an appropriate scale for research. Firstly, the age group for which the scale was developed corresponds with our target group. Secondly, consisting of seven items with dichotomous answer categories, the POCIS is easy and quickly to use. Trained nurses need less than two minutes to observe in a structured way. Furthermore, an instruction video is available. As the VAS is a frequently used instrument for pain assessment by nurses in children [11, 14, 23, 25, 26, 29, 30], we decided to use the VAS, a scale with ratio properties, in our study as well.

1.2 Aim of the study and research questions

The aim of this study was to assess if the POCIS and the VAS are reliable and valid instruments to measure procedural and background pain in burned children aged 0-4 years. The next research questions were composed:

What is the reliability (inter-rater reliability, intra-rater reliability and internal consistency) of the POCIS?

What is the reliability (inter-rater reliability, intra-rater reliability) of the VAS?

What is the construct validity of the POCIS in relation to the VAS?

2. Methods

2.1 Subjects

All 109 registered nurses from the three Dutch burn centres were invited to participate in the study. In line with previous research [25-28], more than two observers were asked to assess pain intensity per case, because the average of observations should have a high reliability when multiple observers assess patients. Errors associated with each observation will be averaged out [31].

2.2 Material

Videotaped vignettes were used to portray children with burns during periods of rest and during wound care procedures. Vignettes are brief impressions of situations to which respondents are asked to react. Visual records are capable to capturing finer units of behaviour, such as facial expression [24], and are frequently used in research on pain in children [25-28]. This method allows a group of nurses to rate the same patient, which is not feasible in daily practice.

Parents signed informed consent that videos would be taken from their children after receiving oral and written information about the purpose of the study. Children with developmental delays were excluded. A convenience sample of 18 children, in the age of 0-4, admitted to Dutch burn centres was videotaped. Videos were taken in the first week of admission, to decrease the influence of wound care procedures on pain behaviour. A total of 24 fragments (18 during wound care and 6 during periods of rest) of 2 minutes each was randomly selected. The number of fragments was limited to 24 in order to avoid satisficing bias. Fragments were divided into two videotapes to prevent nurses from rating recognizable patients.

2.3 Measures

The POCIS measures postoperative pain in children after adenotonsillectomy, adenotomy or insertion of ventilation tubes. The scale comprises seven behavioural items (Table 1). The presence or absence of each item is scored 0 or 1. The POCIS has proven to be reliable, based on inter-rater agreement and internal consistency, and valid, based on principal components analysis that supports construct validity [22].

Table 1. Pain observation scale for young children [22]

	Score
Facial	
At rest, neutral	0
Grimace, nose wrinkled, eyebrows frown	1
Cry	
No cry	0
Moan, scream	1
Breath	
Relaxed, regular	0
Irregular, hold in, gasping	1
Torso	
At rest, neutral, relaxed	0
Tense, restless, contorted, writhed, trembling	1
Arms/fingers	
At rest, neutral, relaxed	0
Tense, restless, clenched fist, wild	1
Legs/toes	
At rest, neutral, relaxed	0
Tense, restless, pulled up, kicking	1
Arousal	
Calm sleepy, calm alert, playing	0
Restless, touchy, fussy	1
Total	

0: No pain; 1-2: light pain; 3-4: moderate pain; 5-7: extreme pain.

The VAS is a quickly and easy to use instrument with ratio scale properties to measure different concepts [24]. The VAS in this study is a straight horizontal 10 cm line with clearly marked terminal ends with the anchor words no pain and unbearable pain. Nurses estimate the child's overall pain intensity during the video fragment along this line. The scale is considered reliable on the basis of inter-rater reliability for procedural pain in neonates and for chronic pain [32, 33] and was demonstrated to correlate highly with postoperative pain measurement instruments [11, 34].

2.4 Data collection procedure

In order to avoid contamination bias, data were collected during team meetings. An instruction video of 15 minutes was shown. Consequently, standardized instruction about the procedure was given. Nurses were asked to give their general impression of the entire fragment, to rate the VAS first and consequently the POCIS after each fragment, to score independently and not to discuss their ratings during the procedure. To avoid correction on the VAS, the total score of POCIS items was not calculated during the session. The first fragment was a practice case. These data were not used for analysis. Between the fragments, nurses completed the scales during a pause of 2 minutes. The tape was not stopped or turned back during the data collection procedure. A second data collection point took place after 2 months. Although retest intervals can vary from 1 day to 1 year [31], we expected nurses not to remember their first responses after 2 months. Reliability coefficients tend to be higher for short term retests than for long term (more than 2 months) retests [24]. The procedure was repeated without showing the instruction video. Subjects did not see their previous records.

2.5 Data analysis

Data from both videos were analysed separately by the statistical program SPSS 12.0 for Windows (SPSS Inc., Chicago, USA). As the number of observers is large (Table 2), intraclass correlations were used to assess inter-rater and intra-rater reliability for POCIS and VAS. For that purpose, the total POCIS score per fragment was calculated and consequently divided in one of the four classes as shown in Table 1. The internal consistency for POCIS was assessed by Cronbach's alpha. To determine construct validity of the POCIS in relation to the VAS, the multitrait-multimethod matrix approach was considered as most appropriate [24]. One-way ANOVA and Chi-square tests were used to assess if the groups of raters showed similar characteristics.

3. Results

3.1 Subject characteristics

A total of 73 nurses participated in the study, which is 67% of all nurses working in Dutch burn units. Corresponding characteristics between the groups of raters were age, gender, parenthood, bachelors of science and pediatric care education and experience in burn care from 1 till 10 years (Table 2).

Table 2. Results subjects' characteristics by descriptive statistics, one-way ANOVA test and Chi-square test

Subjects' characteristics	Group A		Group B		Chi-square
	Data collection point 1 (n = 32)	Data collection point 2 (n = 24)	Data collection point 1 (n = 41)	Data collection point 2 (n = 21)	
Mean age (minimum-maximum)	40 (23-53)	40 (23-53)	37 (18-58)	38 (21-58)	0.46[a]
Gender (% female)	91	92	83	96	0.65
Nurse is parent (%)	69	67	44	52	0.12
Education (%)					
BSc	6	8	15	14	0.64
IC	41	42	17	14	0.03 *
PC	19	17	32	33	0.35
BC	94	96	32	29	0.00 **
Years of experience in burn care (%)					
<1 year	6	8	32	24	0.02 *
>1 year <5 years	28	33	37	48	0.54
>5 years <10 years	6	4	7	5	0.95
>10 years	60	55	24	23	0.004 *

Group A: nurses from burn unit at Beverwijk rate fragments of children admitted in burn units in Groningen and Rotterdam. Group B: nurses from burn units in Groningen and Rotterdam rate fragments of children admitted in the burn unit at Beverwijk. BSc: bachelor of science; IC: intensive care nurse; PC: pediatric nurse; BC: burn care nurse.

[a] This is the ANOVA value.

* $p < 0.05$.

** $p < 0.001$.

Table 3. Results inter-rater reliability for POCIS and VAS by intraclass correlations

Type of pain	Data collection point 1					Data collection point 2				
	N	POCIS		VAS		N	POCIS		VAS	
		ICC	CI	ICC	CI		ICC	CI	ICC	CI
Group A										
Procedural and background	32	0.79	0.65-0.92	0.56	0.38-0.79	24	0.86	0.74-0.95	0.63	0.44-0.83
Procedural	32	0.40	0.22-0.72	0.56	0.38-0.79	24	0.51	0.30-0.80	0.46	0.26-0.77
Background	32	0.97	0.89-0.99	0.52	0.20-0.98	24	0.97	0.90-0.99	0.66	0.32-0.99
Group B										
Procedural and background	41	0.75	0.60-0.90	0.67	0.49-0.86	21	0.72	0.55-0.88	0.63	0.43-0.84
Procedural	41	0.79	0.63-0.93	0.64	0.43-0.87	21	0.77	0.59-0.93	0.58	0.36-0.84
Background	41	0.65	0.32-0.99	0.59	0.27-0.98	21	0.57	0.24-0.98	0.55	0.22-0.98

Group A: nurses from burn unit at Beverwijk rate fragments of children admitted in burn units in Groningen and Rotterdam. Group B: nurses from burn units in Groningen and Rotterdam rate fragments of children admitted to the burn unit at Beverwijk. ICC: intraclass correlation, single rater, two-way random, absolute agreement; CI: confidence interval (95%).

3.2 Inter-rater reliability

Values obtained from intraclass correlations above 0.75 are indicative of good reliability [35]. Poor reliability for POCIS was seen for procedural pain in group A and background pain in group B at both data collection points. Moderate to good reliability was seen for background pain in group A and procedural pain in group B at both data collection points (Table 3). However, confidence intervals were large and under the lower limit of 0.75 [39], except for background pain in group A at both data collection points. Results did not increase when intraclass correlations were calculated for POCIS total scores without division in classes. All intraclass correlations for VAS scores were poor. Separate calculations of experienced nurses, nurses having children of their own and education did not influence the results of both scales.

3.3 Intra-rater reliability

Intra-rater reliability for POCIS was predominantly good, except for procedural pain in group A and background pain in group B, both with large confidence intervals and low minimum values (Table 4). A moderate confidence interval was seen for procedural pain when ratings of both groups were calculated together. VAS ratings for fragments in group A showed poor intra-rater reliability for background and for procedural pain with a low minimum value of confidence interval when assessed for both types of pain together. The confidence interval for background pain in group B was moderate, as were intraclass correlations and confidence intervals for both types of pain when data from both videos were analysed together.

Table 4. Results intra-rater reliability for POCIS and VAS by intraclass correlations

Type of pain	N	POCIS		VAS	
		ICC	CI	ICC	CI
Group A					
Procedural and background	24	0.84	0.81-0.87	0.76	0.70-0.80
Procedural	24	0.53	0.43-0.62	0.52	0.41-0.61
Background	24	0.97	0.95-0.98	0.70	0.56-0.80
Group B					
Procedural and background	21	0.85	0.82-0.88	0.84	0.80-0.87
Procedural	21	0.88	0.84-0.91	0.82	0.76-0.86
Background	21	0.74	0.60-0.83	0.75	0.62-0.84
Group A and B					
Procedural and background	45	0.85	0.82-0.87	0.81	0.78-0.84
Procedural	45	0.76	0.71-0.79	0.73	0.68-0.77
Background	45	0.88	0.84-0.91	0.74	0.65-0.81

Group A: nurses from burn unit at Beverwijk rate fragments of children admitted to the burn units in Groningen and Rotterdam. Group B: nurses from the burn units in Groningen and Rotterdam rate fragments of children admitted to the burn unit at Beverwijk. ICC: intraclass correlation, single rater, one way random, consistency; CI: confidence interval (95%).

3.4 Internal consistency

Cronbach's alphas between 0.70 and 0.90 are indicative for good reliability [31] and were seen on both data collection points for both videos (Table 5). An item contributes to a scale if alpha, when calculated after this item is deleted, has a lower value than alpha of the entire scale. All alpha values were lower when items were deleted, except for 'legs' in group A for both data collection points. Although this item does not meet the criterion, and questions rise whether legs measure another concept or whether raters from group A have difficulties by observing legs, we have accepted this minimal difference.

Table 5. Results internal consistency for POCIS by Cronbach's alpha

	N	Cronbach's alpha	Cronbach's alpha if item deleted						
			Face	Cry	Respiration	Torso	Arms	Legs	Agitation
Group A									
Data collection point 1	32	0.854	0.820	0.817	0.830	0.849	0.850	0.854	0.813
Data collection point 2	24	0.850	0.816	0.808	0.821	0.843	0.846	0.860	0.810
Group B									
Data collection point 1	41	0.862	0.842	0.837	0.843	0.846	0.846	0.847	0.833
Data collection point 2	21	0.881	0.864	0.864	0.862	0.866	0.863	0.869	0.856

Group A: nurses from the burn unit at Beverwijk rate fragments of children admitted to the burn units in Groningen and Rotterdam. Group B: nurses from the burn units in Groningen and Rotterdam rate fragments of children admitted to the burn unit at Beverwijk.

3.5 Construct validity

In both groups at both data collection points, mean total POCIS scores for background pain were statistically significantly ($p = 0.06$) lower than mean scores of procedural pain, indicating distinction between ratings of both types of pain. However, due to poor results of inter-rater reliability in both scales, we decided to leave construct validation undone until more acceptable results are obtained.

4. Discussion

VAS scores turned out to have poor inter-rater reliability and poor to moderate intra-rater reliability. Although the VAS is a suitable instrument for self-report of pain, this simple and easy to use scale, requiring minimal training, is not only inappropriate to rate pain by nurses in adults [36, 37], but also in burned young children. This is probably due to an unstructured way of behaviour observation. The scale will therefore not be taken into further consideration. Although POCIS has moderate to good intra-rater reliability and an acceptable internal consistency, the scale does not fulfil for one raters' use since inter-rater reliability is not sufficient.

4.1 Subjects

Although convenience sampling is the weakest form of sampling [24], we suppose that the results are not due to sampling bias because the number of participants is large enough to represent the population. Groups of raters did not correspond in all characteristics. However, separate analyses of ratings from groups per characteristic did not yield higher values. Both the sampling method as well as characteristics of raters were apparently not responsible for the results. Poor reliability when multiple observers assess patients [31] is, from subjects' perspective, possibly due to a large number of observers. Good reliability can be obtained with two or three observers only [11, 14, 22, 30, 38]. Inadequately trained subjects might have influenced the results as well. Showing an instruction video followed by one practice fragment might be insufficient. Van Dijk et al. [14] developed a 2 h training session for small groups of nurses by means of video fragments and in vivo observations. A trained nurse consequently completed ratings with a trainer till inter-rater reliability was acceptable, before participating in the study. Good reliability was obtained with adequately trained nurses.

4.2 Material

Arguments to support the statement that video fragments are not comparable with real life situations and thus influence the results were not substantiated. An explanation of the lack of reliability must therefore be found in the content of the fragments. Variation between pain classes might have been insufficient. Fragments with more variance between pain classes as well as age, since neonates and young infants 1-6 months old were underrepresented in this study, could improve intraclass correlations. Furthermore, a larger number of fragments could increase variation in pain as is shown in previous research, with 26-311 cases having been observed [11, 14, 22, 28, 30, 38].

4.3 Measure

To assess if the nature of the scale is responsible for the lack of reliability, two aspects have to be taken into consideration, namely the dichotomous answer categories and the completeness of the scale. The literature does not show that scoring absence or presence of behaviour is a limited factor and should be replaced by more extensive graduation of behaviour intensity. An easier to use dichotomous scale is therefore provisionally accepted. The completeness of the scale depends on the comparability of postoperative pain after ear, nose and throat surgery with procedural and background pain in burns. We assume that pain in burns differs from postoperative pain on several aspects, namely that pain in burns is longer-lasting, has, depending on the depth of the burns, a fluctuating course and is related to repetitive daily wound care procedures. Besides, burned children can show fatigue and apathy, which could diminish the effect on expression of behaviour, but this is rarely seen in daily practice, nor were these cases represented on the videos. Despite these differences, we know from experience that procedural and background pain are not expressed by burn specific behaviour other than included in POCIS and as described by Mills [15].

5. Conclusion

POCIS scores have shown to have poor to moderate inter-rater reliability, moderate to good intra-rater reliability and an acceptable internal consistency. The VAS turned out to have poor inter-rater reliability and poor to moderate intra-rater reliability. Factors explaining these results might be the number of raters and the manner they were trained and a lack of variation between pain classes in video fragments.

5.1 Recommendations for further research

Although not all results were satisfying, an easy to use scale as the POCIS has promising qualities and deserves further reliability research. If the use of video vignettes is considered, more variation between pain classes can be obtained by selecting a larger number of fragments. Replacing videos by ratings in real life situations is nevertheless more practical and can save time. At the same time, the number of raters decreases in real life situations, which could influence inter-rater reliability positively. Before participating in a future study, nurses should follow an extensive training program. The approach Van Dijk et al. proposed [14] seems to be promising. To assess if training is indeed an important factor, raters can be divided in trained and untrained groups for comparison purposes. In addition to the POCIS, the use of another scale than the VAS, preferably a scale with graduation of intensity of behaviour, is recommended in order to assess construct validity after obtaining good reliability.

5.2 Recommendations for practice

The VAS is an inappropriate instrument to measure procedural and background pain by nurses in children aged 0-4 years. If nurses consider using the POCIS, they should follow a training program. Nurses are recommended to measure background pain at fixed points in time. To assess procedural pain, nurses are recommended to remember the content of the scale, observe behaviour items during wound care and consequently base their scores on their general impression of the entire procedure.

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(...) ‘onderzoekers worden meer gedreven door wat ze niet weten dan door wat ze wél weten, dit vaak tot grote vermoeienis van hun directe omgeving.’

Robbert Dijkgraaf (2012) [37]

Chapter 3

Reliability, validity and clinical utility of three types of pain behavioural observation scales for young children with burns aged 0 to 5 years

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Abstract

Pain measurement is a prerequisite for individualized pain management and research into pain interventions. There is a need for reliable and valid pain measures for young children with burns. The aim of this study was to investigate whether the pain observation scale for young children (POCIS), the COMFORT behaviour scale (COMFORT-B) and the nurse observational visual analogue scale (VAS obs) are reliable, valid and clinically useful instruments to measure pain in children with burns aged 0-5 years. Participating trained nurses (n = 102) rated pain of 154 children during hospitalization. Two trained nurses simultaneously assessed pain at fixed intervals by using the previous mentioned measures. Cronbach's alpha for POCIS was .87 for background and .89 for procedural pain. Intraclass correlation coefficients (ICCs) were .75 for background and .81 for procedural pain. COMFORT-B observations yielded Cronbach's alpha of .77 for background and .86 for procedural pain and ICCs of .83 for background and .82 for procedural pain. The VAS obs resulted in ICCs of .55 for background and .60 for procedural pain. Correlation coefficient between the POCIS and COMFORT-B was .79 ($p < .01$), standardized response mean was 1.04 for both POCIS and COMFORT-B. Background pain measured with the POCIS and COMFORT-B was lower than procedural pain ($p < .001$). Nurses found the POCIS easier and quicker to use, but the COMFORT-B was found to indicate pain more accurately. Both the POCIS and COMFORT-B are reliable, valid and practical scales for pain measurement in young children with burns and can be used in practice and research. The VAS obs was found to be unreliable.

1. Introduction

Burn pain can be long lasting, has a fluctuating course and is related to extensive repetitive daily wound care procedures. A distinction is made between background pain and procedural pain [1]. Background pain, experienced while resting, is caused immediately postburn when an inflammatory response is initiated, which sensitises nociceptors in and around the burn. Procedural pain is caused by every manipulation involving the burn, which leads to additional stimulation of the nociceptors. Although procedures such as skin transplantations and removal of staples are performed under general anaesthesia, wound care procedures, lasting minimal 30 minutes and including removal of dressings, washing, debridement and application of new dressings (usually ceriumsilversulfadiazine cream or hydrofiber for primary burns), are carried out by using pharmacological and non-pharmacological interventions. Procedural pain is usually of higher intensity, but of shorter duration than background pain.

Adequate management of burn pain is important for many reasons. It is essential to the relationship between the patient and the multidisciplinary team, it increases comfort and makes recovery more tolerable. In addition, adequate pain management affects morbidity by preventing elevated metabolism, thereby reducing the chance of deterioration of the immune system [1]. Furthermore, adequate pain management might reduce acute stress symptoms [2, 3].

To evaluate the adequacy of pain management, pain measurement is essential. Pain measurement is the nurses' responsibility, because, of all health care professionals, nurses are, as inflictors of pain and providers of pain relief, mostly confronted with pain of patients admitted at the burn centre. Approximately 30% of the admitted patients are children up to four years old who got, due to their development stage of motor and cognitive skills, hold of cups filled with coffee or tea or pull down hot liquid containers [2, 4, 5], causing severe dermal and deep dermal burns. Although some 3-year-olds and many 4-year-olds may be capable of providing self-reports, which is the commonly used method of pain assessment, most of these children are too young to express background and procedural pain by self-reports. Their pain should therefore be assessed by behavioural observation [6].

Since pain measurement is a prerequisite for individualized pain management, there is a need for pain behavioural observation measurement instruments with sufficient psychometric properties for young children with burns. Therefore, the aim of this study was to investigate the reliability, validity and clinical utility of three types of pain behavioural observation scales in order to measure procedural and background pain in children with burns aged zero to five years.

2. Methods

2.1 Participants

Participating nurses were employed at the three Dutch burn centres: the Red Cross Hospital in Beverwijk, the Maasstad Hospital in Rotterdam and the Martini Hospital in Groningen.

2.2 Measures

Three pain behavioural observation scales were investigated and a questionnaire was used to assess the clinical utility of these instruments.

2.2.1 Pain behavioural observation scales

2.2.1.1 Pain observation scale for young children

The pain observation scale for young children (POCIS) provides a list of behaviours that are marked as either present or absent. The POCIS was initially developed to measure postoperative pain intensity in children after adenotonsillectomy, adenotomy or insertion of ventilation tubes. The scale comprises seven behavioural items (Table 1) with dichotomous answer categories, which enables easy and quick use of the scale.

Table 1. Pain observation scale for young children [7]

	Score
Facial	
At rest, neutral	0
Grimace, nose wrinkled, eyebrows frown	1
Cry	
No cry	0
Moan, scream	1
Breath	
Relaxed, regular	0
Irregular, hold in, gasping	1
Torso	
At rest, neutral, relaxed	0
Tense, restless, contorted, writhed, trembling	1
Arms/fingers	
At rest, neutral, relaxed	0
Tense, restless, clenched fist, wild	1
Legs/toes	
At rest, neutral, relaxed	0
Tense, restless, pulled up, kicking	1
Arousal	
Calm sleepy, calm alert, playing	0
Restless, touchy, fussy	1
Total	

The absence or presence of each item is scored 0 or 1. The POCIS has proven to be reliable, based on inter-rater agreement and internal consistency, and valid, based on a principal components' analysis that supports construct validity [7]. The POCIS showed moderate to good reliability when children with burns were observed from video fragments [8].

Table 2. COMFORT behaviour scale [11]

		Score
Alertness	Deeply asleep (eyes closed, no response to changes in environment)	1
	Lightly asleep (eyes mostly closed, occasional responses)	2
	Drowsy (child closes eyes frequently, less responsive to environment)	3
	Awake and alert (responsive to environment)	4
	Awake and hyper-alert (exaggerated responses to environmental stimuli)	5
Calmness/agitation	Calm (child appears serene and tranquil)	1
	Slightly anxious (child shows slight anxiety)	2
	Anxious (child appears agitated but remains in control)	3
	Very anxious (child appears very agitated, just able to control)	4
	Panicky (severe distress with loss of control)	5
Crying	No crying sounds	1
	Occasional sobbing or moaning	2
	Whining (monotonous sound)	3
	Crying	4
	Screaming or shrieking	5
Physical movement	No movement	1
	Occasional (three or fewer), slight movements	2
	Frequent (more than three), slight movements	3
	Vigorous movements limited to extremities	4
	Vigorous movements including torso and head	5
Muscle tone	Muscles totally relaxed; no muscle tone	1
	Reduced muscle tone; less resistance than normal	2
	Normal muscle tone	3
	Increased muscle tone and flexion of fingers and toes	4
	Extreme muscle rigidity and flexion of fingers and toes	5
Facial tension	Facial muscles totally relaxed	1
	Normal facial tone	2
	Tension evident in some facial muscles (not sustained)	3
	Tension evident throughout facial muscles (sustained)	4
	Facial muscles contorted and grimacing	5
Total		

2.2.1.2 COMFORT behaviour scale

The COMFORT scale incorporates ratings of intensity and frequency of each behaviour and is appropriate for longer periods of observation [9]. The version that was used in this study, the COMFORT behaviour scale (COMFORT-B), is assumed to measure pain intensity and distress associated with pain and is an adapted version of the one developed by Ambuel et al. [10]. The adapted version has shown good reliability and congruent validity in children with postoperative pain after abdominal and thoracic surgery [11]. The scale comprises six behavioural items with five response categories for each item (Table 2). One of the six items is divided into the options respiratory response and crying. Depending on mechanical ventilation or spontaneous breathing, either respiratory response or crying has to be assessed. As it is very rare for children with burns caused by hot liquids to be mechanically ventilated, the option respiratory response was not considered in this study.

2.2.1.3 Nurse observational visual analogue scale

A visual analogue scale (VAS) provides a rating of the global impression of a patients' pain [6]. The VAS is a frequently used instrument by nurses to assess pain in children [12-18]. It may provide information on individual variations in pain sensitivity, idiosyncratic behaviours and situational influences [19]. The VAS is a quick and easy to use instrument with ratio scale properties. The scale was considered reliable on the basis of inter-rater reliability for procedural pain in neonates and in children with chronic pain [20, 21] and demonstrated a high correlation with postoperative behavioural observation pain measurement instruments [16, 22]. Although the VAS showed poor to moderate inter-rater reliability from video assessments in children with burns [8], the scale has not yet been investigated for use with wound care procedures in real life. The VAS in this study is a straight horizontal continuous 10-cm line with clearly marked terminal ends, with the anchor words 'no pain' at the left side of the line and 'unbearable pain' at the right side. A mark has to be placed on this line and a ruler is needed to read the obtained score. In order to avoid confusion with other applications of the VAS, which is mostly used as a patient self-report tool, in this study, a more specific name for this tool is used, namely the nurse observational visual analogue scale (VAS obs).

2.2.2 Clinical utility questionnaire

To survey clinical utility of the scales from the nurses' point of view, structured closed-ended self-reports by means of a 5-point Likert scale questionnaire were used. The questionnaire is based on clinical utility criteria as assessed by Harris and Warren [23]. It includes items about the extent of the scales in providing clinically useful patient information and readily understandable scores. In addition, items about ease of use, time required and clarity of the scales were included. The degree of the severity of pain, the ability to differentiate between no pain and unbearable pain and the relevance of the scale items were questioned as well.

2.3 Data collection procedure

Approval of the medical ethics committees of the participating hospitals was obtained. Parents received written and verbal information about the study and were asked to give verbal consent. They were assured that standard medical and pain treatment remained unchanged and that the study would not cause any burden to their children.

Nurses were trained to use the POCIS and COMFORT-B before taking part in the study. Two nurses from each burn centre followed training at the two hospitals where these scales were developed. Subsequently, these nurses trained their colleagues in the burn centres using a standardized one-hour educational program about pain and pain assessment. The training also included video and in vivo observations with both scales. The in vivo observations focussed on procedural pain as it was assumed that assessing this type of pain required most training. Each trainee completed ten assessments per scale with one of the trainers, of which five were video observations and another five were in vivo observations. When inter-rater reliability was acceptable, with intraclass correlation coefficients (ICCs) of 0.75 or more, nurses were allowed to rate children for the study and train other nurses.

Children that met the inclusion criteria, i.e. children aged 0-5 years with burns and without developmental delays, were observed by means of the POCIS, COMFORT-B and VAS obs_three times a day at fixed intervals by two nurses who kept independent records. Background pain was recorded in the morning, at least one hour before wound care, and in the afternoon, at least one hour after wound care. Children were observed during two minutes. Procedural pain was assessed directly after wound care. Since procedural pain can be categorised into peak and overall pain, nurses were asked to rate overall pain of the whole wound care procedure only. Peak pain is usually caused by bandages that stick to one or more areas in the wound, is of short duration but of high intensity and does, if it occurs, not represent pain intensity of the whole procedure. Furthermore, in practice, pain interventions are adapted to accommodate overall pain, not peak pain. Research has also shown that peak pain is included in overall pain ratings: a sizable correlation between peak and overall pain is reported [24, 25].

Two data collection forms comprising the three measures were developed. On each form, the POCIS and COMFORT-B were ordered differently to vary the order of completion of scales, which might avoid giving answers that are satisfactory (i.e. a box on the form is filled in), but not optimal [26]. The assumption, namely, is that the nurses may produce different patterns of responses as the previous questions may influence the latter. The VAS obs was in all cases completed after the POCIS and COMFORT-B. The following instruction for its use was given to nurses: Please estimate the level of the childs' pain by making a mark on the line. Nurses were requested not to discuss and compare their individual ratings.

The following characteristics of the participating nurses were recorded: age, gender, parenthood, education and number of years working in burn care. As for the included children, age, gender, extent and cause of the burns and length of stay were recorded. Nurses and children were encoded.

2.4 Data analysis

Data were analysed with the statistical program SPSS 16.0 (SPSS Inc., Chicago USA). Descriptive statistics were used to assess characteristics of nurses and children and clinical utility. Reliability, which is the degree to which an instrument measures a concept in a reproducible fashion, was judged by internal consistency (the degree in which the items of the scale belong to the same concept) and inter-rater reliability (the degree in which observers assign the same ratings) [27]. Internal consistency was assessed by Cronbach's alpha, inter-rater reliability by calculating intraclass correlation coefficients (ICCs). Acceptable reliability coefficients are ≥ .75 [27]. Validity, which is the degree to which an instrument measures what it is intended to measure, was determined by convergent validity and responsiveness. Convergent validity was assessed in order to evaluate how a scale correlates with another measure of the same construct [27]. Responsiveness is the ability of an instrument to detect clinically important change [28, 29]. Spearman's rho was used to determine convergent validity, since patient characteristics were not normally distributed. Independent-samples' T-tests and a standardized response mean (SRM) were calculated to assess responsiveness. The value of an SRM can be considered as an effect size index. An acceptable effect size should be d ≥ .5 [29, 30], where .5 is a medium effect and .8 a large effect.

3. Results

Data were collected from June 2007 until June 2008. All parents gave verbal consent. The number of children included in the study was 154, 101 (66%) of which were boys and 53 (34%) girls. The mean age was 20 months (SD 11). Causes of the burns were scalds in 147 children (95.5%), contact burns in six children and an electricity burn in one child. The mean total burned body surface area was 6.5% (SD 4.5, min 5-max 28) and the mean length of stay 10 days (SD 7.7, min 1-max 39).

3.1 Participants characteristics

A total of 102 nurses working in the three Dutch burn centres, which is 65% of all nurses working in this field, participated in the study. The characteristics of the nurses are described in Table 3.

Table 3. Nurses' characteristics (N = 102)

Mean age in years (SD)		40.8 (8.5)
Gender (% female)		86.3
Nurse is parent (%)		67.6
Education (%)	BSc	13.7
	IC	38.2
	PC	33.3
	BC	65.7
Years of experience in burn care (%)	< 1 year	14.7
	≥ 1 year < 5 years	27.5
	≥ 5 years < 10 years	25.5
	≥ 10 years	32.3

BS: bachelor of science; IC: intensive care; PC: pediatric care; BC: burn care.

3.2 Reliability

3.2.1 Internal consistency

Internal consistency results of the POCIS and COMFORT-B are presented in Table 4. It shows that both instruments are reliable since Cronbach's alpha should range between .70 and .90 [27]. An item contributes to a scale if alpha, when calculated after this item is deleted, has a lower value than alpha of the entire scale. All alpha values were lower when items were deleted. The POCIS showed higher alphas than the COMFORT-B.

3.2.2 Inter-rater reliability

As presented in Table 4, ICCs for the POCIS and COMFORT-B total scores met the criterion of ≥ .75 [27] and showed small confidence intervals (CIs) for background and procedural pain, indicating good reliability. The COMFORT-B showed higher ICC than POCIS. ICCs for the VAS obs were not acceptable for both background and procedural pain.

Table 4. Results reliability for POCIS, COMFORT-B and VAS obs

Scale	Type of pain	Internal consistency		Inter-rater reliability	
		Cronbach's alpha	N	ICC (CI)	N
POCIS	Background	.872	2552	.75 (.72-.77)	1277
	Procedural	.883	1322	.81 (.78-.84)	659
COMFORT-B	Background	.769	2564	.83 (.82-.85)	1277
	Procedural	.861	1323	.82 (.80-.85)	659
VAS obs	Background			.55 (.51-.59)	1277
	Procedural			.60 (.55-.65)	659

N Cronbach's alpha: number of observations; N ICC: number of paired observations; ICC: intraclass correlation coefficient; CI: confidence interval.

3.3 Validity

3.3.1 Convergent validity

In order to assess validity of the POCIS and COMFORT-B, the correlation between these two measures should be rho ≥ .3 [27]. Spearman's rho was .45 for background pain and .88 for procedural pain, which was statistically significant ($p < .01$). As the POCIS and COMFORT-B correlate for both types of pain, they probably measure the same construct. The correlation for background pain, however, is lower than that for procedural pain. Since it is first necessary that an instrument measures a concept in a reproducible fashion [27], the validity of the VAS obs was not assessed because it did not meet the reliability criterion.

3.3.2 Responsiveness

A t-test demonstrated that the POCIS total scores for background pain were statistically significantly lower than those for procedural pain (mean background pain = 0.33 (SD 1.10, median 0), mean procedural pain = 3.41 (SD 2.60, median 4), t = -51.60, df = 3872, $p < .001$, 95% CI = -3.3 to -3.0). Also, the mean COMFORT-B total scores for background pain were statistically significantly lower than for procedural pain (mean background pain = 12.61 (SD 2.95, median 9), mean procedural pain = 18.54 (SD 4.12, median 18), t = -51.69, df = 3886, $p < .001$, 95% CI = -6.3 to -5.6).

The POCIS and COMFORT-B turned out to have a similar SRM of 1.04, which is considered a large effect. As background pain differed significantly from procedural pain and the SRM was large, it was assumed that both scales are able to measure change.

Table 5. Results clinical utility POCIS and COMFORT-B

	POCIS (% agree)	COMFORT-B (% agree)
Provides information that is clinically useful	60.0	90.1
Is short to administer	81.2	56.1
Is easy to administer	77.6	65.9
Is clear and easy to understand	63.1	71.2
Reflects the extent of background pain	44.0	81.7
Reflects the extent of procedural pain	56.5	85.4
Discriminates children with pain from children without pain	43.5	82.9
Score is readily understandable and allows to adapt pain management to childs' need	39.3	82.9
Reflects procedural pain-specific features	77.4	87.7
Reflects background pain-specific features	70.4	87.8

N = 86 (number of responding nurses).

3.4 Clinical utility

To assess the clinical utility of the POCIS and COMFORT-B, 86 of 102 questionnaires (84% response) were analysed. The results are presented in Table 5. In general, nurses found the POCIS easier and quicker to use than the COMFORT-B, but the COMFORT-B was perceived to address procedural and background pain more accurately and to have better properties to connect to a pain management protocol. Since the VAS obs was not reliable and therefore not tested on validity, clinical utility of the VAS obs was not considered.

4. Discussion

The aim of this study was to assess if the POCIS, COMFORT-B and VAS obs are reliable, valid and practical instruments to measure procedural and background pain in children with burns aged zero to five years.

Both the POCIS and COMFORT-B seem to be reliable measures to assess two types of pain in children with burns. Both scales showed high and equal internal consistency. Cronbach's alpha was higher for the POCIS than for COMFORT-B, suggesting that the POCIS items show more coherence. This is in line with the assumption that the POCIS is a unidimensional scale, measuring pain intensity, while the COMFORT-B is supposed to be a multidimensional scale, including measurement of distress [6]. However, internal consistency of the COMFORT-B does not suggest a multidimensional structure.

Good inter-rater reliability was seen for both the POCIS and COMFORT. This corresponds with findings of Boelen-van der Loo [7] and De Jong et al. [8] for the POCIS, and Van Dijk et al. [11], Bear and Ward-Smith [31] and Caljouw et al. [32] for respectively, the COMFORT-B, the COMFORT scale and the adapted COMFORT scale. The higher ICC for COMFORT-B background pain than for POCIS may be explained by a restricted range of variance in total POCIS scores, ranging from 0 to 7 when compared to the variance in COMFORT-B total scores ranging from 6 to 30.

The POCIS and COMFORT-B seem to measure the same concept and are able to distinguish between two types of pain with differences in intensity, suggesting validity of both instruments. The lower correlation between POCIS and COMFORT-B for background pain when compared to procedural pain could also be due to a restricted range of variance in total POCIS scores. SRM for both the POCIS and COMFORT-B was large. This can be explained by the substantial difference between procedural and background pain, which was already demonstrated with the t-test.

In contrast to the good psychometric properties of the POCIS and COMFORT-B, the VAS, when used by nurses as a global rating scale to report the patients' pain, turned out to be unreliable not

only in this study but also in earlier research in children with burns [8], in adults with burns [24, 25, 33, 34,], and in children without burns but with postoperative or procedural pain [20, 27]. In children with burns, De Jong et al. [8] found ICCs between 0.46 and 0.66. In adult patients with burns, Pearson correlation coefficients between 0.33 and 0.47 were found [25, 33]. Geisser et al. [24] considered a rating to be correct when the nurse rated pain within 1 cm of the patients' rating. Using this criterion, it was found that nurses correctly assessed patients' pain in only 25% of the time. Iafrati [34] found correct assessments in only 31% of the time. In non-burn settings, a range of correlation coefficients from 0.42 to 0.91 was found [17, 20]. It should be noted that correlation coefficients may be of limited value to assess inter-rater reliability because they reflect only relative positions of scores [19] and are usually higher than the true reliability [27]. It is possible that nurses are unable to express the patients' pain on a global rating scale as a 10-cm line, because they have their pain assessment affected by other than behavioural factors. Cognitive, emotional, situational and/or relational factors may play conscious or subconscious roles in their observations. These findings for the VAS support the statement of Von Baeyer and Spagrud [6], namely that global observational scales are not recommended as outcome measures for pain.

An important issue in the pain literature is the distinction between pain intensity and fear-laden items like distress. Although this distinction was not subject of investigation, this study demonstrates that the POCIS and COMFORT-B appear to measure the same construct and it is assumed that this construct is pain. Interestingly, although the POCIS is assumed to measure, according to the developers, pain intensity, while the COMFORT-B measures pain intensity and distress, this distinction could not be confirmed by this study. Distress has been defined as behaviours of negative affect associated with pain, anxiety and fear [10]. Although distress is inextricably bound up with pain intensity, especially in children with burns undergoing repetitive wound care procedures, the concept differs from pain intensity. The ability the scales of making distinction between these concepts was not detected in this study.

The question arises whether or not it is possible to distinguish pain intensity from affective components of pain. Von Baeyer and Spagrud [6] have stated that few researchers have presented data showing that their observational instruments can differentiate pain intensity from its affective components. This study seems to support this difficulty. Since the POCIS and COMFORT-B seem to measure the same concept, it is assumed that the affective pain component distress is embedded in the POCIS, suggesting that presence of vocalizations, facial expressions and physical movements are not only indicators for pain intensity but also for distress. Or, with regard to the COMFORT-B, distress is a component of pain intensity in children with burns and cannot be seen separately from pain intensity. This is in accordance with Blount and Loiselle [9], who have postulated that both emotional and sensory components of pain seem to be assessed by pain behavioural assessment scales and that many behaviours do not appear to have specificity as an indicator of pain or distress. They consider this, however, not necessarily problematic, since

pain and distress are both included in the most commonly accepted definition of pain. ('Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage [35]'). The inability of the scales to differentiate between pain intensity and the emotional components of pain may not be problematic, but only from psychometric and theoretical perspective. However, from daily practice perspective, the differentiation between pain intensity and the affective pain components cannot be ignored. Both components require different treatments that should focus on both multimodal pharmacological and non-pharmacological interventions and should be started as soon as possible after the burn incident.

A last issue in this study concerns the clinical utility of the scales. Nurses found the POCIS easier and quicker to use, which can be attributed to the dichotomous answer categories of a behaviour checklist. The COMFORT-B, however, was perceived addressing procedural and background pain more accurately. According to nurses, this was due to the ability of the COMFORT-B to allow reporting degrees of severity within the answer categories. The multiple answer categories per COMFORT-B item gave nurses the impression that a middle course was also optional and that the POCIS presence or absence options were found to be too limited to accurately assess both types of pain.

A limitation of this study is that, although it was assumed that the POCIS and COMFORT-B are able to measure change, we did not assess the minimum clinical significant difference that can be measured. Assessing the minimum clinical significant difference is essential to be able to evaluate declines in pain intensity and the percentage of clinical significant pain decrease can be achieved by comparing pre- and post-treatment pain measurements [36]. These data, however, were not collected during the present study. Another limitation may relate to the use of repeated measurements. Since observations were not independent of each other, this may bias the results. Although it is assumed that repeated measurements have a minor impact on research in which the measurement instrument itself is subject of investigation, analyses were replicated on two subsets of the sample, i.e. one subset comprising the three paired observations attained on one randomly selected day for each child, and a second subset comprising only one paired observation per child. The obtained results remained unchanged, thereby rejecting a possible impact of dependency of observations in this study.

5. Conclusion

Three behavioural observation instruments are investigated for the use in a particular patient group with specific types of pain. These types of pain can be assessed with currently available measurement instruments: the POCIS and COMFORT-B showed good reliability and validity in this study and are considered clinically useful. The VAS obs, when completed by nurses, showed poor reliability to estimate children's pain.

5.1 Recommendations for practice

The POCIS and COMFORT-B can be used to measure background and procedural pain in daily burn nursing practice. Development of pain management protocols is recommended in order to connect them to the total scores of the scales. A global observational rating scale like the VAS obs when completed by nurses is not recommended as pain measurement instrument in children with burns.

5.2 Recommendations for further research

With the aim of connecting the total scores of the scales to a pain management protocol, cut off scores should be assessed to differentiate pain intensity. Also, the minimum clinical significant difference is an important issue to investigate. Furthermore, when pain is measured and treated, the adequacy of pain management can be evaluated. Finally, global observational rating scales completed by nurses are not recommended for the use of validity assessment of pain behavioural observation scales in children with burns.

Conflict of interest

The authors have no financial or other relationships that can lead to conflicts of interest.

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‘Il semble que la perfection soit atteinte non quand il n’y a plus rien à ajouter, mais quand il n’y a plus rien à retrancher.’

Antoine de Saint-Exupéry (1939) [22]

Chapter 4

Construct validity of two pain behaviour observation measurement instruments for young children with burns by Rasch analysis

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Abstract

In this study, construct validity of two pain behaviour observation measurement instruments for young children aged 1 to 56 months (mean age was 20 months) with burns is assessed by using Rasch analysis. The Rasch model, wherein data should meet the model expectations, assumes that an instrument measures one unidimensional construct, and focuses on the items of measurement instruments. The pain observation scale for young children (POCIS) and the COMFORT behaviour scale (COMFORT-B) measure background and procedural pain as unidimensional. Adequate measurements for scientific research and daily practice can now be obtained.

1. Introduction

Measurement is an essential component of scientific research and daily practice. Measurement of subjective constructs like pain requires rigorously developed and tested measurement instruments in order to obtain data of the highest possible quality. A sound methodology for testing measurement instruments is assessment of reliability and validity [1]. Reliability is the degree to which an instrument measures a construct in a reproducible fashion; validity represents the degree to which an instrument measures what it is intended to measure.

Behavioural observation measurement instruments to assess background and procedural pain in young children up to 4 years old with burns, the pain observation scale for young children (POCIS) [2] (Table 1) and the COMFORT behaviour scale (COMFORT-B) [3] (Table 2), are investigated according to this methodology for measurement instrument testing. Although self-reports are considered to be the primary source for pain assessment [4], most children with burns are too young to express background and procedural pain by self-reports.

Table 1. Pain observation scale for young children [2]

		Score
Facial		
	At rest, neutral	0
	Grimace, nose wrinkled, eyebrows frown	1
Cry		
	No cry	0
	Moan, scream	1
Breath		
	Relaxed, regular	0
	Irregular, hold in, gasping	1
Torso		
	At rest, neutral, relaxed	0
	Tense, restless, contorted, writhed, trembling	1
Arms/fingers		
	At rest, neutral, relaxed	0
	Tense, restless, clenched fist, wild	1
Legs/toes		
	At rest, neutral, relaxed	0
	Tense, restless, pulled up, kicking	1
Arousal		
	Calm sleepy, calm alert, playing	0
	Restless, touchy, fussy	1
Total		

Table 2. COMFORT behaviour scale [3]

		Score
Alertness	Deeply asleep (eyes closed, no response to changes in environment)	1
	Lightly asleep (eyes mostly closed, occasional responses)	2
	Drowsy (child closes eyes frequently, less responsive to environment)	3
	Awake and alert (responsive to environment)	4
	Awake and hyper-alert (exaggerated responses to environmental stimuli)	5
Calmness/agitation	Calm (child appears serene and tranquil)	1
	Slightly anxious (child shows slight anxiety)	2
	Anxious (child appears agitated but remains in control)	3
	Very anxious (child appears very agitated, just able to control)	4
	Panicky (severe distress with loss of control)	5
Crying	No crying sounds	1
	Occasional sobbing or moaning	2
	Whining (monotonous sound)	3
	Crying	4
	Screaming or shrieking	5
Physical movement	No movement	1
	Occasional (3 or fewer), slight movements	2
	Frequent (more than 3), slight movements	3
	Vigorous movements limited to extremities	4
	Vigorous movements including torso and head	5
Muscle tone	Muscles totally relaxed; no muscle tone	1
	Reduced muscle tone; less resistance than normal	2
	Normal muscle tone	3
	Increased muscle tone and flexion of fingers and toes	4
	Extreme muscle rigidity and flexion of fingers and toes	5
Facial tension	Facial muscles totally relaxed	1
	Normal facial tone	2
	Tension evident in some facial muscles (not sustained)	3
	Tension evident throughout facial muscles (sustained)	4
	Facial muscles contorted and grimacing	5
Total		

Their pain should therefore be assessed by reliable and valid behavioural observation instruments. The POCIS and COMFORT-B, originally developed to measure pain in children in various clinical settings, were subjects of reliability and validity research in young children with burns. Both instruments, investigated in daily burn nursing practice, showed good reliability (inter-rater reliability and internal consistency) and construct validity (convergent validity and responsiveness) [5, 6]. However, dimensionality, another type of construct validity, that is, what POCIS and COMFORT-B are supposed to measure, was not addressed. The added value of dimensionality analysis is that the trustworthiness of a total score meaning and its interpretation

can be established. By applying dimensionality analysis we can exclude subdimensions that are unrelated to pain and that we do not intend to measure.

A current model to assess dimensionality is the Rasch mathematical measurement model, usually referred to as Rasch analysis [7]. The use of Rasch analysis is increasing in health care [8]. The Rasch model is a theoretical ideal: a mathematical formula that converts ordinal responses obtained by, in this study, pain behaviour observation ratings, into additive measures, like values on a meter rule. This is done by estimating the measures that are most likely to have produced the ordinal observations. In the Rasch model, data should meet the model expectations: the model assumes that an instrument measures one unidimensional construct. The model focuses on the items of a scale, instead of the total scores or the scale as a whole. Application of Rasch analysis has already been used in nursing science since 1985 [9, 10, 11] and in pain research since 1987 [12, 13].

The aim of this study was, therefore, to assess dimensionality as a type of construct validity of the POCIS and COMFORT-B by using Rasch analysis.

2. Methods

This study is a secondary analysis of data collected in 2007-2008 and is part of the original study objective, that is, obtaining evidence for the reliability and validity of the POCIS and COMFORT-B for use in children with burns [5]. No additional ethic review was indicated, as the research goal was still within the original research purposes.

2.1 Measures

The pain behavioural observation measurement instruments POCIS and COMFORT-B were investigated. The POCIS provides a list of seven behavioural items, with two specifically labelled answer categories per item. The absence or presence of each item is scored 0 or 1. The total score of the POCIS can vary between 0 and 7, where 0 is no pain and 7 is severe pain. The COMFORT-B comprises six behavioural items, with five specifically defined answer categories per item, increasing from 1 to 5. The total score of the COMFORT-B can vary between 6 and 30, where 6 is no pain and 30 severe pain. Good reliability for both scales was found by assessing internal consistency (Cronbach's alpha .77-.87) and inter-rater reliability (intraclass correlation coefficients .75-.83). Construct validity was assessed by convergent validity (correlation coefficient between POCIS and COMFORT-B .79; $p < 0.01$) and by responsiveness (standardized response mean 1.04 and t-test background vs. procedural; $p < 0.001$) [5].

2.2 Data collection procedure

Approval of the medical ethics committees of the three participating hospitals with a burn centre (the Red Cross Hospital in Beverwijk, the Maasstad Hospital in Rotterdam and the Martini

Hospital in Groningen) was obtained. Parents received written and verbal information about the study and were asked to give verbal consent. They were assured that standard medical and pain treatment remained unchanged and that the study would not cause any burden to their children.

Nurses were trained in the use of both measurement instruments. Two nurses from each burn centre followed training at the two hospitals where these scales were developed. Subsequently, these nurses trained their colleagues in the burn centres using a standardized 1-hour educational programme about pain and pain assessment. The training also included video and in vivo observations with both scales. Each trainee completed 10 assessments per scale with one of the trainers, of which 5 were video observations and another 5 were in vivo observations. When inter-rater reliability was acceptable, nurses were allowed to rate children for the study and to train other nurses [5].

Since burn pain is divided into background (experienced while resting) and procedural pain (caused by manipulation of the burn during wound care) [14], nurses in charge with the child recorded background pain at least 1 hour before and at least 1 hour after wound care, by observing 2 minutes, and overall procedural pain directly after wound care.

2.3 Data analysis

Data were transferred into the Rasch rating scale model using the Winsteps Rasch Measurement Software (version 3.68.2) [15]. Separate Rasch analyses were conducted for both measurement instruments. To analyse the POCIS, with two answer categories per item, the dichotomous Rasch version was used. To analyse the COMFORT-B, with five answer options per item, the polytomous Andrich version was used. The performed analyses are described below.

2.3.1 Analysis of unidimensionality

Data should fit the Rasch model in order to assess unidimensionality of the underlying construct. To assess the fit of the data to the model, item difficulty and fit statistics on individual items are calculated. Factor analysis of the residual data is carried out as well.

2.3.1.1 Item difficulty

The difficulty of a pain behaviour item is the specific point on pain - when pain is expressed as a unidimensional continuum - at which the highest and lowest answer categories have equal probability of being observed. This is usually near the centre of the middle category of COMFORT-B answer categories. For a dichotomous scale as the POCIS, this is the point at which each answer category has a 50% probability of being observed. The programme ranks the items in a different (hierarchical) order than in the original instruments. In terms of Rasch analysis, the item at the top of the ranking has a high item difficulty; the item at the bottom is an easier-to-rate item. Item difficulty is also expressed in logits, that are, per item, located on

a linear interval continuum. The higher the logit is, the more the item contributes to a higher pain level. Furthermore, the inter-item separation can be assessed. This is expressed in standard errors (the items' precision), conveyed in logits, on a linear interval scale. It allows examination of the space between items along the scale and to detect redundant items. Statistically, two items are separated if they are further apart than the SEM of the items multiplied by 3. The inter-item separation should be 0.15 logits or larger for COMFORT-B (based on the mean standard error of 0.05), indicating no overlap between the items. For POCIS, it should be 0.36 (based on the mean standard error of 0.12) logits or larger.

2.3.1.2 Item fit statistics

To determine how well the items fit the model, chi-square fit statistics are calculated [15]. They represent the difference between observed responses and the responses the model expects. These fit statistics consist of an infit mean square (infit MNSQ) and an outfit mean square (oufit MNSQ). The infit MNSQ represents the mean square residual difference between observed and expected responses and is sensitive to unexpected responses. The outfit statistic is the unweighted MNSQ residual and is more sensitive to outliers. An MNSQ value of 1 means that an item perfectly fits the underlying construct. Infit and outfit MNSQ values should range from 0.6 to 1.4 [16].

2.3.1.3 Factor analysis of residual

Observed data that do not fit the model, the residual, or the unexplained variance, are analysed separately, in order to assess if it contains, besides the explained variance (pain), other dimensions. At least two items are necessary to consider a relevant secondary dimension. Each item namely shares the Rasch dimension, but also has its own features. For these features to accumulate into a dimension, at least two items must share the same features. The residual variance is expressed by eigenvalue units. The eigenvalue implies the number of items that are off-dimension [15].

2.3.2 Category function

Category functioning was examined by category frequencies, average measures, thresholds, and category fit statistics [17].

2.3.2.1 Category frequencies

The POCIS has two and the COMFORT-B has five answer categories per item. The category frequencies indicate how often a particular answer category is observed by the nurse, in order to detect unused answer categories. At least 10 observations per category are required; for dichotomous items even 25 or 50. Furthermore, the category frequencies should be regularly distributed [17].

2.3.2.2 Average measures

An average measure is the location of an answer category on the linear pain continuum, expressed in logits. It is the average amount of pain, assigned by the nurses to a particular answer category. For example, the mean of all first COMFORT-B categories (of all items) is responsible for a certain amount of logits pain. The average measures by category should increase monotonically, moving from lower to higher categories [17].

2.3.2.3 Category fit statistics

The category fit statistics, expressed in outfit MNSQs, indicate if categories have been used unexpectedly. Outfit MNSQ values, associated with a particular category, higher than 2.0 suggest that the category has been used unexpectedly and that there is unexplained noise, indicating that there is more misinformation than information in the observations. Extreme categories are more likely to produce high MNSQs than central categories. Central categories often demonstrate over-predictability [17].

2.3.2.4 Thresholds

A threshold is a measure of the transition between answer categories, for example, between categories 1 and 2 or between categories 2 and 3. The thresholds are expected to increase monotonically from lower to higher categories [17].

2.3.3 Differential item functioning

Differential item functioning (DIF) is assessed to examine if background and procedural pain have a similar hierarchy of item difficulties. The hierarchy of the items is assumed to be the same across groups: it should work uniformly, irrespective of groups, in our case, for burned children with procedural pain and for children with background pain. For example, if an item is invariant across groups, the item with the lowest difficulty on the pain continuum for background pain has also the lowest difficulty for procedural pain. Where item difficulties were first calculated for the entire group, as is described in 2.3.1.1, they are now calculated per type of pain. These are the absolute difficulties for each item per type of pain. Absolute item difficulties are reported in logit values. The contrast is also calculated. This is the difference between the relative item difficulties (item difficulties in relation to the overall difficulty of each item) of procedural and background pain. When this difference is ≥ .50 logits [18], the item exhibits DIF and is thus not working uniformly for the two types of pain. More than one item in a scale, or more than 5% of the items, should demonstrate DIF [11] to distinguish background from procedural pain.

3. Results

The data collection resulted in 1935 POCIS and 1949 COMFORT-B scores, obtained from observations of 154 children of which 101 (66%) were boys and 53 (34%) were girls. Sample size

requirements are met, since a total of 50 measurements and at least 10 observations per answer category are suggested [17]. Their mean age was 20 months (1-56, SD 11.0). Causes of the burns were scalds in 147 children (95.5%), contact burns in 6 children and an electricity burn in one child. The mean total body surface area was 6.5% (5-28, SD 4.5) and the mean length of stay 10 days (0-39, SD 7.7). A total of 102 nurses observed the children. Their mean age was 41 years (22-61 years, SD 9.0); 33% accomplished pediatric care education and 66% burn care education; 58% had experience in burn care for more than 5 years.

3.1 Analysis of unidimensionality

Results of the unidimensionality analysis are shown in Table 3 and 4 for, respectively, the POCIS and COMFORT-B.

Table 3. Unidimensionality of POCIS (number of observations = 1935)

Items	Item difficulty (logits)	Infit mean square	Outfit mean square
Torso	1.63	1.07	1.02
Arms/fingers	1.63	0.79	0.58[a]
Legs/toes	1.36	1.04	1.38
Breath	0.18	1.11	1.29
Facial	- 1.34	1.03	1.15
Arousal	- 1.58	0.93	0.86
Cry	- 1.88	0.90	0.86

POCIS: pain observation scale for young children.
[a] Outfit outside reasonable range of 0.6-1.4.

Table 4. Unidimensionality of COMFORT-B (number of observations = 1949)

Items	Item difficulty (logits)	Infit mean square	Outfit mean square
Crying	2.77	0.98	0.99
Calmness/agitation	2.72	0.74	0.97
Facial tension	0.82	0.46[a]	1.04
Physical movement	- 0.16	0.96	1.35
Muscle tone	- 1.62	0.79	1.01
Alertness	- 4.53	1.63[a]	1.97[a]

COMFORT-B: COMFORT behaviour scale.
[a] Infit or outfit outside reasonable range of 0.6-1.4.

3.1.1 Item difficulty

For the POCIS, the item 'Torso' has a high difficulty and the item 'Cry' has a low difficulty. For the COMFORT-B, the item 'Crying' has a high difficulty and the item 'Alertness' a low difficulty. If a high-response category (e.g., category 4 for COMFORT-B) is assigned to the pain behaviour item

that is on top of the ranking, then a high answer category has also been assigned to the items below the item at the top, which is thus associated with the most severe pain. For example, for the COMFORT-B item 'Crying', a high answer category like 'Screaming or shrieking' is observed by nurses only when high-answer categories are also assigned to the other COMFORT-B items.

The POCIS item 'Torso' and the item 'Arms/fingers' have the same item difficulty of 1.63 logits, meaning overlap between items and thus redundancy of items. Also, separation distances between 'Arms/fingers' and 'Legs/toes' and between 'Facial', 'Arousal' and 'Cry' did not meet the criteria. Apparently, the items 'Torso,' 'Arms/fingers,' and 'Legs/toes' seem to share some form of muscle contraction, while 'Facial,' 'Arousal,' and 'Cry' seem to share behaviour connected to crying. Separation distances of at least 0.36 logits were identified between 'Legs/toes' and 'Breath,' and 'Breath' and 'Facial,' suggesting that these items are effectively separated.

The COMFORT-B item 'Crying' and the item 'Calmness/agitation' have nearly the same item difficulty, with, respectively, 2.77 and 2.72 logits, also suggesting redundancy of items. The inter-item separation of the other items was larger than 0.15 logits, indicating no overlap between these items and suggesting that the item difficulties of the COMFORT-B are more evenly spread and thus better targeted at the studied population than the POCIS item difficulties. No ideal inter-item separation is seen, but the results suggest a degree of unidimensionality.

Because the items on the two instruments have different response structures (dichotomous and polytomous), equivalent items are not expected to have equal difficulties. It is remarkable, however, that the item 'Crying' is the easiest-to-rate POCIS (present or absent) item but the most difficult-to-rate COMFORT-B item. This is possibly due to the COMFORT-B answer categories: 'real Crying' is present in only the fourth and fifth answer categories.

3.1.2 Item fit statistics

All the items of the POCIS, except 'Arms/fingers' have MNSQ infit or outfit values between 0.6 and 1.4 and meet the criteria. 'Arms/fingers' have a low outfit value of .58, indicating that this item has too much predictability: there is less variation in the data than in the model. The item 'Alertness' of the COMFORT-B has a high MNSQ infit of 1.63 and outfit of 1.97 logits, reflecting unpredictability (i.e., erratic (unreliable, unpredictable) responses or noise) and suggests that the item does not contribute to the measurement of a unidimensional construct. 'Facial tension' showed a low infit of 0.46, meaning over-predictability of this item.

3.1.3 Factor analysis of residual

The overall variance of the POCIS that should be explained by the model was 44.5%, and the variance that was actually explained was 45.3%. This minimal difference means that the empirical measures correspond with the model. The unexplained variance of the POCIS residual is 21.6%.

The eigenvalue is 1.5, corresponding with 1.5 items that are off-dimension. Since at least 2 items are necessary to consider a second dimension, the variance of 21.6% of the residual cannot be explained by the existence of more dimensions.

The overall variance of the COMFORT-B that should be explained by the model was 79.4%, and the variance that was indeed explained was 81.9%. This minimal difference means that the empirical measures correspond with the model. The unexplained variance of the COMFORT-B residual is 31.4%. Since the eigenvalue is 1.9, corresponding with 1.9 items, the 31.4% unexplained variance is not explained by a second dimension. In general, for both scales, no substantial and interesting dimension is identified from the residual Rasch factor analysis. Other subdimensions yielded even lower eigenvalues than in the first dimension.

3.2 Category function

The functions of the two POCIS categories and the function of the five categories of the COMFORT-B are presented in table 5.

Table 5. Category function POCIS and COMFORT-B

	Answer category	Category frequency (n)	Category frequency (%)	Observed average (logits)	Expected average (logits)	Outfit mean square	Threshold
POCIS	0	10858	80	- 1.53	- 1.53	1.00	None
	1	2687	20	1.29	1.29	1.04	0.00
COMFORT-B	1	3457	30	- 6.15	- 6.06	1.09	None
	2	2436	21	- 3.84	- 3.84	1.19	- 4.71
	3	3226	28	- 1.35	- 1.43	0.93	- 2.99
	4	2319	20	2.33	2.15	1.62	0.60
	5	259	2	6.20	7.94	2.32	7.10

POCIS: pain observation scale for young children; COMFORT-B: COMFORT behaviour scale.

3.2.1 Category frequencies

All categories meet the criterion of 10-50 observations. POCIS category 0, indicating absence of the pain behaviour item, was most frequently observed. The first COMFORT-B category was most frequently observed. The fifth category has only been rated 259 times (2%), suggesting that this category is underused in relation to the other categories. The POCIS shows no uniform distribution in observation frequencies, nor does the COMFORT-B. The COMFORT-B has peaks at categories 1 and 3. Responsible for the peak in category 1 are the items 'Crying' (No crying sounds) and 'Calmness' (Child appears calm, serene, tranquil). Another peak is seen in category 3. Most contribution for the peak in category 3 originates from 'Physical movement' (More than 3 slight movements) and from 'Muscle tone' (Normal muscle tone). Although it provides 3 points to the total score, category 3 indicates, given the description, in fact, no pain behaviour for our

population: this is behaviour of a child that is awake. Since observations in higher categories must be produced by higher measures [13], this is not the case for these items.

3.2.2 Average measures

The POCIS values increase from the first (-1.53 logits) to the adjacent category (1.29 logits) and correspond with the model expectations. The COMFORT-B logits increase monotonically from the lowest to the highest category (from -6.15 to 6.20 logits), with jumps of 2.3, 2.5, 3.7 and 3.9 and are close to the model expectations, except for category 5.

3.2.3 Category fit statistics

The category fit statistics seem to meet the model expectations. The POCIS outfit MNSQs do not exceed the criterion of 2.0. COMFORT-B categories, except for the fifth, also show good outfit MNSQs. The fifth COMFORT-B category shows a high MNSQ, but extreme categories are most likely to produce high MNSQs [17]. Central categories, however, often exhibit over-predictability. The central category, category 3, has the lowest outfit MNSQ, suggesting more predictability than the other categories.

3.2.4 Thresholds

The POCIS has two answer categories and thus only one distance between categories, which accordingly, yields no thresholds. The COMFORT-B thresholds do increase monotonically from low to high, with jumps of 1.71, 3.59 and 6.5 logits, suggesting that the categorization of the COMFORT-B items works well [9].

3.3 Differential item functioning

The hierarchy of the POCIS items for background pain only is different when compared to the item difficulty of the entire dataset (Table 6). The item 'Torso' exchanged with 'Arms/fingers' and 'Arousal' with 'Cry'. However, for procedural pain, all items are similarly ordered when compared to the overall ordering of the scale. On the other hand, the hierarchy of the COMFORT-B items for background pain is similar to the item difficulty based on the entire dataset (Table 7). For procedural pain however, the items 'Crying' and 'Calmness/agitation' exchanged order.

POCIS items showing ≥ .50 logits contrast are 'Arms/fingers,' 'Breath,' and 'Arousal' (Table 6). With more than one item showing contrast, the POCIS demonstrates DIF for the two types of pain, which means that the items work differently for background and procedural pain. All COMFORT-B items, except for 'Facial tension,' show ≥ .50 logits contrast and thus demonstrate DIF (Table 7).

Table 6. Differential item functioning POCIS

Items	Absolute item difficulty (logits)		Contrast procedural-background
	Background pain	Procedural pain	
Torso	1.88[a]	1.58	0.30
Arms/fingers	2.46[a]	1.49	0.97*
Legs/toes	1.60	1.31	0.29
Breath	- 0.19	0.30	0.50*
Facial	- 1.36	- 1.34	0.02
Arousal	- 2.01[a]	- 1.39	0.62*
Cry	- 1.68[a]	- 1.98	0.29

POCIS: pain observation scale for young children; DIF: differential item functioning.
[a] Differently ordered when compared to item difficulty of entire scale (Table 3).
* ≥ .50 logits and exhibiting DIF.

Table 7. Differential item functioning COMFORT-B

Items	Absolute item difficulty (logits)		Contrast procedural-background
	Background pain	Procedural pain	
Crying	3.72	1.95[a]	1.77*
Calmness/agitation	3.42	2.05[a]	1.37*
Facial tension	0.69	1.13	0.44
Physical movement	- 0.36	0.32	0.68*
Muscle tone	- 1.95	- 0.85	1.10*
Alertness	- 4.71	- 4.06	0.65*

COMFORT-B: COMFORT behaviour scale; DIF: differential item functioning.
[a] Differently ordered when compared to item difficulty of entire scale (Table 4).
* ≥ .50 logits and exhibiting DIF.

4. Discussion

The aim of this study was to assess construct validity of the POCIS and COMFORT-B for procedural and background pain in young children with burns. Some studies have applied the Rasch model to pain measurement instruments for clinical use [12, 13]. However, to our knowledge, this is the first study analyzing pain behaviour observation instruments for young children with burns by using this model.

With regard to unidimensionality, the item difficulties may suggest a slight form of multidimensionality, but this is not supported by the factor analysis of the residual: no second substantial and interesting dimension is identified and therefore, the POCIS and COMFORT-B may measure as unidimensional instruments. The unexplained variance of the residual is probably caused by the narrow range of pain intensity (POCIS) or by noise (the COMFORT-B item 'Alertness'). Furthermore, also the fit statistics imply unidimensionality for both scales. Although less stringent criteria for infit and outfit statistics have been mentioned, namely between 0.5

and 1.7 for clinical observations [16], these criteria would only benefit the POCIS fit for 'Arms/fingers'. In agreement with an earlier study [5], the ability of the scales to distinguish pain intensity from affective components of pain like, for example, anxiety, was not detected in this study, suggesting that affective components are embedded in the entire pain dimension, which is also supported by Von Baeyer and Spagrud [14] and Blount and Loiselle [19].

POCIS item 'Arms/fingers' and COMFORT-B item 'Facial tension' are over-predictable. According to Wright and Linacre [16], even an item with low fit statistics tells us something useful, which we do not want to waste, so item deletion is not advised. Over-predictability is not a major problem because it only means that an item is too easy. The unpredictability of the COMFORT-B item 'Alertness' suggests, however, that the item does not contribute to the measurement of a unidimensional construct. This is probably due to the fact that it seems to be a nominal item instead of an ordinal item: only the fourth and fifth answer categories seem to be relevant for our population. The fourth category ('Awake and alert, responsive to environment') was chosen in 75% of the observations. This result might be due to the particular context for this study. Wound care procedures are typically carried out during daytime, at times when children would normally be awake and alert. Background pain behaviour was also observed during daytime, resulting in a higher likelihood that children were awake. In other contexts, such as critical care, or in the evening, the likelihood of children being assigned scores other than the fourth and fifth 'Alertness' categories might be higher.

In general, the category function is working well. Nurses can discriminate the answer categories, and the results confirm that the rating of higher answer categories indicate more pain behaviour. The fifth COMFORT-B category is underused, indicating unpredictability or noise [17], but probably this category is rarely observed because children just had no or mild pain, since the first category, indicating no or few pain behaviours, is most frequently observed. The underuse of the fifth COMFORT-B may also explain the high threshold jump between the fourth and fifth categories. Relatively rarely observed higher categories and category frequencies that follow an irregular pattern can cause disordering of thresholds [17].

DIF was detected for both types of pain, which means that nurses assess background pain differently than procedural pain. Distinction between background and procedural pain by the POCIS and COMFORT-B was also reported in our previous analysis of this study [5]. Explanations might be that procedural pain and background pain are different types of pain that generate different pain behaviour or that the observation outcome is affected by the length of the observation. Procedural pain observed during the wound care procedure that takes 30 to 60 minutes differs from the background pain observation of 2 minutes. Other researchers [20] indicated that the duration of observation by using COMFORT-B influences the outcome. Besides, there seem to be more interactions with the child during wound care when compared to observation of background pain, which may influence the nature of the observation. On the other hand, it is also

likely that a severity factor is observed, indicating that procedural pain reflects just more severe pain than background pain, which was quite low in this study. This could be an artifact rather than a true indication of a difference between the two pain types [21]. More research in other patient populations is needed to clarify this issue. Furthermore, while the POCIS showed DIF in 3 of the 7 items, the COMFORT-B showed DIF in 5 out of 6 items, suggesting that the COMFORT-B discriminates even more between background and procedural pain.

4.1 Limitations of the study

The Rasch model expects randomness throughout the dataset. Our dataset may not meet this expectation. The first POCIS and COMFORT-B category, indicating no or little pain behaviour, is most frequently observed. We assume that this is due to factors related to background pain. First, it is suggested that background pain is well treated. Second, overt behavioural expressions of pain may dissipate over time since it is common for the observable manifestations of acute pain to fall away after a painful event. Third, the POCIS and COMFORT-B were developed for, respectively, short-term acute pain and acute pain, and may not be able to detect ongoing burn pain. Fourth, background pain is measured twice a day and procedural pain only once. Accordingly, children do not show much background pain behaviour. Consequently, there is a majority of background pain measurements with minimal pain behaviour in this dataset.

4.2. Conclusion

In general, the POCIS and COMFORT-B fit the stringent Rasch model in a clinical situation with a particular group of patients suffering specific types of pain. This suggests that they measure as unidimensional. Adequate measurements for scientific research and daily practice can now be obtained in order to evaluate intervention research and pain management. Correspondence between the data and the Rasch model justifies summation of the scores across items to a total pain score.

4.2.1 Recommendations for research

The consequence of the DIF results is that groups with procedural pain and background pain cannot be compared in future intervention research: treatment effects should be separately analysed for background and procedural pain. In addition, construct validity of the POCIS and COMFORT-B can be further investigated by using Rasch analysis, preferably in other clinical settings with children unable to provide self-reports and experiencing background and procedural pain, and in settings where children experience other types of pain. Rasch analysis in other patient populations could also clarify the distinction between background and procedural pain: do the different types of pain generate different pain behaviour or does procedural pain reflect just more severe pain than background pain, and does duration of observation influence the nature of observation? Furthermore, to be able to evaluate declines in pain behaviour, the minimum clinical significant difference is an important issue to investigate. This can be achieved by comparing

pre- and posttreatment pain measurements. Finally, with the aim of connecting the total scores of the scales to a pain management protocol, cutpoints should be assessed to differentiate pain behaviour.

4.2.2. Recommendations for practice

First, the POCIS and COMFORT-B can be used to measure background and procedural pain in daily burn nursing practice. However, with regard to the clinical utility, the COMFORT-B allows report of degrees of severity within the answer categories. Nurses preferred these multiple-answer categories. They found that, although the POCIS was easier and quicker to use, the two POCIS answer categories are too limited to accurately assess both types of pain [5]. The COMFORT-B can be successfully implemented in daily nursing practice by using a pain management education program for nurses. Second, development of an individualized pain management protocol based on the total pain behaviour scores is recommended. The protocol should address both pain intensity and anxiety. Although both components appear closely intertwined and could not be separated in this study, the current state of knowledge on pain is clear: only by addressing both components as soon as possible after the burn incident can pain be sufficiently treated.

Conflicts of interest statement

The authors have no financial or other relationships that can lead to conflicts of interest.

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‘No matter how long you work, it’s always going to end sometime. And there’s always going to be things left undone. (...) There would still be new ideas. There would still be things that you wished you would have accomplished.’

Keith Haring (1958-1990) [39].

Chapter 5

Pain in young children with burns: extent, course and influencing factors

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Abstract

Little evidence is available on the extent, course and influencing factors of pain in young children with burns. At present, reliable and valid measurement instruments to assess pain behaviour in these children are available, implying that valuable insight into these issues can now be obtained. The aim of this study was to document the extent and course of background and procedural pain behaviour with the COMFORT-B, and to identify factors that may influence procedural pain. First, cutpoints for COMFORT-B scores were established by Rasch analysis to enable assessment of clinically relevant changes. Second, the extent of pain behaviour was assessed by descriptive statistics. Third, the course of background and procedural pain, as well as factors that may influence procedural pain behaviour, were investigated by latent growth modeling. Trained nurses collected pain behaviour data of 168 children (mean age 20 months, mean total burned body surface area (TBSA) 6%, mean length of stay 10 days). Cutpoints of COMFORT-B scores were as follows: 6-13 (mild pain), 14-20 (moderate pain) and 21-30 (severe pain). This study suggests that background pain was more adequately treated than procedural pain. Factors that seemed to influence baseline pain scores and/or the course over 8 days included TBSA, the number of surgical procedures, acetaminophen administration by the referring hospital, and the application of hydrofiber dressings. The implications of these findings are discussed.

1. Introduction

Burns are often associated with pain. Perry et al. [1] reported in 1981 that pain in burns was undertreated. Choinière [2] stated in 2001 that little had changed in the pain management of burns, whereas Martin-Herz et al. reported in 2003 [3] that there had been advances in pediatric burn pain control. At present, we assume that the current knowledge on adequate pain management should be gradually implemented in daily burn care to optimize pain treatment. The state of art is that adequate management of burn pain should consist of early treatment starting at the referring hospital [4] and of an individualized multimodal approach, i.e., using two or more drugs with different mechanisms of action, combined with non-pharmacological interventions [2, 5-7]. Additional pain relief could be attained by using advanced synthetic wound dressings that remain in place for several days, requiring less wound care procedures [2]. To date, documentation on pain severity and the adequacy of pain management in young children, considerably represented in burn centres [8, 9], is limited.

Latarjet and Choinière [10] identified the typical characteristics of burn pain in adults based on patients' self-reports, including the distinction between background and procedural pain, the fluctuation between and within patients, and the relationship of pain with repetitive daily wound care procedures [2]. We assume that pain in children demonstrates similar characteristics. However, although some 3-year-olds and many 4-year-olds may be capable of providing self-reports, which is the commonly used method of pain assessment, most children are too young to express background and procedural pain by self-reports. Within the past decade, pain behaviour observation instruments for pain assessment in young children have been tested for reliability and validity [11, 12]. Recently, the COMFORT behavioural scale (COMFORT-B) was identified as a useful instrument for pain assessment in both background and procedural pain in young children with burns [13, 14], which provides avenues to optimize pain treatment in this group.

The aim of this study was to document the extent and course of background and procedural pain behaviour and to detect factors that may influence procedural pain in children during hospitalization in Dutch burn centres. The categorization of COMFORT-B scores into descriptive adjectives that are connected to cutpoints may be useful in the evaluation of changes in pain behaviour severity [15]. Our research questions were therefore as follows: What are the cutpoints of the COMFORT-B scores? To what extent do background and procedural pain behaviour occur? What is the course of background and procedural pain behaviour? Which factors influence the occurrence of procedural pain behaviour?

2. Methods

This study includes a secondary analysis of data collected in 2007-2008 for a prospective multicentre cohort study. The aim of the study was to obtain evidence for the reliability and validity

of pain behaviour measurement instruments for young children aged 0 to 4 years with burns and without developmental delays [13, 14]. In the study, paired pain behavioural observations were collected. As good inter-rater reliability was obtained, for the present study, only one of the paired observations, randomly selected, was used for analyses. Approval of the medical ethics committees of the three participating hospitals with a burn centre (the Red Cross Hospital in Beverwijk, the Maasstad Hospital in Rotterdam and the Martini Hospital in Groningen) was obtained. Parents received written and verbal information about the study and were asked to give verbal consent. The parents were assured that standard medical and pain treatment remained unchanged and that the study would not cause any burden to their child. This study was performed in accordance with the guidelines of the Declaration of Helsinki.

2.1 Measure

The COMFORT-B [11] was used to assess pain behaviour. The instrument is a pain behavioural observation scale and is a reliable and valid instrument to measure pain behaviour in young children with burns [13, 14]. The COMFORT-B comprises six behavioural items with five answer categories per item. The total score of the COMFORT-B can vary between 6 and 30 (Table 1).

2.2 Data collection procedure

This study includes pain behaviour observations by nurses who were trained in the use of the COMFORT-B [13]. As burn pain is divided into background (experienced while resting) and procedural pain (caused by manipulation of the burn during wound care, which leads to additional stimulation of the nociceptors) [10], nurses assigned to the child's care recorded background pain behaviour for two minutes at a time at least one hour before and at least one hour after wound care [16]. The overall procedural pain behaviour was assessed directly after wound care. Baseline characteristics (gender, age, cause of the burn, total burned body surface area (TBSA), the number of surgical procedures (an indicator of the extent of deep dermal burns), analgesics provided by the referring hospital, pharmacological pain treatment in the burn centre, the nature of wound care and the length of hospital stay) were retrieved from the medical file by the researchers. The presence of parents and child life specialists and the number of nurses present during wound care were registered daily by the nurses when completing the COMFORT-B.

2.3 Data analysis

The statistical program PASW Statistics 18 was used for descriptive data analyses and t-tests. Cutpoints were calculated using the polytomous Andrich version of Winsteps® Rasch Measurement Software (version 3.68.2). The classification of COMFORT-B total scores by means of cutpoints may help to evaluate changes in pain behaviour severity and adapt pain treatment. The classification of pain into mild, moderate and severe categories is described [17-20]. This classification was assessed using patients' self-reports with numeric rating scales and visual

analogue scales and with pain interference data (the extent to which pain interfered with daily activities) as dependent variables. We were unable to reproduce this procedure because the children of our target group (0-4 years old) are typically, due to their age, unable to provide us with these self-reports. We therefore based cutpoints on item difficulty [14], obtained by Rasch analysis. This program ranks the items in a hierarchical order according to the item difficulty. In terms of Rasch analysis: the item at the top of the ranking has a high item difficulty, and the item at the bottom would be the one most frequently endorsed in the sample. Item difficulty is also expressed in logits, that are, per item, located on a linear interval continuum. The higher the logit, the more the item contributes to a higher pain level.

MPlus (version 6.1, Muthen and Muthen) was used for latent growth modeling (LGM) analysis to establish the course of COMFORT-B scores of background and procedural pain behaviour and to examine the influencing factors of procedural pain. The advantage of LGM is that children are allowed to have different starting points (random intercept model) and different courses (random slope model) [21] and that equal numbers of observations across time are not required. Another advantage of the program is that it uses full information maximum likelihood estimation (FIML): all cases remain in the analysis, including those with missing observations on one or more days. However, many children in this study had only one or two observations. To increase the reliability of the estimations, we selected those children with at least three COMFORT-B scores measured during the first eight days of hospitalization. Eighty children met this criterion. In this group, we first examined the overall fit of COMFORT-B procedural pain scores to a linear model. Second, we examined the variance at the intercept level, to determine whether children differed in the starting level of pain, and the variance at the slope level, to examine if children exhibited different courses over this 8-day period. The goodness-of-fit indicators used in this study included the root mean square error of approximation (RMSEA), the comparative fit index (CFI) and the Tucker-Lewis index (TLI). The goodness-of-fit target values were < 0.05 for RMSEA and > 0.95 for CFI and TLI [22]. In a second step, we evaluated the influence of the patient characteristics (gender, age, TBSA, length of stay and number of surgical procedures) on the intercept and slope. All of the effects are reported as significant at $p < 0.05$. Non-significant variables were removed from the model to obtain sufficient power for further analyses. In the next step, the surplus value of analgesia provided by the referring hospital was evaluated. In these analyses, we used dummies for administered analgesics: 0 for not provided and 1 for provided. Furthermore, we examined the influence of wound care aspects that were typically used in the participating hospitals. We used dummies to examine their influence: 0 for not applied, 1 for applied. Finally, an R-square value was reported to provide information on the proportion of variance that was explained by the model. In all models, a robust maximum likelihood estimator was used because the frequencies of some of the variables were non-normally distributed.

Table 1. COMFORT behaviour scale [11] with items in hierarchical Rasch order for cutpoint assessment

Behavioural item	Answer categories	Score	Minimal mild pain	Maximal mild pain	Minimal moderate pain	Maximal moderate pain	Minimal severe pain	Maximal severe pain
Alertness	Deeply asleep (eyes closed, no response to changes in environment)	1	x					
	Lightly asleep (eyes mostly closed, occasional responses)	2						
	Drowsy (child closes eyes frequently, less responsive to environment)	3						
	Awake and alert (responsive to environment)	4		x	x	x		
	Awake and hyper-alert (exaggerated responses to environmental stimuli)	5					x	x
Muscle tone	Muscles totally relaxed; no muscle tone	1	x					
	Reduced muscle tone; less resistance than normal	2						
	Normal muscle tone	3		x	x			
	Increased muscle tone and flexion of fingers and toes	4				x	x	
	Extreme muscle rigidity and flexion of fingers and toes	5						x
Physical movement	No movement	1	x					
	Occasional (three or fewer), slight movements	2		x				
	Frequent (more than three), slight movements	3			x			
	Vigorous movements limited to extremities	4				x	x	
	Vigorous movements including torso and head	5						x
Facial tension	Facial muscles totally relaxed	1	x					
	Normal facial tone	2		x	x			
	Tension evident in some facial muscles (not sustained)	3						
	Tension evident throughout facial muscles (sustained)	4				x	x	
	Facial muscles contorted and grimacing	5						x
Calmness/ agitation	Calm (child appears serene and tranquil)	1	x	x	x			
	Slightly anxious (child shows slight anxiety)	2				x	x	
	Anxious (child appears agitated but remains in control)	3						
	Very anxious (child appears very agitated, just able to control)	4						
	Panicky (severe distress with loss of control)	5						x
Crying	No crying sounds	1	x	x	x			
	Occasional sobbing or moaning	2				x	x	
	Whining (monotonous sound)	3						
	Crying	4						
	Screaming or shrieking	5						x
Total			**6**	**13**	**14**	**20**	**21**	**30**

3. Results

3.1 Baseline characteristics

The patient characteristics of the entire sample and of the selection of 80 children with three or more pain behaviour observations for LGM are presented in Table 2.

Table 2. Patient characteristics

	All children	Children ≥ 3 observations
N	168	80
Gender, % boys	68	68
Mean age in months (range, SD)	20 (1-60, 11.7)	21 (1-53, 11.9)
Cause, N (%)		
Scald	162 (96)	76 (95)
Contact	5 (3)	3 (4)
Electricity	1 (1)	1 (1)
Mean % TBSA (range, SD)	6.3 (0.25-28, 4.3)	7.9 (1-28, 5)*
Mean % TBSA deep dermal (range, SD)	0.5 (0-18, 2.2)	0.74 (0-18, 2.6)**
Mean length of stay in days (range, SD)	10 (1-39, 7.5)	13 (2-39, 6.8)
Surgical procedures N (%)		
0	140 (83)	62 (78)
1	22 (13)	14 (17)
2	5 (3)	4 (5)
4	1 (1)	0 (0)
Mean	0.17	0.28***

TBSA: total burned body surface area; independent t-test: * p = 0.001, ** p = 0.025, *** p = 0.042.

Table 3. Pharmacological pain treatment during hospitalization (n = 168)

Type of pain	Medication administered dose (mg/kg body weight/length of stay)	
Background	Acetaminophen	42.30
	Morphine	0.24
	Codeine	0.09
	Tramadol	0.05
Procedural	Acetaminophen	5.41
	Morphine	0.42
	Ketamine (anesthetic)	0.09
	Midazolam (anxiolytic)	0.15
	Diazepam (anxiolytic)	0.07

The analgesics provided by the referring hospitals included acetaminophen, morphine, fentanyl and ketamine. An overview of pharmacological pain management during hospitalization in the burn centres is presented in Table 3. Typically, more than one type of medication was administered. Although procedural pain medication is reported separately in this table, background pain medication was also administered to prevent potential procedural pain. Acetaminophen and morphine were generally used to treat both types of pain.

Table 4. Wound care with respect to the total number of procedures (n = 1188)

Type of wound care product		%
Antibacterial products	Silversulfadiazine	35
	Cerium silversulfadiazine	23
	Other*	23
Wound contact products	Hydrofiber	25
	Other**	10
Location of wound care		
Bath/shower		76
Bed		24
Individuals present		
Parent/guardian***		60
Child life specialist		19
1 Nurse		23
2 Nurses		77

*Other: mupirucin, povidone-iodine, zinc oxide, or fusidic acid cream, silver nitrate solution, nitrofural solution or cream; **Other: tulle gras dressings, hydrocolloids, silicone dressings; ***Parent, child life specialist and/or nurse presence implies that distraction techniques (bubble blowing, reading stories, music or singing) and/or attention techniques (comforting and praising the child) were applied.

An overview of the nature of wound care is presented in Table 4. A total of 1188 wound care procedures was registered between admission and day 21 post-burn (7 wound care procedures per child on average). Wound care products were newly applied or were in situ. Combinations of wound care products were also applied. Although there were some fluctuations over time, the type of dressing was generally quite stable, particularly during the first 8 days. Silversulfadiazine and hydrofiber were typically used for wound management (in 35% and 25% of the procedures, respectively). Most of the procedures were combined with bathing or showering (76%) and were carried out by two nurses (76%) (one for wound care and one for assistance and distraction). The wound care of donor sites is not included in the table. Donor sites were usually treated with foam products or calcium alginates that were only removed after healing of the donor site.

We collected COMFORT-B scores up to day 21 post-burn. However, most children were discharged within 10 days after admission, resulting in a limited number of pain behaviour observations in the

second and third week post-burn. A total of 2559 pain behaviour observations were obtained, divided in 975 observations of background pain in the morning (mean 6.4 observations per child (n = 151)), 896 observations of procedural pain (mean 5.9 observations per child (n = 152)) and 688 observations of background pain in the afternoon (mean 5.1 observations per child (n = 134)). However, 1188 wound care procedures were performed, implying that 292 measurements of procedural pain behaviour are missing, possibly because nurses were not yet trained at the time of the procedure or because nurses forgot to fill in the data collection form. Nurses collected the pain behaviour data of 168 children. Fourteen children were provided with pain scores obtained from untrained nurses, leaving 154 children for analyses of the means per type of pain.

3.2 Cutpoints

According to the item difficulties (Table 5), the COMFORT-B items Alertness and Muscle tone are at the bottom of the hierarchical ranking and are thus the most frequently endorsed items. This corresponds with ticking one of the higher answer categories for these items. For minimal pain behaviour, this implies Alertness answer category 4 (awake and alert) and Muscle tone category 3 (normal muscle tone). For the higher ranked items, the lower categories are observed: Physical movement category 2, Facial tension category 2, Calmness category 1, Crying category 1, all indicating maximal mild pain behaviour (Table 1). When added up, the total COMFORT-B score of 13 is the upper boundary for mild pain. The next item in the hierarchical ranking is Physical movement.

Table 5. Item difficulty of COMFORT-B

Items	Item difficulty (logits)
Crying	2.77
Calmness/agitation	2.72
Facial tension	.82
Physical movement	-.16
Muscle tone	-1.62
Alertness	-4.53

The answer category that is closest to minimal moderate pain is Physical movement answer category 3. When added to the earlier mentioned observations, this implies a minimal moderate total pain behaviour score of 14. For the upper limit of moderate pain, according to the ranking, Facial tension category 4 is the first addition. Second, higher categories of Physical movement (category 3), Alertness and Muscle tone (category 4), as well as higher categories for the 'difficult' items Calmness (category 2) and Crying (category 2) were added. The summation indicates a total score of 20 as cutpoint for moderate to severe pain. In summary, total COMFORT-B scores 6-13 indicate mild pain, scores of 14-20 indicate moderate pain and scores of 21-30 indicate severe pain. As COMFORT-B total scores may vary between 6 and 30, there are 24 steps. Given

that the first cutpoint is 13 and that there are 24 steps, our classification of mild pain (13/24 = 0.54) is comparable to a score of 5 on a scale from 0 to 10 on numeric rating or visual analogue scales. As the second cutpoint is 20, our classification of moderate pain (20/24 = 0.83) corresponds to 8 on a scale from 0 to 10.

3.3 Extent of pain behaviour

The mean total pain scores overall and per week for morning and afternoon background pain behaviour and procedural pain behaviour as well as the classification by the cutpoints are presented in Table 6. The means for background pain behaviour did not exceed the total score of 13 (mild pain behaviour) and appeared to be stable over time. Mean procedural pain behaviour scores did not exceed 19 (moderate pain behaviour) and were also stable over time. With respect to the number of children, the majority exhibited mild background pain behaviour. However, a considerable number suffered from moderate procedural pain (66%) and severe pain was also observed (25%).

3.4 Course of pain behaviour

We first investigated whether there was evidence for a linear increase or decrease in pain scores over the 8-day period. The overall fit of the linear model for COMFORT-B procedural pain scores to the model was good: RSMEA = 0.035, CFI = 0.951 and TLI = 0.955. This indicates that pain scores on average showed a linear decrease. The mean baseline pain score (intercept) was 18.529. The mean change in pain scores (slope) was -0.007, indicating that on average the pain scores diminished 0.007 points per day over the 8-day period. This decrease is small, indicating an overall stable pattern in pain behaviour. Despite the overall stable pain scores, the model provided evidence for variance across the children regarding their baseline pain scores (12.758 (SD 3.424)) and the change over time (0.310 (SD 0.140)). Figure 1 presents the observed pain observation scores in procedural pain behaviour of 25 randomly selected children in the first eight days of admission and clearly illustrates the fluctuations within and between children as well as between the mild, moderate and severe pain behaviour ranges.

3.5 Influencing factors

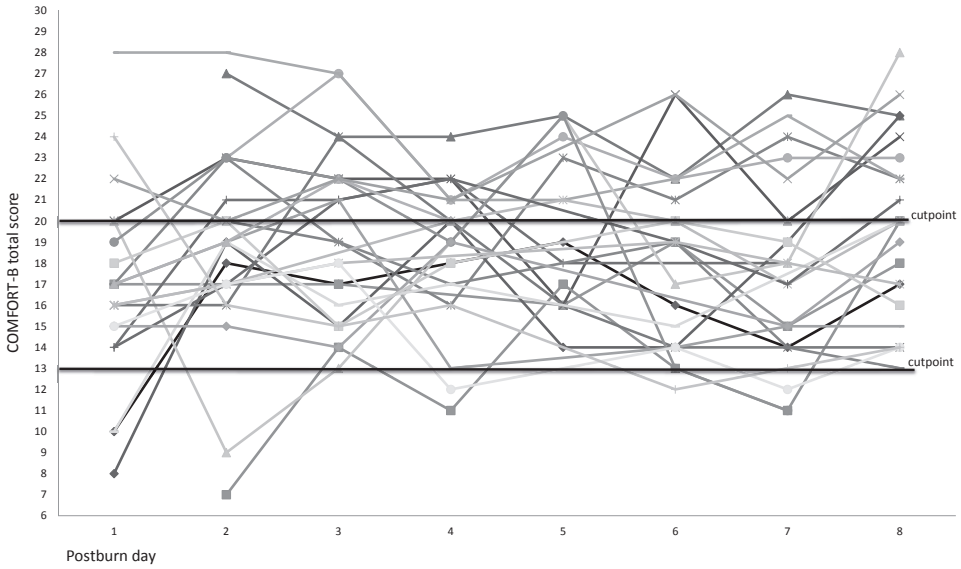
In an attempt to explain the variation in pain scores across children, several factors were examined to identify influencing factors on procedural pain behaviour. The role of patient characteristics, pharmacological pain treatment by the referring hospital and wound care aspects were examined step by step as possible influencing factors.

Table 6. Mean pain total scores and classification of pain per child

Type of pain	Mean total pain score								Classification of pain				
	Overall		Week 1		Week 2		Week 3			Overall	Week 1	Week 2	Week 3
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)		N (%)	N (%)	N (%)	N (%)
Background morning	151	13.1 (1.5)	146	13.0 (1.9)	79	13.3 (1.5)	43	13.1 (1.9)	Mild	108 (72)	101 (69)	52 (66)	29 (67)
									Moderate	43 (28)	44 (30)	27 (34)	14 (33)
									Severe	0	1 (1)	0	0
Procedural	152	18.7 (3.2)	147	18.6 (3.5)	79	19.2 (3.5)	42	17.9 (3.6)	Mild	14 (9)	18 (12)	6 (8)	4 (10)
									Moderate	100 (66)	93 (63)	47 (59)	29 (69)
									Severe	38 (25)	36 (25)	26 (33)	9 (21)
Background afternoon	134	12.1 (2.1)	130	12.1 (2.3)	64	11.9 (2.2)	30	12.4 (1.9)	Mild	106 (79)	99 (76)	48 (75)	20 (67)
									Moderate	28 (21)	31 (24)	16 (25)	10 (33)
									Severe	0	0	0	0

N: number of children; Mild: COMFORT-B score 6-13; Moderate: COMFORT-B score 14-20; Severe: COMFORT-B score 21-30.

Figure 1. Course of observed procedural pain of 25 children



3.5.1 Patient characteristics

In the first step, we evaluated the effects of gender, age, and the injury severity parameters TBSA and the number of surgical procedures. Gender and age were not statistically significantly related to baseline pain scores (intercept) or the course over time (slope). Girls and boys did not differ regarding their baseline pain scores or their course over time, nor did age (in months) contribute to differences in baseline pain or pain course. Therefore, these variables were removed from the model to obtain sufficient power for further analyses. TBSA and the number of surgical procedures seemed to influence pain behaviour (Table 7): TBSA showed no effect on the starting point of pain but was statistically significantly related to an increase in pain behaviour over the 8-day course (per % TBSA, a 0.047 increase in pain behaviour per day was identified). The number of surgical procedures was statistically significantly related to the baseline pain scores: children with more surgical procedures, i.e., with more deep dermal burns, had lower starting levels of pain. There was no statistically significant influence of the number of surgical procedures on the change in pain scores during the 8-day period.

3.5.2 Pharmacological pain treatment by referring hospital

In the following step, the influence of acetaminophen, morphine, ketamine and fentanyl administration by the referring hospitals was analyzed, controlled for TBSA and surgical procedures. Only acetaminophen was identified as statistically significantly related to the course of pain. Children receiving this analgesic at the referring hospital exhibited a higher decrease in pain scores over the 8 days (Table 7) when compared to children not receiving acetaminophen. We removed the analgesics that were not significantly related to the pain scores from the model.

Table 7. Unstandardized estimate coefficients for the model of influencing factors of COMFORT-B total scores

	Estimate (standard error)	Confidence intervals		P value
Intercept		Lower 2.5%	Upper 2.5%	
TBSA	-0.054 (0.111)	-0.272	0.164	0.627
Surgical procedures	-2.644 (1.026)	-4.656	-0.633	0.010*
Acetaminophen by referring hospital	1.233 (0.939)	-0.608	3.074	0.189
Hydrofiber	-3.272 (0.948)	-5.131	-1.414	0.001*
Slope				
TBSA	0.047 (0.021)	0.006	0.089	0.025*
Surgical procedures	0.153 (0.195)	-0.228	0.535	0.431
Acetaminophen by referring hospital	-0.422 (0.191)	-0.796	-0.048	0.027*
Hydrofiber	0.504 (0.205)	0.103	0.905	0.014*
R Square				
Intercept	0.394			
Slope	0.582			

*Statistically significant, two-tailed.

3.5.3 Wound care

Because modern wound care products such as hydrofiber may influence the nature of wound care procedures, we examined whether we could detect any influence of this product on pain behaviour. We therefore added, in the last step, the variable hydrofiber to the LGM analysis. Hydrofiber use was statistically significantly related to the baseline pain scores and the course over time. Children treated with hydrofiber exhibited statistically significantly lower baseline pain scores but exhibited an increase in pain behaviour over the following 8 days (Table 7). On day 8, children had, on average, an increase of 8 x 0.5 = 4 points on the COMFORT-B score.

This final model showed moderate fit statistics (RMSEA = 0.071, CFI = 0.83, TLI = 0.81), but explained a considerable amount of variance, i.e., 39% of the variance in baseline pain scores and 58% of the variance over time was explained by the variables (Table 7).

Unfortunately, our database was too small to perform LGM analyses to test the relationship between parental presence and daily pain scores. Therefore, we analyzed the influence of parental presence by descriptive statistics. To assess an influence of parental presence on COMFORT-B scores, two consecutive days, one without and one with a parent present during wound care, were selected for analysis. Only 29 children yielded these consecutive observations. The mean COMFORT-B score of procedural pain with parents present was 17.79 (SD 3.6), a slightly lower score than when parents were absent (mean 18.72 (SD 4.1)), but this difference was not statistically significant ($t = -0.95$, $df = 28$, $p < 0.35$, 95% confidence interval -2.39 to 0.88). Furthermore, both mean COMFORT-B scores, with and without parents present, remained in the moderate pain behaviour range.

4. Discussion

To our knowledge, this is the first study documenting the extent, course and influencing factors of pain behaviour in young children with burns using a reliable and valid pain behavioural observation measurement instrument and using a latent growth modeling analysis. Furthermore, this is the first study that determined cutpoints of the COMFORT-B based on statistical evidence.

Cutpoints are important in clinical practice to guide pain management. Rasch analyses in this patient group identified 13 and 20 as statistically relevant cutpoints. These cutpoints are also clinically meaningful [23]. Several researchers identified cutpoints at 4 and 7 on self-reported visual analogue scales and numeric rating scales [17-20]. Although our calculated COMFORT-B cutpoints of 5 and 8 for comparison purposes were offset from these prior values by one point each, they are overall consistent with the cutpoints of 4 and 7 on the visual analogue and numeric rating scales. In addition, the cutpoints between mild and moderate and between moderate and severe pain may differ across patient groups [15]. This is consistent with two COMFORT-B cutpoints that are used in daily practice for non-burn patient groups in two academic hospitals in the Netherlands. Although the cutpoint 16 for acute pain and the cutpoints 16 and 24 for postoperative pain are based on clinical decision making, they are fairly in line with our calculations. However, cross-validation in a separate sample is needed to obtain stronger evidence for the cutpoints.

This study illustrated that background pain behaviour in young children consisted of mild total scores on average, suggesting that in the majority of the children, background pain seemed adequately treated. Nevertheless, a quarter of the children observed in this study exceeded the mild pain threshold. Less background pain behaviour is observed in the afternoon. When compared to background pain in the morning, the decreased afternoon background pain is likely due to bandages that stick in the morning and/or to the after-effect of procedural pain medication. Procedural pain observation scores were higher on average, ranging from moderate to severe pain (66% and 25%, respectively). This finding indicates that there is room for improvement for the considerable number of children showing moderate and severe procedural pain. Although commonly used types of medication were administered, we have not investigated whether appropriate dosages with respect to weight and medical prescription per type of pain were administered.

Furthermore, this study demonstrated that COMFORT-B scores fluctuated from day to day. Although on average stable over time, the children in this study showed a variety of pain behaviours, particularly during wound care. Although the extent and course of pain behaviour in young children with burns has not been published, our results are in accordance with pain reported by older children aged 7-17 [24] and by adults [25]. An inconsistent trend over repeated

pediatric procedures has also been reported in cancer pain studies [26], in which various patterns were found, such as sensitization (increased pain), habituation (decreased pain) and stable patterns (little change over time). In sum, the variation in pain behaviour observed in this study supports prior studies in older patients with burns and other pediatric populations.

Results derived from the LGM analyses indicated that children differed in the extent of procedural pain behaviour, both at baseline and over time. Burn severity, in terms of TBSA and the number of surgical procedures, influenced procedural pain behaviour scores. The number of surgical procedures was associated with a lower basic pain level. This finding can be explained by the destruction of nerve endings in deep dermal burns shortly after the burn event [25]. TBSA predicted a slight increase in pain behaviour in the 8-day period, indicating that within the first week post-burn, pain scores in general became higher with an increased TBSA. Although the effect was quite small (an increase of 8 x 0.047 = 0.38 on average per % TBSA over 8 days), it may be an indication of an accumulative effect of the wound care procedures in the more severely burned children.

Furthermore, treatment with acetaminophen by the referring hospital shortly after the burn event was associated with a higher decrease in pain behaviour scores during the following 8 days. This result suggests that when acetaminophen is generated by the referring hospital, followed by the continuation of acetaminophen for the treatment of background pain in the burn centre, as was the case in this study, pain diminished more quickly over an 8-day period. It has been reported that when a child undergoes a painful procedure with inadequate pain treatment, the pain may condition an anxiety response and heighten arousal for subsequent procedures [27-29]. The underlying mechanism possibly explaining this result may be similar to the effects of preemptive analgesia in planned surgical interventions [30, 31]. These results may indicate the importance of pain treatment starting immediately after the burn event. Alternatively, one may argue that the group of children provided with acetaminophen by the referring hospital had certain characteristics that influenced the referring medical doctors' decision to opt for this analgesic. However, in our opinion, this explanation is unlikely because children were referred from many different hospitals all over the country, and a standardized pain protocol for referring hospitals for children with burns is not yet in place. Moreover, this effect was statistically significant after controlling for TBSA and surgical procedures, suggesting that this effect could not be attributed to burn severity. Unexpectedly, morphine provided by the referring hospital did not demonstrate such an effect. Although most children received morphine for the treatment of procedural pain, only a minority of the children in this study received morphine as the standard round-the-clock treatment for background pain, indicating a discontinuation of the morphine administered by the referring hospital. We can only conclude that a single dose of morphine did not influence the pain behaviour scores in this study.

This study demonstrated the beneficial influence of hydrofiber on the baseline level of pain. However, children treated with hydrofiber exhibited an increase of pain behaviour over time. This may be explained by formation of crusts that elicit pain in young children or by the removal of hydrofiber within this 8-day period when the depth of the burn was revealed to be different than the initial assessment. Despite this increase over time, mean COMFORT-B scores did not exceed the moderate pain level. We therefore suggest that hydrofiber should have priority in the choice of wound care products, as hydrofiber can remain in place for several days and therefore can reduce the nature of the wound care procedures and repeated pain stimuli [2, 32] and avoid adaptations throughout the central nervous system (hyperalgesia) [7]. Unfortunately, hydrofibers are not suitable for all types of burns. Hydrofibers are particularly suitable for partial thickness burns. On full thickness burns, hydrofibers fail to adhere. For these burns, early surgery and treatment with antibacterial products may be more suitable.

The mean COMFORT-B score for procedural pain with parents present was slightly lower than when parents were absent, but this difference was not statistically significant. Our results are in line with two other studies reporting that parental presence did not seem to reduce nor increase pain [33, 34]. Meanwhile, it is common practice in some burn units to give parents the option of being present during wound care [33-35]. Several advantages are attributed to parents' presence in the burn literature: parents maintain their parental role of comforting and praising a child, parents feel helpful to their child, parents can provide physical comfort (by touch, soothing voice) and are able to make decisions in daily care [35, 36]. Furthermore, nurses can teach parents wound care [36], especially when discharge is close, and parents can get used to wounds and scars. Additionally, Smith et al. [37] argued that as wound care procedures may be performed by a different nurse each day, the parent is the only constant person throughout the wound care procedures. Despite these beneficial assumptions, currently available studies do not provide evidence for or against the use of parental presence. Renewed research regarding parental presence, using the now-available reliable and valid measurement instrument in larger cohorts, is essential.

Some limitations of this study must be considered to optimally interpret our findings. Because this study is part of a clinimetric study objective using the research method appropriate for that purpose, the study was limited by a small sample size when opting for LGM. These advanced statistics have many advantages but require large sample sizes to reduce error in estimating variance around the intercept and slope. Therefore, replication in a larger sample is warranted. Another limitation is that the data were collected in 2007-2008. However, the results are still current and applicable because pain and wound treatment has not undergone substantial changes in the intervening years. Furthermore, observations were made by the same nurses who provided burn care rather than by independent observers. This may cause bias because care providers may have an interest in demonstrating that their care does not involve severe distress. However, an independent observer was, for practical and financial reasons, not included in the study design.

An extra data collector for research purposes only would cause unnecessary extra stress during wound care, and, after all, nurses observe pain behaviour to evaluate pain in daily practice. In addition, according to our results, high pain behaviour levels were actually included. Nevertheless, we considered it important to report these results because pain measurements obtained with appropriate instruments are currently not available in the burn literature. Additionally, these pain behaviour reports enable comparisons with future research results and may be helpful in designing future research.

5. Conclusion

Since the reports of Perry et al. in 1981 [1] and Choinière in 2001 [2], developments in pain management have been gradually implemented in daily burn care, although there remains room for improvement. Adequate pain evaluation in young children with burns is now achievable with progress in pain behaviour observation instruments such as the COMFORT-B. In this study, cutpoints of the COMFORT-B total scores were determined. The classification of COMFORT-B total scores into mild, moderate and severe pain behaviour using the cutpoints may help to evaluate changes in pain behaviour severity and adapt pain treatment. Because pain behaviour fluctuates, daily measurement is recommended. Standardized documentation, an algorithm for the application of analgesics and training in pain management for nurses may help to implement daily pain measurement.

This study suggests that background pain is adequately treated in the majority of the children, as total COMFORT-B scores were in the mild pain behaviour range for 72 to 79% of the children. However, a considerable percentage of children exhibited moderate and even severe procedural pain behaviour. This result suggests that there is room for improvement regarding the pharmacological and/or non-pharmacological approach of procedural pain in young children with burns. Interestingly, this study demonstrated an influence of early acetaminophen administration by the referring hospital when this pain treatment is continued in the burn centre. Furthermore, as hydrofibers reduced baseline procedural pain, the use of modern synthetic wound dressings that can stay in situ for several days is recommended. Although we found no evidence for a pain-relieving effect of parental presence, which may be expected in such a small subsample, more research is needed to increase our understanding of this intervention for young children with burns. We should examine what parent behaviours are helpful and what preparation is appropriate for parents to maximize helping their children during wound care. For example, Blount and colleagues reported that verbal reassurance by adults increases the child's distress, whereas other adult behaviours may decrease distress [38]. Future pain research should also focus on comfort-increasing interventions, such as attention and distraction techniques, in children exhibiting moderate and severe pain behaviour.

Conflicts of interest statement

The authors have no financial or other relationships that could lead to conflicts of interest.

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‘Nursing scholarship must answer global questions and ensure that infrastructure is built to enable international research and education.’

Susan Gennaro (2012) [39].

Chapter 6

The visual analogue thermometer and the graphic numeric rating scale: a comparison of self-report instruments for pain measurement in adults with burns

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Pain 2012; 153(11): 2260-6.

Abstract

The commonly used method of pain assessment in adults with burns is by patients' self-reports. However, the comparison of pain scores in research and in practice may be hampered by the different measures used. Frequently used patient self-report instruments for the measurement of background and procedural pain are the visual analogue thermometer (VAT) and the 0 to10 graphic numerical rating scale (GNRS). To legitimise interchangeable use, the aim of this study was to compare self-reports obtained by the VAT with those obtained by the GNRS, to compare their ability to differentiate background from procedural pain, and to compare cutpoints of both scales.

A total of 319 adult patients with acute burns participated in the study (67% male, mean age 40.3 years (SD 16), mean TBSA 9.9% (SD 10.4), mean TBSA deep dermal 3.4% (SD 7.5), mean length of stay 17.5 days (SD 14.5) and mean number of surgical procedures 1.0 (SD 1.7).

Self-reports were compared by Spearman's rho correlations: 0.64 for morning background pain, 0.51 for procedural and 0.55 for afternoon background pain ($p < 0$ .01), and by Wilcoxon signed ranks tests: VAT scores were statistically significantly lower than GNRS scores for all types of pain ($p < 0.01$). Both scales were able to differentiate background from procedural pain: Wilcoxon signed ranks tests indicated that procedural pain was statistically significantly higher than background pain ($p < 0.01$) for both scales, although the standardized response mean was moderate (0.518 for VAT and 0.571 for GNRS). Furthermore, ROC analyses showed similar cutpoints for both scales and for both types of pain.

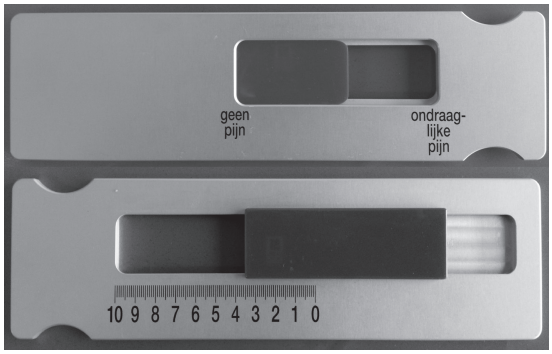
Apparently due to the large variability in pain scores, the results suggest that the instruments cannot be used interchangeably in daily practice or in research. This study also suggests that pain scores should ideally be 2 or lower. However, since large variability was also seen in medians of unacceptable pain, nurses may, when asking the patient about the extent of pain, also ask if that specific pain score is acceptable or not, before adapting pain treatment.

1. Introduction

Acute pain is an important complication of burn injuries. Researchers continue to report that burn pain is a worldwide, unresolved problem [1]. In particular, pain experienced during wound care procedures with highly fluctuating patterns [2-5] is difficult to control. But also background pain, experienced at rest, varies widely in intensity [6]. To evaluate the adequacy of the treatment of this fluctuating pain, pain should be measured. The commonly used method of pain assessment in adults with burns is by patients' self-reports. However, the comparison of pain scores across study reports may be hampered by the different measures used. The global burn field is a small area that may benefit from reliable comparisons across studies. This may be particularly relevant for pain intervention studies that received increasing attention in recent years [7-11]. Also for daily practice, to evaluate the adequacy of pain treatment, it may be useful if several measures could be offered to patients to match with their preference for a specific instrument. Therefore, this study aimed to compare two commonly used self-report instruments.

One of the frequently used patient self-report instruments for the measurement of background and procedural pain in adults with burns is the visual analogue thermometer (VAT) [2, 3, 12, 13]. The VAT (Figure 1) has good clinimetric properties and is specially developed for clinical use in burn care. Another frequently used self-report pain measure is the 0 to 10 graphic numerical rating scale (GNRS) [14-17] (Figure 2).

Figure 1. Front side and back side of the visual analogue thermometer



While pain on the VAT is expressed by the perceptible extent of a red coloured band, pain on the GNRS is expressed by a series of numbers. Up to now, it is unclear whether the VAT and the GNRS can be used interchangeably. Another indefinite issue relates to cutpoints: it is unknown whether the two instruments have similar cutpoints. This is a relevant question for both clinical practice and research because cutpoints are useful for treatment guidelines and evaluation of changes in pain in daily practice and for determining effects in intervention studies [18].

To legitimise interchangeable use, the aim of this study was to compare self-reports obtained by the VAT with those obtained by the GNRS, to compare their ability to differentiate background from procedural pain, and to compare cutpoints of both scales.

Figure 2. Graphic numeric rating scale

Background pain
Please rate your pain by circling the number that best describes your pain at this moment

0	1	2	3	4	5	6	7	8	9	10
No pain										Pain as bad as you can imagine

2. Methods

This study is part of a multicentre longitudinal prospective cohort study into the extent, course and influencing factors of clinical pain. Data were collected between April 2010 and October 2012. Approval of the local medical ethics committees of the three participating hospitals provided with a burn centre (the Red Cross Hospital in Beverwijk, the Maasstad Hospital in Rotterdam and the Martini Hospital in Groningen), and of the official regional medical ethics committee was obtained. The study was conducted according to the principles of the Declaration of Helsinki.

2.1 Inclusion criteria

Inclusion criteria were: adult patients (18 years and older) with acute burns, with a minimal length of stay of 48 hours and a minimal total burned body surface area (TBSA) of 1%. Patients had sufficient Dutch proficiency and had no acute or chronic psychotic pathology, nor did they have cognitive impairments that prevented reliable data collection. Patients requiring artificial ventilation were invited to participate as soon as they were extubated and able to provide self-reports.

2.2 Measurement instruments

2.2.1 Visual analogue thermometer

The VAT is a frequently used instrument for self-reports of pain in patients with burns and is an adapted version of the visual analogue scale (VAS). The VAT (Figure 1) [2] is an aluminium and plastic endurable tool that can be easily disinfected, which allows reusability in the burn centre. The left and right extremities of the device are marked by the anchor words 'no pain' and 'unbearable pain.' A red band can slide from left to right. As the band is moved from the left to the right, an increasing intensity of pain is shown. The more intense the pain, the more the red band lengthens toward the anchor 'unbearable pain.' On the back is a 10-cm ruler corresponding to the red band, where the numerical value can be read by the nurse. Construct validity in patients

with burns was assessed by comparing the VAT to a verbal numeric rating scale (VNRS) (0-10) and an adjective pain scale. Significant correlations were seen for all scales (Spearman's rho ≥ 0.71, p = 0.001) for background and procedural pain. Also, the VAT was able to differentiate background from procedural pain (mean background pain scores were 41% lower than mean procedural pain scores) [2].

2.2.2 Graphic numeric rating scale

The 0 to 10 GNRS (Figure 2) is a brief, simple and easy to use tool for the assessment of several types of pain in both clinical and research settings. Pain on the GNRS is expressed by the numbers 0 to 10 that are placed at equal distance. The anchor words are 'no pain' and 'pain as bad as you can imagine'. The GNRS is part of the brief pain inventory (BPI) [19]. Construct validity of the BPI is assessed by using confirmatory factor analysis [20]. However, for the GNRS as an isolated scale, clinimetric properties were not located. A 10-point GNRS is used in research into burn pain by several researchers [14-17, 21, 22], but the focus of these studies was not on the clinimetric properties.

2.2.3 Verbal assessment of pain adjectives

Cutpoints can be determined by asking patients how they define pain categories [23]. In this study, we first asked patients to classify their pain scores into the adjectives 'acceptable' or 'unacceptable' before comparing their classification to cutpoints that were used in the burns literature.

2.3 Data collection procedure

During the first week of admission, local researchers (nurse scientists) invited patients who met the inclusion criteria to participate in the study. The procedure was explained orally and in writing. When patients agreed to participate, written informed consent was obtained. Patients were assured that standard medical and pain treatment remained unchanged and that they could withdraw at any time for any reason without consequences. The baseline characteristics gender, age, cause of the burn, TBSA, length of stay and number of surgical procedures were retrieved from the medical file by the researchers.

Since VAT measurements are part of routine daily nursing care, nurses were already trained in the use of the VAT by a standardized educational program about pain and pain assessment. To introduce the study, an extra one-hour educational session was organized to explain the purpose of the study and to focus on the appropriate use of the VAT. Besides, an information flyer was handed out. Since burn pain is divided into background (experienced while resting) and procedural pain (caused by manipulation of the burn during wound care procedures), nurses assigned to the patient recorded background pain at least one hour before wound care, and in the afternoon (or at least one hour after wound care), by asking the patient to indicate his current

pain. They assessed procedural pain directly after wound care by asking the patient to indicate overall pain of the whole wound care procedure. Nurses asked the patient to slide the red band to the point where pain was experienced. Subsequently, nurses read the score from the backside of the device and recorded the score on the data collection form.

The researchers asked the patients to categorise the obtained VAT pain scores into 'acceptable' or 'unacceptable'. This was limited to twice a week, in order to protect patients against overcharging and to avoid bias. Patients were also given a diary to register their pain scores and categorisation of the score obtained with the GNRS. Patients were asked to draw a circle around one of the numbers on the scale that corresponded with their pain. When patients were unable to write, due to bandages, the researchers assisted the patient.

2.4 Data analysis

The statistical program IBM SPSS Statistics 20 (release 20.0.0) was used for data analyses except for receiver-operating characteristic tests (ROC). ROC analyses were calculated by MedCalc Software version 12 (release 12.5.0).

To compare the VAT with the GNRS, Spearman's rho was used to calculate correlations, since patient characteristics were not normally distributed. Because pain scores were not normally distributed and measurements were obtained from the same patients, Wilcoxon signed ranks tests were calculated to compare VAT mean scores with GNRS mean scores. Wilcoxon signed ranks tests were also calculated to detect differences between background and procedural pain mean scores per scale. Furthermore, a standardized response mean (SRM) was calculated to compare the ability of the scales to differentiate background from procedural pain.

Finally, receiver-operating characteristic tests (ROC) were carried out to identify cutpoints. The ROC test expresses the quality of the scales in percentage 'area under the curve' (AUC) with a confidence interval and standard error. When AUC is 100, the scale is able to perfectly identify unacceptable pain, while 50 means that there is a chance of only 50% that unacceptable pain is detected [24]. The ROC test also expresses coordinates on a curve by sensitivity (correct classification 'unacceptable': the probability that 'unacceptable' pain is indeed 'unacceptable' pain) and specifity (the probability that the scale detects 'unacceptable' pain while this is not the case). Median pain scores for 'unacceptable' pain that are reported by patients in this study, cutpoints that are reported in the literature and cutpoints that are used as quality indicator in the Netherlands, yielded a range of cutpoints of 2 up to 7 inclusive. They were considered as potential cutpoints for pain in the burn population. The cutpoints are determined visually by assessing which score combines highest sensitivity with lowest specificity [25].

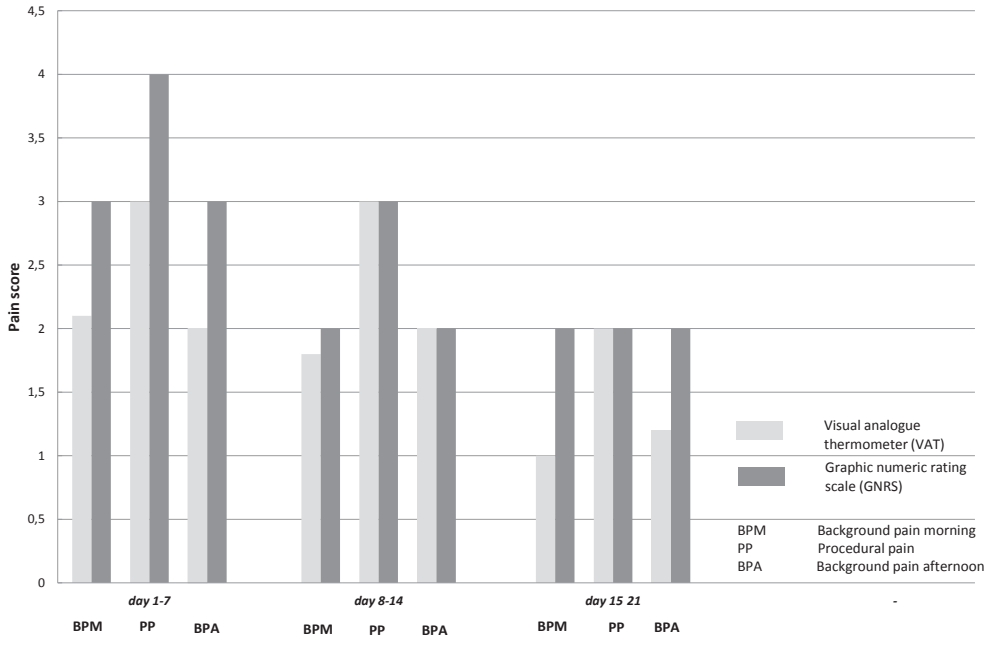
3. Results

A total of 319 patients participated in the study and yielded 7142 VAT assessments (of which 4742 for background pain and 2400 for procedural pain) and 4639 GNRS assessments (of which 3185 for background pain and 1454 for procedural pain) from postburn day 1 to 21.

3.1 Patient baseline characteristics

The majority of the patients was male (67%), mean age was 40.3 years (SD 16), mean TBSA was 9.9% (SD 10.4), mean TBSA deep dermal 3.4% (SD 7.5), mean length of stay 17.5 days (SD 14.5) and mean number of surgical procedures was 1.0 (SD 1.7). The median extent of pain, divided in the first, second and third week of admission, when measured with the individual scales, is presented in Figure 3 and shows a decrease in time. Overall, when postburn day 1 to 21 are taken together, median pain scores for VAT and GNRS were identical: score 2 for morning and afternoon background pain and 3 for procedural pain. The mean difference between VAT and GNRS scores was 0.5, but VAT scores of 9 points higher than GNRS scores were seen, as well as VAT scores of 9 points lower than GNRS scores, suggesting that some patients may have reported reversed anchor points. In general, when visually inspecting the frequencies, patients reported a large variation in pain scores between 0 and 10.

Figure 3. Median pain scores by VAT and GNRS



3.2 Comparison of self-reports

Spearman's rho was 0.64 for morning background pain, 0.51 for procedural pain, 0.55 for afternoon background pain, 0.59 for morning and afternoon background pain together and 0.59 for all types of pain together ($p < 0.01$). The correlations for background pain were higher than the correlation for procedural pain.

Wilcoxon signed ranks tests indicated that VAT scores were statistically significantly lower than GNRS scores (mean morning background pain 1.9 and 2.4 respectively ($z = -10.79$, $p < 0.01$), mean procedural pain 3.1 and 3.8 respectively ($z = -7.5$, $p < 0.01$), and mean afternoon background pain 1.9 and 2.5 respectively ($z = -10.70$, $p < 0.01$)).

3.3 Comparison of ability to differentiate types of pain

Wilcoxon signed ranks tests also indicated that procedural pain (mean 3.2 for VAT, 3.5 for GNRS), when measured by VAT or GNRS, was statistically significantly higher than morning background pain (mean 2.2 ($z = -24.19$, $p < 0.01$) and 2.4 ($z = -18.44$, $p < 0.01$ respectively)) and afternoon background pain (mean 2.1, $z = -20.47$, $p < 0.01$ and 2.4 ($z = -19.95$, $p < 0.01$ respectively)).

The ability of the scales to differentiate background from procedural pain, expressed in SRM, was 0.518 for VAT and 0.571 for GNRS. The value of an SRM can be considered as an effect size index. An acceptable effect size should be $d \geq 0.5$ [26, 27], which corresponds with a moderate effect.

3.4 Comparison of cutpoints

Not all pain scores were accompanied with the patients' classification of their pain scores into the adjectives 'acceptable' or 'unacceptable'. Concerning the VAT, the classification was assessed twice a week only. With regard to the GNRS, patients were asked to report their classification daily, but they did not always complete it on the form. Medians of the patients' classification of their pain scores into the adjective 'unacceptable', divided in week 1, 2 and 3 postburn, are presented in Figure 4 and paralleled the decrease in time of the self-reported pain scores. Overall, when these classifications are taken together, medians for 'unacceptable pain' differed for VAT and GNRS: 2.8 and 4 for morning background pain, 4 and 6 for procedural pain, 2.9 and 4 for afternoon background pain, respectively. On average, the median GNRS 'unacceptable' scores were higher.

For the ROC analyses, the overall classifications of postburn day 1 to 21 were used. The quality (AUC) of the VAT was fair (66 to 72%, depending on the type of pain, (confidence interval 63-75%, standard error 0.02), while the quality of the GNRS was good (86 to 88%, confidence interval 85-90%, standard error 0.01), indicating that GNRS had better qualities to detect 'unacceptable pain'. Sensitivity and specifity per possible cutpoint are presented in Table 1.

Unfortunately, for both scales, none of the potential cutpoints seemed to show an optimal combination of high sensitivity with low specificity. However, where the patients' classification of 'unacceptable pain' differed per scale and per type of pain, the VAT and the GNRS seemed to share common cutpoints for background and procedural pain in the ROC analyses. Although the median patients' classifications where higher, cutpoint 2 obtained with the ROC analyses showed the best combination of highest sensitivity and lowest specificity for both scales and both types of pain.

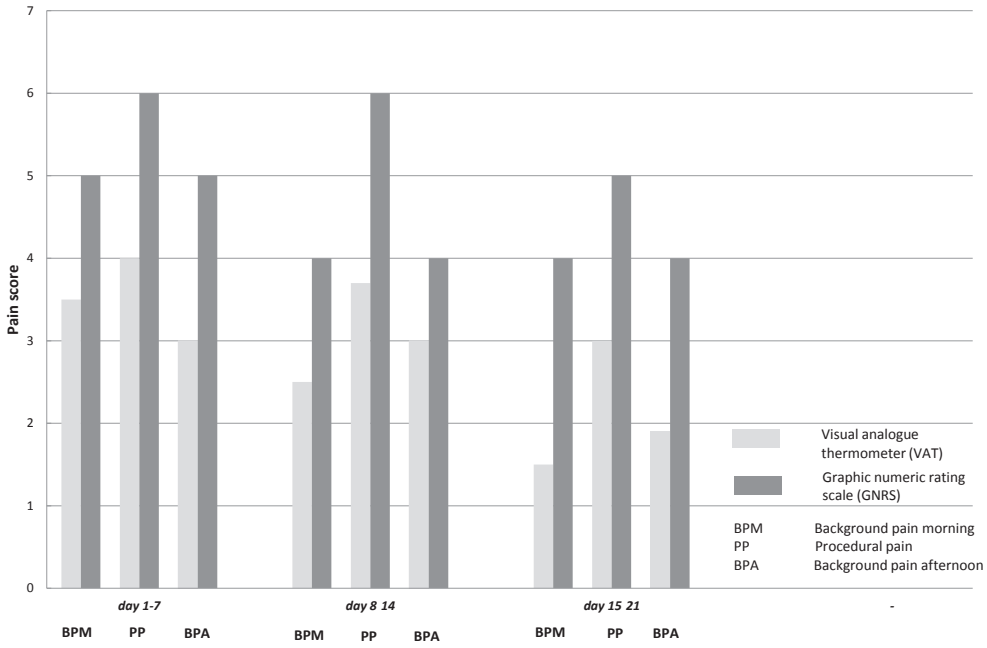
Table 1. Sensitivity and specifity per possible cutpoint

Type of pain	Visual analogue thermometer			Graphic numeric rating scale		
	Possible cutpoint	Sensitivity %	Specifity %	Possible cutpoint	Sensitivity %	Specifity %
Background morning	>2	60	70	>2 [3]	91	67
	>3 * [1 2]	43	84	>3	73	84
	>4 **	27	91	>4 ** [4 5]	47	94
	>5	16	95	>5 *	34	98
	>6	9	97	>6 [4 5]	20	99
	>7 **	5	99	>7 **	10	100
Procedural	>2	75	47	>2 [3]	95	52
	>3	59	67	>3	83	71
	>4 * [2]	43	80	>4 **	67	86
	>5	28	88	>5	55	93
	>6	19	94	>6 *	39	97
	>7 **	10	96	>7 **	22	99
Background afternoon	>2	64	70	>2 [3]	94	67
	>3 * [1 2]	39	83	>3	76	85
	>4 **	22	93	>4 ** [4 5]	47	93
	>5	12	97	>5 *	35	97
	>6	7	98	>6 [4 5]	21	99
	>7 **	2	99	>7 **	8	100

* Median classification 'unbearable pain' by patients in this sample; ** Considered as standard cutpoint in the Netherlands (4 = moderate, 7 = severe pain) [28]; [1] Cutpoint according to Choinière et al. 1994 [2]; [2] Cutpoint according to Weinberg et al. 2000 [3]; [3] Cutpoint according to Carrougher et al. 2003 [15]; [4] Cutpoint according to Mendoza et al. 2004 [29]; [5] Cutpoint according to Jensen et al. 2001 [30].

☐ Highest sensitivity with lowest specificity, indicating most appropriate cutpoint.

Figure 4. Median pain scores marked as 'unacceptable' by VAT and GNRS



4. Discussion

In this study, clinimetric properties of the VAT and GNRS and cutpoints are investigated in order to assess whether these scales can be used interchangeably. With regard to the extent of pain, it seemed that mean background pain, as reported in paragraph 3.3, did not exceed 3 when measured with both scales. In the first week of admission, mean background pain by VAT of 3 or less was reported by other researchers [3, 31]. Higher means of background pain were also reported: VAS 3.2 [4], GNRS 3.9 [15] and VAS 4.4 and GNRS 4.3 [5]. Mean procedural pain, as reported in paragraph 3.3, did not exceed 4 in our study. Higher means were reported by others: VAS 5.4 [4], GNRS 4.1 [15], VAS 4.4 [32] and GNRS 5.4 and VAS 4.9 [5], although one study [32] included patients which larger percentages TBSA.

4.1 Comparison of self-reports

We expected the correlations to be higher, since higher correlations (0.86 and 0.94) between GNRS and VAS were reported by others [33, 34]. We suggest that the procedure, the patients and/or the scales may have influenced the results. First, VAT and GNRS scores were not always registered simultaneously. Often, GNRS scores were completed when it suited best in the patients' busy daily schedule, for example in the afternoon. This, however, can explain the results only partly, because patients showed to have a long-lasting memory for pain intensity after the

burn incident [35]. Second, patients may split the GNRS as follows: 0 is 'no pain', 10 is 'unbearable pain' and therefore 5 is in the middle and corresponds to 'medium pain'. As patients may interpret 'medium pain' intensity as not being strong, this may contribute to inflation of GNRS scores [2]. Third, the GNRS, since this scale has no decimals, forces the patient to choose a whole number out of 11 possibilities, whereas the VAT allows for more possibilities. Patients may round up GNRS scores, which may result in higher pain levels. Finally, although we assume that the scales are easy to use, patients may have had difficulties in understanding how to complete a pain score. This is possibly due to a lack of receiving adequate instructions. Also, patients may have interchanged the anchor words since VAT scores of 9 points higher than GNRS scores were seen, as well as VAT scores of 9 points lower than GNRS scores.

Median GNRS scores in this study were higher than median VAT scores. This is consistent with the burns literature. Choinière et al. [2] found that mean VNRS scores were 0.7 to 0.9 points higher than VAT scores ($p = 0.001$). Also, on average, GNRS scores were found 0.5 to 1.0 point higher than VAS scores [33]. Furthermore, for procedural pain, mean VAS scores of 4.9 and mean GNRS scores of 5.4 were reported [5]. In acute pain, a tendency toward higher pain intensity ratings on the GNRS when compared with the VAS was reported [34]. These results may be explained, as mentioned above, by how the patient used the scale: the patient may split the GNRS in two parts, where 5 is considered as 'medium pain' which causes inflation of the score, and by the fact that only whole numbers can be chosen. In conclusion, the current study supports prior results that all point to a higher numeric rating scale scores when compared to visual analogue scales. When comparing studies, and when using the two scales in practice, this difference should be taken into account.

4.2 Comparison of ability to differentiate types of pain

The individual scales had the ability to differentiate background from procedural pain. Choinière et al. [2] also reported the ability of the VAT to detect change. Furthermore, GNRS and VAS were able to detect differences between treatments in acute pain [34].

4.3 Comparison of cutpoints

Overall medians for 'unacceptable pain' in this study were 3 and 4 for background pain and 4 and 6 for procedural pain on VAT and GNRS respectively, but decreased, parallel to the pain scores, in time. This indicates that in 50% of the patients using the VAT, a background pain score of 3 or more was found 'unacceptable', whereas a background pain score of 4 or more was found 'unacceptable' in 50% of the patients when using the GNRS. The higher medians for 'unacceptable pain' associated with the GNRS are in accordance with the overall higher pain scores that were obtained with this scale. However, according to the ROC analyses, the most appropriate cutpoint for both scales was lower, namely 2, because 2 had the highest probability to correctly classify 'unacceptable pain' (sensitivity), in combination with the lowest probability that patients

not suffering 'unacceptable pain' were diagnosed as suffering 'unacceptable pain' (specificity). Consequently, at this point, the probability of undertreated pain is lowest, suggesting that patients reporting a pain score higher than 2 may need pain treatment evaluation. However, the higher medians for self-reported 'unacceptable pain' do reflect a large inter-individual variation and may indicate that a personal cutpoint may vary considerably across patients.

Although the most appropriate cutpoint did not differ across the scales, the GNRS showed a larger AUC, implying that the GNRS had better properties to detect patients suffering 'unacceptable pain'. An explanation may be that patients found it easier to convert and remember pain in a rational number than in an amount of red colour when asked to give a personal cutpoint. Possibly, the VAT score may be determined more intuitively and may be more difficult to reproduce. Nevertheless, both scales did not show optimal performance on sensitivity and specificity. This may be related to the large variation of the classification of the self-report ratings. Considerable variability in pain scores was previously reported between patients and for repeated measures from the same patient [6, 34, 36]. Also, variation in cutpoints was described, varying between 3 and 6 [4, 17, 23, 37]. Although the latter studies involved other scales and different settings, it indicates the difficulty to determine cutpoints for 'unacceptable pain' due to large variability. In summary, we suggest to use cutpoint 2 for both scales when the aim is to decrease the probability of undertreating pain.

Lastly, some limitations of this study should be mentioned. First, a considerable amount of data was missing. This may be due to flaws in the data collection procedure. Although patients and nurses were instructed to complete the diary, we were unable to control if simultaneous measurements with both scales were completed. Second, we did not analyze potential causes of the VAT scores of 9 points higher and 9 points lower than GNRS scores on an individual patient level. This may be helpful in detecting explanations for the reported differences between these instruments.

5. Conclusion

In this study, we compared self-reported pain scores obtained with the VAT and the GNRS, we compared their ability to differentiate background from procedural pain and we compared cutpoints. The results suggest, in accordance with previous findings [38], that the instruments cannot be used interchangeably. Self-reports obtained with the VAT turned out to be statistically significantly lower than when obtained with GNRS. However, both scales were comparable in their ability to differentiate background from procedural pain. Furthermore, although median 'unacceptable pain' ratings differed across the scales and per type of pain, cutpoint 2 showed to have the highest sensitivity and lowest specificity irrespectively of type of pain or scale. This suggests that to decrease the probability of undertreating pain, patients reporting pain scores exceeding 2 may need adjustment of pain treatment, which is in accordance with previous findings

[15]. However, because of the large variability in 'unacceptable pain' scores on an individual level, nurses may not only ask the patient about the extent of pain, but may also ask if that specific pain score is acceptable or not, before adapting pain treatment [23].

Conflicts of interest statement

The authors have no financial or other relationships that could lead to conflicts of interest.

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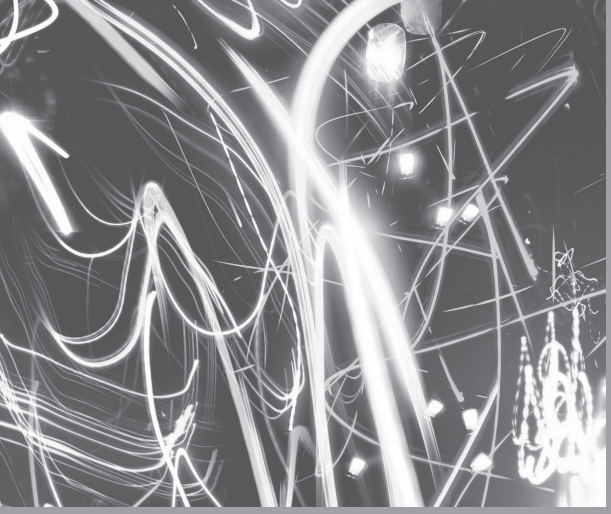

Part II

Pain interventions

‘Simplicity is the ultimate sophistication.’

Leonardo da Vinci (1452-1519) [38]

Chapter 7

Use of a simple relaxation technique in burn care: literature review

AEE de Jong
C Gamel

Journal of Advanced Nursing 2006; 54(6): 710-21.

Abstract

This paper presents a literature review examining the implications of previous research in order to make evidence-based decisions about the possible use of breathing exercises with adult patients with burns for pain management during wound care. Adult patients with burns experience pain during wound care despite pharmacological interventions. Additional interventions are needed to improve the effectiveness of pain management. Relaxation techniques can be considered, for example breathing exercises, music and distraction. A simple breathing relaxation technique is especially relevant because it involves no risk, is easy and quick to learn, equipment does not need to be purchased and it can be employed immediately by the often exhausted and ill patient. However, the effect of breathing exercises on procedural pain during burn wound care has not been investigated. The CINAHL, PubMed and Cochrane databases were first searched in 2004 in order to answer two questions: are breathing exercises effective in the management of procedural pain in adult burn patients, and what are the implications of previous investigations for future research concerning pain reduction in adult patients with burns during wound care? Eleven papers were included in the review. The effect of breathing exercises for pain management in patients with burns has not been investigated. Prior to undertaking an effect study, additional basic research is needed. The number of sessions necessary to learn to use the technique should be clarified. A valid and reliable instrument to assess relaxation must be developed. The adequacy of the proposed data collection procedure needs to be assessed. It is not possible at this time to base decisions about the use of breathing exercises during wound care in adult patients with burns on research specific to the procedure and patient group. The most suitable relaxation technique for future investigation is concentration on breathing, in combination with jaw relaxation.

1. Introduction

Pain caused by severe burns is considered the worst form of pain [1]. Patients describe their pain as a 'living hell' [2] or as the most excruciating pain they have ever experienced [3]. The main cause of these pain experiences is daily wound care of superficial to deep dermal burns that most often involve 10% or more of the total body surface area. In general, wound care has a minimum duration of an hour and is continued for 2-12 weeks.

McCaffery and Beebe [4] identified two categories of pain, namely chronic and acute pain. Acute pain has a predictable and limited duration and a tendency to diminish [5]. This description is applicable to burn pain. However, acute pain in patients with burns is further divided into background and procedural pain. Pain associated with burns is caused by stimulation of nociceptors in the dermis and epidermis. Intact or partial intact nerve ends generate pain impulses. Immediately after the burn, an inflammatory response is initiated which sensitizes the nociceptors in and around the burn. This causes background pain, which is experienced continuously. Every manipulation involving the burn leads to additional stimulation of the nociceptors, which explains the development of procedural pain [3]. Despite pharmacological pain interventions, 75% of adult patients with burns experience considerable to unbearable procedural pain [1].

Adequate pain management plays an important role in building a trusting therapeutic relationship between the burn patient and the multidisciplinary team. In addition, it can aid in the prevention of elevated metabolism, thereby reducing the chance of malnutrition and deterioration of the immune system. Furthermore, adequate pain management is a key factor in the prevention of posttraumatic stress syndrome [6].

Burn care nurses are confronted daily with the phenomenon of pain. They find themselves in a paradoxical position because they are often the cause of pain during wound care procedures as they remove bandages, clean and debride the wound area, yet at the same time they are also the providers of pain relief [7]. The current state of pain management is not satisfactory to nurses working in burn care, and research into pain management has a high priority [8].

Nurses contribute to pain management by using pharmacological and non-pharmacological interventions. Pharmacological pain management is not the focus of this article because it falls primarily within the realm of medical decision-making. Rather, we examine the use of non-pharmacological interventions because, as Patterson [1] reported, patients experience pain in spite of the use of medication. When non-pharmacological methods are used in combination with pharmacological interventions, a positive effect on pain relief can be seen [9]. In addition, nurses can independently implement many non-pharmacological interventions.

There are various non-pharmacological interventions. Important considerations when selecting a non-pharmacological intervention for patients with burns are: simplicity, easy to learn, immediate usability and minimal expenditure of time and effort during use. Patients with burns are often too tired and ill to take the time and exert the discipline to learn complex techniques [1]. Simple relaxation techniques meet these criteria, for example breathing exercises, music therapy and distraction. Specifically, breathing exercises are important to consider because they meet these criteria, and also because no additional equipment costs are incurred with their use.

The self-regulation theory provides a plausible explanation for the effect of relaxation on procedural pain during wound care. Leventhal and Johnson [10] propose that reactions to threatening situations can be influenced through cognitive structuring. Patients should be able to consciously influence the experience associated with threatening situations. Providing three types of information is central to the self-regulation theory. Information is provided about the procedure itself, the sensations the patient can expect to feel and about how to cope with the procedure. When providing information about coping, the patient is taught new coping behaviours in order to deal with painful medical procedures. Coping advice empowers the patient to take control of a difficult aspect of the procedure and subsequently the procedure runs more smoothly. An example of coping advice is giving instruction in a relaxation technique. The patient learns to use the technique independently. Relaxation techniques can have a positive effect on anxiety for a procedure. If the patient is less anxious and therefore more relaxed, then less pain is experienced.

Nurses working on burn units regularly encourage patients to use breathing exercises during wound care. However, there is no standard approach. The choice of a breathing technique, the moment to teach it and how to coach the patient depend on the experience and background of the nurse. Furthermore, the effect of breathing exercises on procedural pain in wound care is not known. Clarification of these issues is a necessary prerequisite in order to make evidence-based decisions about the possible use of breathing exercises during wound care with adult patients with burns.

The aim of this literature review was to address two questions: are breathing exercises effective in the management of procedural pain in adult patients with burns, and what are the implications of previous investigations for future research concerning pain reduction in these patients during wound care?

2. Search method

The CINAHL, PubMed and Cochrane databases were searched in 2004. Combinations of the keywords 'burns', 'pain', 'wound care', 'breathing exercises' and 'breathing techniques' were used. A total of 43 articles were located, but none described the use or effect of breathing exercises

with adult patients with burns. In order to assess what research is needed and which factors are of importance when designing future studies with these patients, the search was broadened by substituting the keywords 'relaxation' and 'relaxation techniques' for 'breathing exercises' and 'breathing techniques'. The first author reviewed all abstracts that resulted from the expanded search. Articles were selected if (quasi-) experimental designs were used and when pain was an outcome measure. Publications were rejected if one or more of the following characteristics were applicable: an abstract was not available, the focus was on complex relaxation techniques, opinion article, case study (but burn case studies were included), non-clinical setting and the article was not written in English or Dutch. Only three of the 77 reviewed abstracts met the selection criteria.

Once again the search strategy was expanded by including studies concerning breathing exercises with other patient populations suffering from acute pain. The keywords 'burns', 'pain' and 'wound care' were replaced by 'postoperative pain' (a type of acute pain that also applies to burn patients) and combined with 'relaxation' or 'relaxation techniques'. One selection criterion was added, namely that the relaxation technique included concentration on breathing. Nine of the 144 abstracts were selected for complete review, but one article was deemed inappropriate because of the minimal focus on breathing [11].

An overview of the 11 reviewed studies is presented in Table 1. Three investigations with patients with burns are included even though none is consistent with the central question concerning the effect of breathing exercises on pain during burn wound care. One study examines relaxation techniques with children [12], another tests a distraction technique with adults [13] and a third tests music relaxation with adults [14]. Despite these differences with the review question, the findings of these studies are examined because they are the only investigations of simple relaxation techniques conducted with burn patients. Furthermore, examination of the research designs used in these three studies with the target group of patients with burns is imperative when planning future research with this target group.

Table 1. Overview of included studies

Authors	Type of acute pain	Sample	Design	Intervention	Instruction and guidance	Outcomes	Measurement instruments	Data collection points	Statistically significant findings
Flaherty and Fitzpatrick (1978) [15]	Procedural, postoperative	N = 42 Adults after elective surgery	Pre- and post-test, quasi-experimental (not randomized)	Rhythmic breathing with jaw relaxation derived from Jacobson (1938) [24] or standard care	Verbal instruction one day before operation, unknown duration	Pain Distress	Visual analogue scale	One day before operation and 8 hours postoperative, directly after first mobilization	Reduction of pain, distress, respiratory rate, use of analgesics in intervention group when compared to control group receiving standard care
						Respiratory rate, blood pressure, heart rate, use of analgesics	Patient record		
Knudson-Cooper (1981) [12]	Background	N = 27 Children with burns	Pre- and post-test, quasi-experimental (not randomized)	Progressive muscle relaxation or biofeedback or standard care	Verbal instruction on first postoperative day, unknown duration, followed by 20-30 minutes guidance while practising the next 5 days	Pain Anxiety	Observation and self-report scales developed by researcher	Directly before and after training, 5 consecutive days	Reduction of pain and anxiety in intervention groups when compared to control group receiving standard care
Wells (1982) [20]	Postoperative	N = 12 Adults after elective surgery	Pre- and post-test, experimental	Progressive muscle relaxation including concentration on breathing or standard care	Verbal instruction during 45 minutes on evening before operation	Pain Distress	Visual analogue scale	Evening before operation and the following 3 postoperative evenings	None
						Abdominal muscle tension	Electro-myography		
						Use of analgesics	Patient record		

Table 1. Overview of included studies (Continued)

Authors	Type of acute pain	Sample	Design	Intervention	Instruction and guidance	Outcomes	Measurement instruments	Data collection points	Statistically significant findings
Levin et al. (1987) [21]	Postoperative	N = 40 Adults after elective surgery	Pre- and post-test, experimental	Rhythmic breathing or progressive muscle relaxation according to Benson (1975) [37] or information about history of hospital or standard care	Instructions on audiocassette 1 day before operation with practice under guidance, unknown duration, and advice to use independently whenever the patient feels generally unwell	Pain Distress	Visual analogue scale	Evening before operation, twice a day during first and second postoperative day	None
						Use of analgesics	Patient record		
Miller and Perry (1990) [16]	Postoperative	N = 29 Adults after coronary bypass surgery	Pre- and post-test, quasi-experimental (not randomized)	Rhythmic breathing or standard care	Verbal instruction on evening before operation, practice under guidance on first and second postoperative day, unknown duration	Pain	Visual analogue scale, visual descriptor scale	Second postoperative day before approaching patient, immediately following intervention	Reduction of pain on visual descriptor scale, respiratory rate, systolic blood pressure, heart rate in intervention group when compared to control group receiving standard care
						Respiratory rate, blood pressure, heart rate, use of analgesics	Patient record		
Miller et al. (1992) [13]	Procedural, wound care	N = 17 Adults with burns	Pre- and post-test, experimental	Distraction-relaxation film or standard care	Information about instruction and guidance was not provided	Pain	McGill pain questionnaire	Directly before and after wound care, twice a day, 5 consecutive days	Reduction of pain and anxiety in intervention group when compared to control group receiving standard care
						Anxiety	State trait anxiety inventory		

Table 1. Overview of included studies (Continued)

Authors	Type of acute pain	Sample	Design	Intervention	Instruction and guidance	Outcomes	Measurement instruments	Data collection points	Statistically significant findings
Good (1995) [22]	Postoperative	N = 84 Adults after elective surgery	Pre- and post-test, experimental	Rhythmic breathing and jaw relaxation [15] or rhythmic breathing and jaw relaxation with music or music or standard care	Instruction on audiocassette (20 minutes), followed by practice under guidance on the day before operation and first post-operative day, guidance 2 minutes before first mobilization	Pain Distress	Visual analogue scale, McGill pain questionnaire	First postoperative day directly after intervention and mobilization	None
						Anxiety	State trait anxiety inventory		
						Use of analgesics	Patient record		
Good et al. (1999) [17]	Procedural and at rest, postoperative	N = 500 Adults after abdominal surgery	Pre- and post-test, experimental	Rhythmic breathing and jaw relaxation [15] or rhythmic breathing and jaw relaxation with music or music or standard care	Instruction on audiocassette twice, preoperative practice under guidance twice, with evaluation of mastering technique, patients listen to cassette (15 minutes) during data collection	Pain Distress	Visual analogue scale	First and second postoperative day, before and after 15 rest minutes and at four points during second mobilization	Reduction of pain and distress in intervention groups at all data collection points except after mobilization, when compared to control group receiving standard care
						Use of analgesics	Patient record		
Good et al. (2001) [18]	Procedural and at rest, postoperative	N = 468 Adults after abdominal surgery	Pre- and post-test, experimental	Rhythmic breathing and jaw relaxation [15] or music or rhythmic breathing and jaw relaxation and music or standard care	Instruction on audiocassette, preoperative practice (2 minutes) under guidance, with evaluation of mastering technique, patients listen to cassette during data collection	Pain Distress	Visual analogue scale	First and second postoperative day, before and after 15 rest minutes and at four points during second mobilization	Reduction of pain and distress in intervention groups during second mobilization and after recovery when compared to control group receiving standard care
						Use of analgesics	Patient record		

Table 1. Overview of included studies (Continued)

Authors	Type of acute pain	Sample	Design	Intervention	Instruction and guidance	Outcomes	Measurement instruments	Data collection points	Statistically significant findings
Good et al. (2002) [19]	Procedural and at rest, postoperative	N = 311 Adults after gynaecological surgery	Pre- and post-test, experimental	Rhythmic breathing and jaw relaxation [15] or music or rhythmic breathing and jaw relaxation and music or standard care	Instruction on audiocassette, preoperative practice with evaluation of mastering technique, patients listen to cassette during data collection	Pain Distress	Visual analogue scale	First and second postoperative day, before and after 15 rest minutes and at four points during mobilization	Reduction of pain and distress in intervention groups when compared to control group receiving standard care
						Use of analgesics	Patient record		
Ferguson and Voll (2004) [14]	Procedural, rehabilitation	N = 11 Adults with burns	Pre- and post-test, experimental	Music relaxation or standard care	Information about instruction and guidance was not provided	Pain	Visual analogue scale	Before and after procedure, once	None
						Anxiety	State trait anxiety inventory		
						Respiratory rate, blood pressure, heart rate	Vital signs monitor		

3. Findings and discussion

3.1 Effect

As described in the search strategy, breathing exercises were not studied in burn patients. A statistically significant decrease in pain was seen with the use of progressive muscle relaxation [12], relaxation-distraction [13] and music [14]. Relaxation-distraction and music relaxation were employed for management of procedural pain during burn wound care in the acute and rehabilitation phases. However, these encouraging findings should be viewed with reservation because the sample sizes were relatively small and measurement instruments were not validated for the use in patients with burns. Furthermore, Knudson-Cooper [12] did not focus on adults with procedural pain. In their study, it is unclear if the children could actually perform the technique. The required equipment and positioning associated with relaxation-distraction [13] and music relaxation [14] are possible disadvantages of these relaxation techniques.

A statistically significant reduction of pain intensity also was seen in the studies by Flaherty and Fitzpatrick [15], Miller and Perry [16] and Good et al. [17-19]. Although breathing techniques were used with adults and measurement instruments were validated, the sample size was small in the first two studies, and Miller and Perry [16] examined another type of pain, namely pain at rest. In the studies by Wells [20], Levin et al. [21], Good [22] and Ferguson and Voll [14], no statistically significant results were found. The authors attributed this to small sample size, timing of the intervention (to early), the use of audiotapes or limited musical selection.

Encouraging results are seen in the limited number of studies of the effect of simple relaxation techniques on the management of procedural and acute pain. However, few studies were conducted with patients with burns, and breathing exercises were not always used. Clearly, further research is needed into pain reduction in adult patients with burns during wound care. In the following section, 11 studies are critiqued to identify implications for the research design of future investigations with these patients. Four aspects of the research design are analysed, namely the protocol for providing the relaxation technique (including type of relaxation technique and instruction and guidance in the use of the technique), outcomes, measurement instruments and data collection points.

3.2 Type of relaxation technique

The only simple relaxation technique used with patients with burns was progressive muscle relaxation, and it was used with children rather than adults [12]. Relaxation-distraction [13] and music relaxation [14] are not considered simple relaxation techniques because of the required equipment and positioning. Progressive muscle relaxation also has limitations. Although the children in the study of Knudson-Cooper [12] listened to the relaxation tape during a period of rest and reported less pain when compared with the control group, it was not stated

whether they could actually perform the progressive muscle relaxation. Patterson [1] points out that progressive muscle relaxation generally requires lengthy and frequent training before the technique is sufficiently mastered. Patients with burns are often too exhausted and ill to invest the time or muster the discipline required to learn these techniques. Taal [23] expresses further objections to this technique because the muscles must be tensed before they can be relaxed. Muscle tension in burned parts of the body can further increase pain during wound care. In other words, even a simple technique such as progressive muscle relaxation can be inappropriate for patients with burns. More benefit for these patients with burns is expected from the use of breathing techniques in order to gain control over their pain [1, 23].

In the studies with populations other than patients with burns, rhythmic breathing was used most often, frequently in combination with jaw relaxation. Progressive muscle relaxation [20] and relaxation-distraction [13] were also used. Information about the nature, origin and choice of one method over another was not always given.

Levin et al. [21] and Miller and Perry [16] opted for a breathing technique alone. Flaherty and Fitzpatrick [15], Good [22] and Good et al. [17-19] combined a breathing technique with jaw relaxation. They used the same composition, namely a method derived from the Jacobson technique [24], consisting of jaw relaxation and concentrating on breathing. In a review of nursing research on relaxation, Snyder [25] concludes that using a combination of techniques will have a better effect than using one single technique.

3.3 Instruction and guidance

Important factors to consider in the use of relaxation techniques are the number, duration and initiation of sessions during which instruction and guidance in the use of the technique are provided. Uncertainty exists about the total number of sessions and duration of each session in order to learn to use the technique independently. In most of the reviewed studies, one instruction session (verbal or on audiocassette) was provided. However, two sessions were used by Good et al. [17-19]. Only three studies described the duration, either 45 minutes [20], 20 minutes [22] or 60 minutes [19]. In five studies, guidance in practising the technique was given in one, two, three or five sessions. Only Knudson-Cooper [12] and Good et al. [18] reported the duration of a guidance session, respectively 20-30 and 2 minutes. Little information was given regarding the so-called 'nurse dose' [26], which specifies the nurse's role (by which nurse, how often and how long per day) associated with relaxation techniques. Snyder [25] states that at least four sessions, including guidance during use of the technique, are required before relaxation can be mastered.

The moment to initiate instruction in the technique is also a matter for discussion. Instruction sessions began preoperatively, with the exception of Knudson-Cooper [12], who started teaching

the first post-operative day. Since operations in patients with burns can be scheduled throughout the entire hospital stay, preoperative initiation is not the most appropriate moment. Furthermore, most patients with burns experience procedural pain in association with wound care and this begins on the first postburn day. The best moment to prepare patients for threatening and painful procedures is as far in advance as possible [27], which for patients with burns is as soon as possible after admission. Based on these findings, a proposal for instruction and guidance would consist of four sessions, each lasting no longer than 20-30 minutes and starting as soon as possible after admission.

3.4 Outcomes and measurement

Three components of pain (sensation, physiological reaction and psychological reaction) were investigated in the reviewed studies. Pain sensation was assessed by measuring the intensity of wound pain and use of analgesics. The physiological reaction was determined by measuring systolic and diastolic blood pressure, respiratory rate, heart rate and muscle tension. The psychological reaction was evaluated by measuring anxiety and distress. Pain intensity was measured in all studies. The physiological components of pain were measured by Flaherty and Fitzpatrick [15], Wells [20], Miller and Perry [16] and Ferguson and Voll [14]. Distress, a psychological component of pain, was assessed by Flaherty and Fitzpatrick [15], Wells [20], Levin et al. [21], Good [22] and Good et al. [17-19]. In the burn studies, Knudson-Cooper [12] and Miller et al. [13] measured a different psychological component, namely anxiety.

Several instruments were used to measure pain intensity, distress and anxiety. A visual analogue scale (VAS) was used to measure pain intensity by all researchers except for Knudson-Cooper [12] and Miller et al. [13]. They used a self developed scale and the McGill pain questionnaire respectively. However, the reliability and validity of these scales with patients with burns was not reported. Miller and Perry [16] used a visual descriptor scale in addition to the VAS. In 1994, Choinière et al. introduced the visual analogue thermometer (VAT) [28], which is an adapted VAS. It consists of a rigid strip with a horizontal opening of 10-cm long by 2-cm wide. The left and right extremities of this opening are identified by the anchor words 'no pain' and 'unbearable pain'. The opening is covered with a red band that slides from left to right. On the back is a 10-cm ruler. As the strip is moved across the opening, the red band gives the patient a visual indication of pain intensity. The corresponding numerical value is then read to the nearest mm from the back of the device. Choinière et al. [28] established ease of use, sensitivity, concurrent and construct validity of the VAT in adult patients with burns for both procedural and background pain. The VAT is appropriate for use in future research because it is valid, reliable and specific for patients with burns.

Except for the burn studies, the use of analgesics was recorded in all studies as an indicator of pain intensity. However, there was no discussion of controlling the type and amount of analgesics.

Ferguson and Voll [14] examined medication use as a possible confounding variable and found no statistically significant difference between groups. From a research design perspective, the type and amount of pain medication is an important variable to measure and control in both experimental and control groups.

Researchers who measured distress used a VAS. Because the VAT is an accepted alternative tool to the VAS to measure pain in patients with burns, and the VAS is suitable for measuring both pain and distress, we suggest that the VAT can be used to measure distress in these patients.

Knudson-Cooper [12] measured anxiety using a self-developed scale, whereas Miller et al. [13] and Good [22] and Ferguson and Voll [14] used the state trait anxiety inventory (STAI). Taal and Faber [29] argue that the STAI is not the most appropriate instrument to measure anxiety during wound care in patients with burns because the list of questions is too long for use in a clinical setting. Furthermore, they maintain that there is no statistically significant correlation of the STAI with pain scores in patients with burns and the questions are not related to a specific situation, such as wound care. Because the STAI does not indicate the essential elements of anxiety for burn populations, Taal and Faber [30] developed the burn specific pain anxiety scale (BSPAS). This consists of five items that measure procedural anxiety and is easy to use, reliable and valid. Consequently, the BSPAS is a more advantageous instrument for use with patients with burns than the STAI.

Another important outcome in a study of the effect of relaxation techniques on pain is whether or not patients are able to achieve relaxation. Although Ferguson and Voll [14] measured blood pressure, heart rate and respiratory rate, they did not mention whether these parameters represent relaxation. In the other burn studies, relaxation was not assessed. The degree of relaxation was determined in six studies with postoperative patients. However, not all studies used the same measure of relaxation. Wells [20] judged a relaxed state by measuring tension of the abdominal muscles. Miller en Perry [16] measured blood pressure, heart rate and respiratory rate. Good [22] and Good et al. [17-19] used observations of tension in the face and the nature of patients' breathing patterns. McCaffery and Beebe [4] define relaxation as 'a state of relative freedom from both anxiety and skeletal muscle tension, a quieting or calming of the mind and muscles'. This situation is characterised by decreased intake of oxygen, decreased muscle tone, lower heart and respiratory rates, normal blood pressure, decreased skin resistance and intense, slow alpha-waves in the brain [4, 31, 32]. Given the aggravating and ongoing nature of burn wound care procedures, the practicability and costs of assessing oxygen intake, muscle tone, skin resistance and brain waves are questionable. Subsequently, assessment of heart and respiratory rates, blood pressure, tension of face and breathing pattern, in particular regularity and audibility, seem appropriate for patients with burns. A reliable and valid instrument for assessment of relaxation in these patients needs to be developed, and the identified parameters should be included, as well as patients' self-reports of the extent of relaxation.

No study reported whether or not patients continued to use the relaxation technique independently. This question was probably not relevant in the studies of postoperative pain because it manifests differently, with regard to duration and nature, than procedural pain in burn patients. Pain associated with burns is long-lasting and, depending on the depth of the burns, has a fluctuating course and is related to repetitive daily wound care procedures. Assessment of the ongoing use and possible merits of relaxation from a patient perspective is needed for future research.

None of the investigators examined the effects of the interventions on pain and distress from the perspective of the self-regulation theory.

3.5 Data collection

Diversity was apparent in the reviewed papers as far as the timing and the continuation of data collection are concerned. Knudson-Cooper [12] collected data directly before and after giving instruction in relaxation techniques during a period of rest, whereas Miller et al. [13] collected directly before and after the painful experience of wound care. Ferguson and Voll [14] also took measurements before and after wound care. Flaherty and Fitzpatrick [15] collected data directly after a postoperative mobilization procedure, and Wells [20] used pre- and postoperative measurements directly after instruction and guiding the intervention at rest. Levin et al. [21] took pre- and postoperative measurements at rest. Miller and Perry [16] collected their information on the second postoperative day, before and after use of the intervention, during a period of rest. Finally, Good [22] took postoperative measurements directly before and after use of the intervention after mobilization and Good et al. [17-19] did this before and after rest and at four points during mobilization.

During burn wound care, when the issue is additional pain management, it may not be relevant to take measurements at rest or before the procedure [12-14]. Furthermore, wound care procedures are long-lasting, with possible fluctuations in pain. Therefore patients should be asked to report pain, distress and anxiety directly following wound care because this report represents an accurate, overall experience of the procedure. In order to determine whether patients are able to relax during wound care, relaxation should be measured at a fixed moment during the procedure, for example after removal of bandages from one part of the body and following cleansing of this part.

Knudson-Cooper [12] continued to collect data for 5 days and Miller et al. [13] did this twice daily for 5 days. In contrast, Ferguson and Voll [14] measured only once. While Flaherty and Fitzpatrick [15] stopped measuring after the first mobilization, Wells [20] continued her measurements until the third postoperative day. Levin et al. [21] followed patients for 2 days. Both Miller and Perry [16] and Good [22] used only one data collection point and Good et al. [17-19] measured on the

first and second postoperative days. Repeated measurements were carried out in seven of the studies, and pre- and post-test measurements in all studies. Both methods strengthen a design [33].

The least serious burn needs approximately 2 weeks to heal spontaneously. As mentioned earlier, the best moment to learn a technique is as far in advance as possible [27]. Instruction in the use of a relaxation technique and the associated data collection should start as soon as possible after admission and continue for 2 weeks.

3.6 Summary

This review of the literature shows that it is not possible at this time to base decisions about the use of breathing exercises during wound care in adult patients with burns on research specific to the procedure and patient group. The best available evidence comes from studies evaluating breathing exercises for the management of postoperative or procedural pain and from the three studies of relaxation techniques other than breathing exercises for pain management in patients with burns. Although reduction in postoperative pain is seen when the sample size is large [17-19], additional research is needed because of the differences in acute postoperative pain and procedural pain during wound care. Analysis of the reviewed studies revealed that the most suitable relaxation technique for future investigation is concentrating on breathing, in combination with jaw relaxation.

A limitation of this review is that not all databases were searched. However, confidence in the adequacy of the review is enhanced because the search strategy yielded relevant articles that were also included in three previous systematic reviews [34-36]. Furthermore, the conclusion of these reviews was that methodological inadequacies limit the strength of available evidence. These previous authors recommend additional research in order to advance knowledge about the effects of relaxation in acute pain. This is consistent with our conclusion. A second limitation is the fact that only one researcher reviewed the abstracts and selected the articles.

4. Conclusion

4.1 Recommendations for practice

Management of procedural pain during wound care in patients with burns is a complex and challenging issue. Based on the reviewed literature, slow rhythmic breathing in combination with jaw relaxation is a low risk intervention which shows promise in improving pain management. Burn nurses are already teaching their patients to use breathing exercises. No evidence was found that indicated the need to stop using the intervention until further research provides a stronger evidence base for its effects. However, the procedure for giving instruction and guidance to patients is inconsistent in both practice and research. An inconsistent approach may be confusing

to patients. We have formulated recommendations based on findings with other patient groups and on knowledge of patients with burns. These recommendations constitute best practice and nurses can be trained to use them in daily practice until additional research evidence is available.

Before investigating the effect of relaxation techniques used during burn wound care, descriptive and methodological research into the practical application of the intervention is needed. Clarity is needed about the number of sessions necessary to learn to use the technique. Based on the reviewed literature, the following proposal is made for the frequency, duration and timing of instruction and guidance with patients with burns.

Patients should receive one session of structured oral instruction from a trained teacher, directly followed by a guidance session in the use of the technique. Thereafter, guidance is provided for the next 3 days. All sessions should have a maximum duration of 20-30 minutes, since patients with burns have a busy daily program. Instruction should begin as soon as possible after admission. Instruction and the first guidance session are given during a period of rest, and not directly before or after wound care, because anxiety and fatigue associated with wound care can influence the take up of information. The three guidance sessions should take place during wound care, specifically the first part when bandages are removed. The feasibility of teaching breathing exercises to patients with burns as proposed needs to be tested.

4.2 Recommendations for research

An instrument to assess relaxation needs to be developed and validated for use with these patients. There are striking similarities of the characteristics of the physiological aspects of pain and those of relaxation. Muscle tension, heart rate, blood pressure and respiratory rate are indicators for relaxation as well as for the physiological components of pain. These physiological parameters should be taken into consideration in future research, either as part of the concept pain or the concept relaxation.

Once these issues are resolved, a descriptive study can be designed to answer the questions:
Can patients with burns, after receiving instruction and guidance, independently use a breathing exercise in combination with jaw relaxation during wound care?
Are patients with burns able to relax during wound care while using a breathing exercise in combination with jaw relaxation with instruction and guidance and without guidance?

Multiple components of pain should be measured, namely pain sensation (intensity), physiological components and the psychological components distress and anxiety. Relaxation should be measured as well. Assessment of pain intensity during wound care is the primary outcome for future effect research. An appropriate instrument to assess pain sensation in patients with burns is the VAT. Because the intervention is a supplement to and not a replacement of pharmacological

interventions, the use of analgesics is an important variable to control and/or measure in experimental studies. Distress, the general experience of discomfort caused by pain, is another important outcome in future research and can be measured using the VAT. Similarly, anxiety is an important outcome because pain caused by wound care can increase anxiety for the next wound care procedure, which in turn can increase pain. The BSPAS can be used to measure anxiety. If possible, a design should be used which examines the degree to which the self-regulation theory explains the effect of relaxation on pain intensity, distress and anxiety during wound care.

Data should be collected throughout the first 2 weeks of admission and at three points: directly after wound care without intervention (pretest), directly after wound care while the nurse gives guidance, and directly after wound care once this guidance has stopped. Pretest measurements should be taken during the first 3 days after enrolment in the study. On the third day, the relaxation technique should be taught during a period of rest. On the following 3 days, measurements should be taken when patients receive guidance in the application of the technique during wound care. Finally, spread over the second week, three measurements should be taken while the patient uses the technique independently.

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‘The future of burn nursing lies in continued education and clinically related research.’
Janet Marvin (1983) [73].

Chapter 8

Non-pharmacological nursing interventions for procedural pain relief in adults with burns: a systematic literature review

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Abstract

Adult burn patients experience pain during wound care despite pharmacological interventions. Additional nursing interventions are needed to improve pain management. A systematic review was undertaken in order to examine the implications of previous research for evidence based decisions concerning the use of non-pharmacological nursing interventions and for future research. Twenty-six studies met the inclusion criteria and were discussed. The majority of the included studies concerned behavioural nursing interventions and focussed on promotion of psychological comfort. Although 17 studies showed that the intervention had a positive effect on pain outcomes and no adverse effects of the reviewed interventions were reported, the best available evidence was found for active hypnosis, rapid induction analgesia and distraction relaxation. However, in order to reduce methodological limitations, further research is needed before well-founded evidence based decisions for nursing practice can be made. Aspects that seem important for future research, like the type of the intervention, theoretical framework, manner of giving instruction and guidance, cost, outcomes, measurement instruments and data collection points are considered.

1. Introduction

Of all professionals involved in the care for patients with burns, nurses are mostly confronted with the phenomenon of pain. They find themselves in a paradoxical position because they often inflict pain during wound care procedures, yet at the same time they are also the providers of pain relief [1]. Daily recurrence of wound care procedures, including removal of dressings, washing, debridement and application of new dressings, is still the main cause of pain experiences in patients with burns. Adequate management of procedural pain plays an important role in building a trusting therapeutic relationship between the patient with burns and the multidisciplinary team, especially with respect to nurses. Besides, it may make recovery more tolerable and may affect morbidity by means of prevention of elevated metabolism, thereby reducing the chance of malnutrition and deterioration of the immune system [2]. Furthermore, it was suggested that adequate pain management could contribute to the prevention of posttraumatic stress disorder [3] and can give a growing sense of patients' self-confidence and strength [4]. Although freedom from pain might be unrealistic, the objective should be to reduce pain as much as possible [5].

As the ideal wound dressing, that would reduce considerably the number of daily wound care procedures, has not been developed yet, to date, alleviation of pain is aimed by administration of analgesics and anxiolytics. However, despite many efforts with various pharmacological approaches, daily practice demonstrates that adult burn patients still experience considerable pain. Adjunct interventions are thus indicated. It was shown that non-pharmacological interventions used in combination with pharmacological interventions, may result in pain relief [6]. This effect can be partly ascribed to reduction of the affective components of pain [7, 8], as for example anxiety, which subsequently can have analgesic effects on the patients' pain intensity [9]. Nurses contribute to pain management by using pharmacological and non-pharmacological interventions. Whereas pharmacological pain management falls primarily within the realm of the physician, many non-pharmacological interventions can be implemented independently by nurses. Besides the benefits for the patients described before, it may not be inconceivable that it has positive effects on the nurses as they can actively contribute to pain relief whereas they are also the inflictors of pain. Non-pharmacological pain interventions should therefore be taken into consideration for nursing practice.

The management of procedural pain is a complex and challenging issue for nurses in practice and should be a priority for nurse researchers. They should help the patient through the wound care procedure by providing prevention and relieve of pain and building trust that the patient will need in order to be able to face future procedures [4]. Yet, the effects of non-pharmacological interventions on procedural pain are not clear. Clarification of this issue is a prerequisite in order to make evidence based decisions concerning the possible use of non-pharmacological interventions during wound care with adult burn patients. The aim of this study was to gain insight into what is known about the effects of non-pharmacological pain interventions that can be used

independently by nurses. This insight may help the professional to make evidence based decisions for daily practice in adult patients with burns during wound care procedures. In addition, an effort is made to examine the implications of previous research for future empirical research.

2. Search method

The databases CINAHL, Pubmed, Embase, Cochrane database of systematic reviews, Cochrane central controlled trials register, DARE, PsychInfo, Sumsearch, ISI Web of Knowledge, Invert, ERIC and UMI ProQuest digital dissertations were searched in January 2006. The used keywords and combinations of these keywords are presented in Table 1. Additional reports were manually identified from the reference lists of retrieved studies. Unpublished studies were not sought. The first and last author reviewed abstracts and consequently selected publications for inclusion. Abstracts describing studies investigating adjunct interventions to pain medication and using experimental, quasi-experimental or non-experimental designs with pain as an outcome were selected. Interventions ought to be described in the Nursing Interventions Classification (NIC) [10]. Also included were interventions that were differently labelled compared to NIC terms but that were similar with respect to content or were combinations of NIC interventions. Publications were not selected if one or more of the following characteristics were applicable: opinion articles, single or multiple case studies, non clinical settings and publications in other than English or Dutch language.

Table 1. Keywords used in literature search

Burns and pain and adults	And	Wound care or burn wound care or dressing change or bandage change or therapeutic procedure or wound treatment or painful procedure or bandages and dressings or dressing or therapeutics or debridement or wound cleansing	And	Nursing or nurses	And	Non-opioid approaches or non-pharmacological interventions or adjunct interventions or non-pharmacological approaches or nursing interventions or nursing approaches or adjunct approaches or alternative therapies or complementary interventions

3. Results

Overall, 202 potential studies were identified. Twenty-six reviewed abstracts met the inclusion criteria and were selected for complete review. An overview of these studies is presented in Table 2. It reveals that 21 different interventions or compositions of interventions have been tested. According to the NIC, which proposes seven domains, all interventions can be placed under two domains, namely behavioural (17 studies) and physical interventions (4 studies). The majority of behavioural interventions concerned the NIC class 'promotion of psychological comfort'.

Table 2. Studies on non-pharmacological interventions for procedural pain

Authors	Intervention			Subjects			Statistical significant findings
	Type	Theory or conceptual framework	Instruction and guidance	N	Mean age	Mean TBSA (%)	
Wakeman and Kaplan (1987) [11]	Hypnosis tailored to patient or attention	Not reported	Instruction and guidance by therapist on regularly scheduled time and during procedure till self-hypnosis is mastered	42	Range 7-70	Range 0-60	Reduction of use of medication in experimental group when compared to comparison group
Wernick et al. (1981) [20]	Stress inoculation (distraction, breathing, relaxation) or standard care	Cyclic model of stress responding [67]	30 min instruction and guidance by trained nurse, 5 consecutive days, day 5 is during wound care	16	Adults	≥ 15	Increase of pain tolerance, reduction of use of medication and anxiety in experimental group after use of intervention when compared to before use of intervention
Powers et al. (1985) [42]	Interrupted debridement (15 s respite after each minute of debridement) or standard care	Increasing sense of cognitive control is associated with decreased pain and anxiety	Not reported	12	30 (SD 14, range 18-64)	24 (SD 12, range 8-46)	None
Kimball et al. (1987) [40]	TENS and saline injection or placebo TENS with morphine injection	Gate control theory [41]	Not reported	24	41 (range 18-71)	13 (range 2-30)	None
Achterberg et al. (1988) [21]	Relaxation (breathing, muscle relaxation, ocean sounds) or relaxation with imagery or relaxation with imagery and biofeedback or standard care	The triple code model for imagery [68]	Relaxation and imagery by audiotaped instructions. Biofeedback by 3 training and 3 treatment sessions directly before wound care, technician remains 15 min during wound care, providing instruction	149	35 (SD 15)	26 (SD 17)	Reduction of pain after training and before and after use of intervention when experimental groups were compared to control group. Reduction of use of medication after training and use of intervention in relaxation with imagery group when compared to control group. Reduction of anxiety before use of intervention in biofeedback group when compared to control group
Van der Does et al. (1988) [12]	Hypnosis (relaxation, distraction, dissociation, suggestion tailored to patient) or standard care	Not reported	1 practice session at rest followed by 5 sessions with guidance by therapist during wound care with gradually diminishing involvement	4	36	20	None

Table 2. Studies on non-pharmacological interventions for procedural pain (Continued)

Authors	Intervention			Subjects			Statistical significant findings
	Type	Theory or conceptual framework	Instruction and guidance	N	Mean age	Mean TBSA (%)	
Blew et al. (1989) [43]	Natural cognitive (e.g. focussing on environment, placing thoughts elsewhere, reinterpreting or denying pain) and behavioural (e.g. TV/ radio, sleeping, crying, talking about pain) coping	Not reported	No professional guidance	44	38	8	None
Patterson et al. (1989) [13]	Modified version of Barber's [67] RIA or standard care	Not reported	1-3 practice sessions of 45 min by therapist before wound care, nurse provides induction instructions directly before wound care	13	Median 29	Median 12	Reduction of pain after use of intervention in experimental group when compared to before use of intervention
Lewis et al. (1990) [28]	Auricular acupuncture-like TENS to six ear points or placebo pill	Release of endogenous opioids	Not reported	11	43 (range 24-70)	13 (range 3-30)	Reduction of pain in experimental group when compared to comparison group
Miller et al. (1992) [22]	Distraction-relaxation film or standard care	Refocus attention from pain to pleasant sensory stimulus	Not reported	17	34	22 (range 11-39)	Reduction of pain and anxiety in experimental group when compared to control group
Patterson et al. (1992) [14]	Active hypnosis (modified version of Barber's RIA [66]), placebo hypnosis (attention/ information about pain and relaxation) or standard care	Not reported	RIA: 1 session of 25 min by psychologist before wound care, nurse recalls posthypnotic suggestion during wound care. Attention/ information: 25 min with 30 s practice in relaxation	30	34 (SD 9)	16 (SD 16)	Reduction of pain after use of intervention in experimental group when compared to before use of intervention

Table 2. Studies on non-pharmacological interventions for procedural pain (Continued)

Authors	Intervention			Subjects			Statistical significant findings
	Type	Theory or conceptual framework	Instruction and guidance	N	Mean age	Mean TBSA (%)	
Everett et al. (1993) [15]	Hypnosis (Barber's RIA [66]) and placebo anxiolytic or placebo hypnosis (information about pain and relaxation) and anxiolytic or hypnosis and anxiolytic or placebo hypnosis and placebo anxiolytic	Not reported	Hypnosis: 1 instruction session of 25 min by psychologist before wound care. Placebo hypnosis: instruction and 30 s guidance in relaxation. Guidance by instructed nurse during wound care	32	37 (SD 12)	14 (SD 10)	Reduction of anxiety in all groups after use of intervention when compared to before use of intervention
Sutherland (1996) [29]	Patient-performed washing or standard care	Not reported	Instruction by nurse during wound care	10	38 (SD 12, range 24-65)	19 (SD 10, range 5-38)	Reduction of pain in experimental group when compared to control group
Patterson and Ptacek (1997) [16]	Modified version of Barber's RIA [66] or placebo hypnosis (information/ distraction)	Not reported	RIA: 1 session of 25 min before wound care by psychologist, nurse recalls posthypnotic suggestion during wound care. Attention/ information: 25 min with 30 s practice in relaxation	61	37 (SD 12)	14 (SD 11)	Reduction of pain in patients in experimental group with baseline pain >5 on VAS when compared to comparison group
Field et al. (1998) [30]	Massage therapy (stroking of legs, arms, face, chest, back) or 20 min sitting and relaxing	Gate control theory [41]	1 session of 20 min per day before wound care during 1week by massage therapist	28	Adults	10	Reduction of pain in experimental group on last study day when compared to first study day. Reduction of state anxiety in experimental group after use of intervention when compared to before use of intervention
Turner et al. (1998) [31]	Therapeutic touch (Krieger-Kunz method) or placebo therapeutic touch	Roger's theory of unitary human beings [69, 70]	TT: 5 sessions of 5-20 min on separate days at rest by TT therapist. Placebo TT: 5 sessions by research assistant	99	38 (range 15-68)	17 (range 1-75)	Reduction of pain on McGill pain questionnaire and anxiety when experimental group was compared to comparison group
Hoffman et al. (2000) [32]	Virtual reality or standard care	Conscious attention on virtual reality and not on painful stimuli	Not reported	12	30 (range 19-47)	21	Reduction of pain when experimental group was compared to control group

Table 2. Studies on non-pharmacological interventions for procedural pain (Continued)

Authors	Intervention			Subjects			Statistical significant findings
	Type	Theory or conceptual framework	Instruction and guidance	N	Mean age	Mean TBSA (%)	
Wright and Drummond (2000) [17]	RIA (suggestions for comfort, relaxation and analgesia using imagery and reappraisal) or standard care	Not reported	15 min instruction by therapist before wound care, guidance after showering and removal bandages till end of wound care	30	35 (range 16-48)	13 (range 1-45)	Reduction of pain and distress during and after use of intervention when experimental group was compared to control group. Reduction of anxiety in experimental group during second use of intervention when compared to first. Reduction of use of medication when experimental group was compared to control group
Byers et al. (2001) [23]	Music or gentle touch or humour or guided imagery or deep breathing or wound teaching or massage or family presence or family assistance or patient assistance	Not reported	Not reported	23	33 (SD 13, range 18-75)	Not reported	Reduction of pain when family is present
Fratianne et al. (2001) [24]	Music therapy (music based imagery, music alternate engagement) or standard care	Not reported	Music therapist carries out music based imagery 15-30 min before and after procedure and music alternate engagement during wound care	25	43 (range 7-83)	10 (range 1-43)	Reduction of pain in experimental group when compared to control group
Frenay et al. (2001) [18]	Hypnosis tailored to patient or stress reducing strategies (deep breathing, relaxation, focussing on pleasant memory)	Not reported	Study day 8 and 10 during wound care by psychologist	26	Range 18-65	Range 10-25	Reduction of anxiety before and during wound care in experimental group when compared to comparison group

Table 2. Studies on non-pharmacological interventions for procedural pain (Continued)

Authors	Intervention			Subjects			Statistical significant findings
	Type	Theory or conceptual framework	Instruction and guidance	N	Mean age	Mean TBSA (%)	
Haythornthwaite et al. (2001) [25]	Sensory focussing (attention toward sensation, reconceptualising sensory information) or music distraction or standard care	1. Identification and evaluation of sensory reactions may reduce pain [71]. 2. Sensory focussing alters meaning assigned to somatic experiences [72]	20 min audiotaped instruction and guidance directly before procedure	42	44 (SD 13)	16 (range 3-65)	Reduction of pain in experimental group when compared to comparison group
Hoffman et al. (2001) [33]	Virtual reality or standard care	Sensory input reduces attention to nociceptive input. Reduction of visual cues associated with painful procedure	Not reported	7	22 (range 9-23)	24 (range 3-60)	Reduction of pain and distress in experimental group when compared to control group
Prensner et al. (2001) [26]	Music therapy (song phrase cued response, adapted progressive muscle relaxation to music, music based imagery or relaxation)	Gate control theory [41]	Trained music therapist leads patient through procedure	63	Not reported	Not reported	Not reported
Ferguson and Voll (2004) [27]	Music relaxation or standard care	Gate control theory [41]	Not reported	11	42	20 (range 18-75)	None
Harandi et al. (2004) [19]	RIA or standard care	Diversion of pain sensation by inhibiting thalamic-somatosensory cortical pathways	1 guidance and instruction session at rest and 3 sessions directly before physiotherapy	44	32 (SD 14, range 16-75)	29 (SD 10)	Reduction of pain and anxiety in experimental group when compared to control group

Table 2. Studies on non-pharmacological interventions for procedural pain (Continued)

Authors	Method				Subjects			Statistical significant findings
	Design	Pain outcome	Measure	Data collection points	N	Mean age	Mean TBSA (%)	
Wakeman and Kaplan (1987) [11]	Quasi-experimental (no control but comparison group)	Use of medication	Patient chart	Not reported	42	Range 7-70	Range 0-60	Reduction of use of medication in experimental group when compared to comparison group
Wernick et al. (1981) [20]	Experimental	Pain tolerance	VAS	5 days before, 5 days during, 5 days after intervention and follow up (3-28 days)	16	Adults	≥ 15	Increase of pain tolerance, reduction of use of medication and anxiety in experimental group after use of intervention when compared to before use of intervention
		Use of medication	Not reported					
		Anxiety	STAI					
Powers et al. (1985) [42]	Quasi- experimental (not randomized)	Pain intensity	VAS	Directly after wound care	12	30 (SD 14, range 18-64)	24 (SD 12, range 8-46)	None
		Anticipatory anxiety						
		Procedural anxiety						
		Distress						
		Heart rate	Monitor	During wound care, each 5 min				
		Blood pressure						
Kimball et al. (1987) [40]	Quasi-experimental (no control but comparison group)	Pain intensity	VAS, verbal categorial scale	Each 15 min in first hour after application enzymatic crème, each hour through 4 h, repeated for 1-5 days	24	41 (range 18-71)	13 (range 2-30)	None
Achterberg et al. (1988) [21]	Quasi- experimental (not randomized)	Pain intensity	Numeric rating scale 0-10	Before and after training and use of intervention	149	35 (SD 15)	26 (SD 17)	Reduction of pain after training and before and after use of intervention when experimental groups were compared to control group. Reduction of use of medication after training and use of intervention in relaxation with imagery group when compared to control group. Reduction of anxiety before use of intervention in biofeedback group when compared to control group
		Use of medication	Patient chart	After training and use of intervention				
		State anxiety	State Anxiety Scale	Before and after training and use of intervention				
		Heart rate	Not reported					
		Bloodpressure						
		Respiration rate						
		Muscle activity	Electro-myography	During training and use of intervention				

Table 2. Studies on non-pharmacological interventions for procedural pain (Continued)

Authors	Method				Subjects			Statistical significant findings
	Design	Pain outcome	Measure	Data collection points	N	Mean age	Mean TBSA (%)	
Van der Does et al. (1988) [12]	Quasi-experimental (not randomized)	Pain intensity (overall, worst)	VAS	5 consecutive days before and after use of intervention	4	36	20	None
		Pain intensity (by nurse)						
		Anxiety (before, overall)						
		Anxiety (by nurse)						
Blew et al. (1989) [43]	Non-experimental (not randomized, no control group)	Pain intensity (average, severe, duration)	Burn pain questionnaire	Not reported	44	38	8	None
		Frequency and efficacy of coping strategies						
Patterson et al. (1989) [13]	Quasi-experimental (not randomized)	Pain intensity (worst)	VAS	3 consecutive days before and 2 after use of intervention, within 3 h after wound care	13	Median 29	Median 12	Reduction of pain after use of intervention in experimental group when compared to before use of intervention
Lewis et al. (1990) [28]	Quasi-experimental (no control but comparison group)	Pain intensity	VAS	Directly before and after wound care and at 15, 30 and 60 min after wound care	11	43 (range 24-70)	13 (range 3-30)	Reduction of pain in experimental group when compared to comparison group
Miller et al. (1992) [22]	Experimental	Pain intensity	McGill pain questionnaire	5 consecutive days directly before and after wound care, twice a day	17	34	22 (range 11-39)	Reduction of pain and anxiety in experimental group when compared to control group
		Anxiety	STAI					

Table 2. Studies on non-pharmacological interventions for procedural pain (Continued)

Authors	Method				Subjects			Statistical significant findings
	Design	Pain outcome	Measure	Data collection points	N	Mean age	Mean TBSA (%)	
Patterson et al. (1992) [14]	Experimental	Pain intensity	VAS	2 consecutive days, 1 before and 1 after use of intervention, within 3 h after wound care	30	34 (SD 9)	16 (SD 16)	Reduction of pain after use of intervention in experimental group when compared to before use of intervention
Everett et al. (1993) [15]	Quasi-experimental (no control but comparison groups)	Pain intensity Anxiety	VAS	2 days before and after use of intervention, within 3 h after wound care	32	37 (SD 12)	14 (SD 10)	Reduction of anxiety in all groups after use of intervention when compared to before use of intervention
Sutherland (1996) [29]	Quasi-experimental (not randomized)	Pain intensity	Verbal numeric rating scale	Every 30 s during wound care	10	38 (SD 12, range 24-65)	19 (SD 10, range 5-38)	Reduction of pain in experimental group when compared to control group
		Use of medication	Patient chart	Before discharge				
Patterson and Ptacek (1997) [16]	Quasi-experimental (no control but comparison group)	Pain intensity (worst)	VAS	4 consecutive days, 2 before and 2 after use of intervention, within 1 h after wound care	61	37 (SD 12)	14 (SD 11)	Reduction of pain in patients in experimental group with baseline pain >5 on VAS when compared to comparison group
Field et al. (1998) [30]	Experimental	Background pain intensity	VAS, McGill pain questionnaire	First and last study day	28	Adults	10	Reduction of pain in experimental group on last study day when compared to first study day. Reduction of state anxiety in experimental group after use of intervention when compared to before use of intervention
		State anxiety	STAI	20 min before and after use of intervention, first and last study day				
		Heart rate	Not reported	30 s before and after use of intervention				
Turner et al. (1998) [31]	Quasi-experimental (no control but comparison group)	Background pain intensity	Vertical VAS	Study day 1, 3 and 6 before and after use of intervention	99	38 (range 15-68)	17 (range 1-75)	Reduction of pain on McGill pain questionnaire and anxiety when experimental group was compared to comparison group
			McGill pain questionnaire	Study day 1 and 6				
		Anxiety	VAS					
Hoffman et al. (2000) [32]	Experimental	Pain intensity (average, worst)	VAS	Once, directly after use of intervention during physical therapy	12	30 (range 19-47)	21	Reduction of pain when experimental group was compared to control group
		Anxiety						

Table 2. Studies on non-pharmacological interventions for procedural pain (Continued)

Authors	Method				Subjects			Statistical significant findings
	Design	Pain outcome	Measure	Data collection points	N	Mean age	Mean TBSA (%)	
Wright and Drummond (2000) [17]	Experimental	Pain intensity Distress	Numeric rating scale	During wound care at each wound site and after wound care	30	35 (range 16-48)	13 (range 1-45)	Reduction of pain and distress during and after use of intervention when experimental group was compared to control group. Reduction of anxiety in experimental group during second use of intervention when compared to first. Reduction of use of medication when experimental group was compared to control group
		Use of medication	Patient chart	After wound care				
		Anxiety	STAI	Directly before wound care				
Byers et al. (2001) [23]	Non-experimental (not randomized, no control group)	Pain intensity	VAS, McGill pain questionnaire	Not reported	23	33 (SD 13, range 18-75)	Not reported	Reduction of pain when family is present
		Anxiety	VAS					
Fratianne et al. (2001) [24]	Experimental	Pain intensity Anxiety	Combined vertical Wong/ Baker faces rating scale, VAS	First and second wound care, directly before, during and directly after wound care	25	43 (range 7-83)	10 (range 1-43)	Reduction of pain in experimental group when compared to control group
		Heart rate	Patient chart					
		Tension	Adapted Trippett objective muscle relaxation inventory					
Frenay et al. (2001) [18]	Quasi-experimental (no control but comparison group)	Pain intensity Pain control	VAS	Study day 1, 3, 5, 7, 8, 10, 12, 14, before, during and after wound care	26	Range 18-65	Range 10-25	Reduction of anxiety before and during wound care in experimental group when compared to comparison group
		Anxiety						

Table 2. Studies on non-pharmacological interventions for procedural pain (Continued)

Authors	Method				Subjects			Statistical significant findings
	Design	Pain outcome	Measure	Data collection points	N	Mean age	Mean TBSA (%)	
Haythornthwaite et al. (2001) [25]	Experimental	Pain intensity (average, worst)	11 Point Likert scale	Every 10 min during wound care and 30 min after wound care	42	44 (SD 13)	16 (range 3-65)	Reduction of pain in experimental group when compared to comparison group
		Pain relief		Before and after training and wound care				
Hoffman et al. (2001) [33]	Experimental	Pain intensity (worst, average)	VAS	3 days, directly after use of intervention	7	22 (range 9-23)	24 (range 3-60)	Reduction of pain and distress in experimental group when compared to control group
		Distress						
Prensner et al. (2001) [26]	Non-experimental (not randomized, no control group)	Pain intensity	Not reported	Before and during use of intervention	63	Not reported	Not reported	Not reported
		Anxiety						
		Heart rate						
Ferguson and Voll (2004) [27]	Experimental	Pain intensity	VAS	Before and after wound care, once	11	42	20 (range 18-75)	None
		Anxiety	STAI					
		Heart rate	Monitor					
		Blood pressure						
		Respiratory rate						
Harandi et al. (2004) [19]	Quasi-experimental (not randomized)	Pain intensity	VAS	Directly before therapy, directly after hypnotherapy sessions	44	32 (SD 14, range 16-75)	29 (SD 10)	Reduction of pain and anxiety in experimental group when compared to control group
		Anxiety						

VAS: visual analogue scale; STAI: state trait anxiety inventory; SD: standard deviation.

Hypnosis and rapid induction analgesia (RIA) were most frequent subject of investigation [11-19]. Combinations of relaxation, imagery, attention, information, distraction and/or music are often made, namely in eight of the 21 interventions [20-27]. Except for sensory focussing [25], all interventions refocus attention from pain to a more pleasant stimulus.

The majority of the investigations (17 studies) showed that the intervention had a positive effect on the reported pain outcomes. It should be noted that pain outcomes are measured by different parameters: (1) pain sensation, i.e. pain intensity and/or use of medication, (2) psychological reaction, i.e. anxiety and/or distress and (3) physiological reaction, i.e. heart rate, blood pressure, respiratory rate, and/or muscle tension. Pain intensity was measured in all studies. Fifteen studies [13, 14, 16, 17, 19, 21, 22, 24, 25, 28-33] reported a statistically significant reduction of pain intensity and four [11, 17, 20, 21] out of five studies reported a statistically significant reduction of the use of medication. Distress was found to diminish in two [17, 33] out of three studies and anxiety in nine [15, 17, 18-22, 30, 31] out of sixteen studies. None of the four studies using physiological parameters as an outcome of pain reported reduction of this component. Yet, at first sight, encouraging results are observed in the majority of the studies.

However, many of the studies suffer from methodological shortcomings such as suboptimal experimental design, relatively small sample sizes and focussing on a mixture of adults and children or on background pain. This prevents making sound evidence based decisions for nursing practice. Therefore, only experimental studies testing a standardized intervention by using a control group and randomization were further analysed, since results from randomized controlled trials should provide the highest level of evidence [34]. Control groups were considered as such when receiving standard care. Comparison groups receiving other interventions than standard care were not considered as control groups. When the intervention was pre- and post-tested in the experimental group, with patients as their own control, the pre-test was considered as control group.

Three studies used an appropriate experimental design, included more than ten adults using the intervention during wound care and showed reduction of pain intensity when compared to the control group receiving standard care. These concerned active hypnosis [14], RIA [17] and distraction relaxation [22]. Although these studies indicate statistically significant reduction of pain intensity, these findings should also be interpreted with some caution, mainly due to methodological limitations and to patient and nursing specific factors.

Concerning methodological aspects, some studies used measures with unknown reliability and validity for patients with burns. Also, standard care in control groups was not described and a Hawthorne effect, caused by the patients' awareness that they are participants under study [35], could have influenced the outcomes when there was no possibility of blinding patient and staff.

Furthermore, although the studies indicate statistically significant pain reduction, it is not clear whether these changes were also clinical significant. In order to identify changes in pain ratings in future studies, patients should preferably have procedural pain scores on a visual analogue scale (VAS) of 5 or more before enrolment in a study since pain ratings lower than 5 are assumed to be acceptable [36].

Patient and nursing specific factors may also have influenced the results, but were not a topic of discussion. Nevertheless, they may be important factors to bear in mind for future research. First, the type of intervention in relation to patient characteristics could have affected the outcomes. It is not unconceivable that some interventions are better applicable to one patient than another. Characteristics like past pain experiences, substance abuse, coping style or sensitivity to hypnotic suggestions [12] could have influenced patients' susceptibility. Second, regarding the burns, the extent, the stage of wound healing and type of dressing could have influenced the results. It was found that patients with a large burned total body surface area experienced more anxiety for pain rather than patients with a small burned total body surface area [37], which may affect the patients' pain sensation. Third, handling pain is also influenced by the duration, frequency of repetition, difficulties in the performance of the procedure and previous experiences with staff [38]. Regarding this latter issue, Madjar [4] concluded from qualitative research that patients divide nurses in 'good' and 'good-but' nurses. 'Good nurses' are gentle, trustworthy and sensitive and have technical competence, knowledge and skilful communication. 'Good-but nurses' are characterized by unpredictability, rushing, limited technical competence and restricted communication. Nursing specific aspects, like nurses' behaviour, style and skills as well as rotation of nurses can thus be confounding factors. Finally, the so called nurse dose, which consists of the nurse-patient ratio, nurse education, expertise and experience [39] is very difficult to standardize and should also be considered as confounder. These above mentioned factors may have partly contributed to the non-statistically significant results found in the reviewed studies mentioned in Table 2. Although not all of these factors play a dominant role, they may have an impact on the results to some extent. In conclusion, it may be clear that further research is needed before well-founded evidence based decisions for nursing practice can be made.

4. Discussion and implications for future research

It is encouraging to notice that non-pharmacological pain interventions receive growing attention in adjunction of the pharmacological treatment of pain in patients with burns. However, many concepts need further clarification and standardization. Implications for future research will be further discussed according to several factors that are of relevance to improve the scientific value, such as the theoretical framework, type of intervention, nature of instruction and guidance and the research method including design, outcomes, measures and data collection points.

4.1 Theory or conceptual framework

The overall purpose of theories and conceptual frameworks is to make scientific findings meaningful and to allow generalizations. Although research without a specific conceptual framework also contributes to knowledge, a research problem should preferably be placed into a theoretical context in order to advance nursing science [35].

Out of the 26 studies earlier discussed, 14 were provided with a theory or conceptual framework. Eleven different frameworks were identified (Table 2). The gate control theory was mostly used [26, 27, 30, 40]. The gate control theory suggests that sensory, affective and cognitive systems control the neurophysiological process, the reaction to pain and the evaluation of past pain experiences [41]. Also, conceptual frameworks with the emphasis on refocusing attention from pain to a more pleasant stimulus were often used [20-22, 32, 33]. Finally, frameworks with a physiological [19, 28] and nursing perspective [31] were found as well as a framework with the emphasis on sensory focussing [25]. In contrast, one study [42] used a conceptual framework focussing on increasing the patients' sense of control, which in turn is associated with decreased pain and anxiety.

In our opinion, the concept that should have a key position in the foundation of non-pharmacological pain interventions is increasing the sense of control during painful procedures. It was suggested that the lack of procedural controllability and predictability can cause anxiety related to procedural pain, which subsequently can contribute to the development or maintenance of posttraumatic stress symptoms [37]. Although patients possibly will attempt to control the situation by using delay, information and reassurance seeking [38] or natural coping strategies e.g. distraction [43], this may not always be sufficient. Therefore, additional methods to enhance control might be indicated. According to the self-regulation theory of Leventhal and Johnson [44], developed to prepare patients for painful procedures, predictability can be enhanced by offering procedural and sensory information, while controllability can be enhanced by offering the patient coping information. Being told what to expect to feel physically, as well as being informed about the procedure itself helps the patient to form a clear idea of what exactly is going to happen. This allows the patient to disconnect from emotional memories of pain. It was found that it reduced anxiety before and during a procedure, diminished the intensity of the emotional reaction to pain and helped the patient to cope more effectively when confronted with painful stimuli. Providing coping information, of which systematic application might benefit burn pain management [45], empowers the patient with the idea that he controls the situation. The nurse teaches the patient how to deal with painful procedures through developing new coping behaviours which enables the patient to consciously influence the experience of threatening situations. In conclusion, the self-regulation theory seems a relevant theory for clinical practice and should be taken in consideration for future research.

4.2 Type of intervention

Factors of importance when selecting an intervention for daily practice are, besides the effectiveness of the intervention, the feasibility, the acceptability to the patient and the capability of the nurse [10]. These factors will be discussed in more detail.

4.2.1 Feasibility

A non-pharmacological pain intervention is feasible when it interacts with other interventions related to burn care, such as wound care, practice of daily life activities, physiotherapy and occupational therapy. Patients with burns have a busy daily program and they often have a poor physical and/or emotional condition. Important feasibility aspects are therefore: simplicity of the intervention, easy to learn or to use, immediate usability and minimal expenditure of time and effort when learning and using the intervention. An intervention should also withstand concentration interruptions coming from the environment like noise, nurse discussion and requests and should allow a walk to a shower. Moreover, since removal of dressings is the most painful part of wound care [46], an intervention should therefore also be applicable during this part of the procedure. Furthermore, the intervention should not cause extra pain. For example, muscles tension, required in interventions like progressive muscle relaxation, can increase pain when it is implemented in burned parts of the body [47, 48] and seems therefore not the most appropriate technique.

It was not described whether the interventions included in this review are simple and easy to learn. With respect to immediate usability, all interventions need equipment or time and personnel to teach, except for interrupted debridement and patient performed washing. Interventions that seem to withstand interruption from the environment are interrupted debridement, transcutaneous electric nerve stimulation (TENS), patient performed washing and VR. Most interventions do not appear to cause extra pain, although it is conceivable that TENS and interventions wherein progressive muscle relaxation is integrated, can cause extra pain. Some reservation with respect to these interventions seems therefore suitable. In conclusion, interventions that seem most feasible in the burn care environment are interrupted debridement, patient performed washing and VR.

Another aspect of feasibility is the cost of time, personnel and equipment. Cost aspects are rarely described in the studies. Patterson et al. [13] mentioned that RIA requires little time, i.e. one to three practice sessions of 45 minutes taught by a therapist before wound care. Next to it, nurses were provided with instructions to induce the patient directly before wound care. Everett et al. [15] reported that one hypnosis session of 25 minutes before wound care will do, followed by instructions provided by a nurse during wound care. In contrast, hypnosis was found time-consuming in another study [12], because the therapist stayed present during six wound care procedures. It seems therefore reasonable to make use of nurses who will be with the patients

anyway [49], in order to reduce costs of time and personnel. Interventions that make use of equipment are TENS, audio taped interventions, music, distraction-relaxation, VR and biofeedback. Using equipment does not add to cost reduction, particularly VR is an expensive intervention. However, available equipment depends on resources in the hospital and interventions needing equipment should therefore not be rejected a priori. Nevertheless, the cost of the intervention may play an important role in evaluating the feasibility of an intervention and should therefore be consciously considered.

4.2.2 Acceptability

The second factor of importance when selecting an intervention is the acceptability of an intervention to the patient. It refers to the patients' preference, capability and personality characteristics. These issues were mentioned in none of the studies. However, it has been postulated that research should focus on person related variables, in order to elucidate the mechanisms responsible for their effects on pain [50]. According to Grypdonck [51], personality characteristics such as state anxiety, coping style and locus of control are assumed to influence outcomes of preparatory procedural, sensory and coping interventions for threatening procedures. Persons with high state anxiety may benefit more from instruction than persons with low state anxiety [52]. With regard to coping style, it was reported that patients with an avoiding coping style profit from late, brief and broad emotional supporting coping information. In contrast, sensitizers should gain from early, detailed, clear procedural, sensory and coping information [53-56]. It was also suggested that patients with an internal locus of control benefit more from information than patients with an external locus of control [57, 58]. However, more research is required to investigate whether these characteristics are of importance and how they interact with outcomes when selecting a non-pharmacological intervention in patients with burns. If these are important characteristics, an instrument able to match these characteristics with interventions should be developed. Finally, interventions that match with different personality characteristics should be identified [49].

4.2.3 Capability of the nurse

The last factor of importance when selecting an intervention is the capability of the nurse which refers to the necessary skills required to carry out an intervention. The degree to which an intervention makes an appeal to specific capabilities of the nurse largely depends on the nature of the intervention. Interventions that require trained nurses are stress inoculation, TENS, hypnosis, relaxation, imagery, biofeedback, RIA, massage, TT, music therapy and sensory focusing. The level of training or licensing necessary to teach an intervention was not reported in the studies. From an economic point of view however, it is recommended that several nurses are trained in teaching the patient a specific intervention and that all other nurses are provided with standardized instructions that can be used during wound care. Interventions that can be applied without required training are interrupted debridement, distraction relaxation, patient performed

washing, VR and music. These interventions have the advantage that they are less susceptible to nursing capability confounders.
In conclusion, aspects like feasibility, acceptability and capability of the nurse were not a topic of interest in the reviewed studies. However, they are important factors with the view on an effective intervention, especially easiness, amount of time and effort to learn and use the intervention, the nature of withstanding interruption and the acceptability of the patient. Although they are difficult to assess, the impact is large enough in to be considered in future research.

4.3 Manner of giving instruction and guidance

The manner of giving instruction and guidance in the use of the intervention was not reported or not relevant in 11 studies. These studies concerned natural coping or relatively passive and easy to use interventions with minimal instruction and guidance. In nine studies, instruction before and guidance during wound care was provided in order to teach the patient to use the intervention independently during the procedure [11, 13-17, 19, 21, 25]. Instruction was mostly given by audiotape or by a therapist who did not attend the wound care procedure. All of them showed statistically significant pain reduction. Independent usability was not the aim in six studies [12, 18, 20, 24, 26, 29], where a therapist or nurse guided the patient through the procedure. In four of these studies [18, 20, 24, 29], statistically significant pain reduction was found. Continuing guidance during wound care appears effective, either with trained nurses or through audiotapes played on headsets [16, 21, 59]. The presence of a therapist during wound care however does not seem a prerequisite to obtain pain reduction. Provisionally, there is no rationale to assume that the presence of a therapist who instructs, guides and provides in pain relief lead to more positive outcomes than the use of audiotapes or the presence of a nurse who instructs, guides and provides in pain relief. Presence of a therapist even can have drawbacks. Besides the already mentioned time consuming nature of attending a large number of wound care procedures, patients can become dependent on the psychologists' presence [16]. Concisely, presence of a therapist does not seem to add surplus value.

Other important factors to consider are the initiation, duration and number of sessions during which instruction and guidance in the use of the technique are provided. It was reported that the best moment to prepare patients for threatening and painful procedures is as far in advance as possible [51]. This is not clear for patients with burns. However, it may be assumed this should be as soon as possible after admission. Interventions were, when reported, mostly initiated directly before wound care. The post burn day of initiation was mentioned in none of the studies. Further, it was suggested that hypnosis should be provided at least 1 h prior to wound care, when patients are in relatively calm state and less on medication [16]. This recommendation may be of relevance for other interventions requiring instruction and guidance. Duration of sessions in the reviewed studies was between 15 and 45 minutes, predominantly 25 minutes. Considering the situation of the patient with burns, we should aim at not exceeding 25 minutes, since minimal

expenditure of time and effort is a criterion when selecting an intervention. With regard to the number of instruction and guidance sessions, most studies indicated that a single session was sufficient, although a larger number of six sessions was also reported. Snyder [60] stated that the more a patient practices, the better the results and that at least four sessions, including guidance during use of the technique, are required before relaxation can be mastered. As relaxation is a component of many behavioural interventions, at least four sessions (one session per day) are recommended. Nevertheless, research is needed to further elucidate the initiation and number of sessions required to prepare the patient in the use of the intervention.

4.4 Design

Ten studies were experimental, 13 used quasi-experimental designs and three used non-experimental designs. Pre- and post-test measurements were carried out in six of the discussed studies [13-16, 18, 20]. Since the ideal controlled study has an experimental design [35] with a control group receiving standard care, this approach should be sought in future research. In order to strengthen a design, intra-individual comparisons can be made using pre- and post-test measurements [35]. Pre-test measurements should be taken on several days prior to application of the intervention. According to Cook and Campbell [61], in order to locate outliers in pre- as well as in post-tests, measurements on consecutive days can be taken by using an interrupted time series design as was performed in five studies [13, 15, 16, 18, 20]. In conclusion, more experimental designs with pre- and post-tests and time series is needed in order to enlarge the body of knowledge concerning the effects of non-pharmacological pain interventions.

4.5 Outcomes

As is earlier mentioned, pain can be measured by different parameters. Pain intensity is one of these parameters and was measured in all studies. In accordance with these studies, our opinion is that assessment of pain intensity during wound care should be the primary outcome for future effect research. In contrast, the use of medication as an indicator of pain intensity is questionable, because interventions are adjunct to medication and should not replace it. Besides, patients can report less pain, because they asked for more medication. Therefore, the type and amount of pain medication should preferably be considered as a control variable but not as an outcome variable. Next to pain intensity, distress caused by pain may be an important outcome in future research. Likewise, procedural anxiety should be considered for research because it can increase anxiety for the next wound care procedure, which in turn can increase pain. The relevance of physiological parameters such as heart and respiratory rate, blood pressure and muscle tension as indicators of pain in burn patients during wound care may be questioned. Research indicated that no reduction of physiological parameters was observed. In addition, measurement of these parameters can cause pain, can disturb concentration or a relaxed state during a painful, stressful and long lasting procedure. Next to the aforementioned outcomes, the extent of mastering the technique with and without guidance may be of relevance when the self-regulation theory will

be used as framework for future research and to assess if pain reduction is indeed a result of the intervention under research. To the best of our knowledge, instruments to assess mastery of an intervention and independent usability are not available and should be developed.

4.6 Measures

Different instruments were used to measure pain intensity, distress and anxiety. With respect to pain measurement, a VAS was mostly (18x) used, followed by the McGill pain questionnaire (3x). Currently, the visual analogue thermometer (VAT) is the only reliable and valid scale to assess both procedural and background pain in adults with burns [62] and is therefore recommended. Concerning the measurement of distress, researchers also used a VAS. Because the VAT is an accepted alternative tool for the VAS to measure pain in burn patients, and the VAS is suitable for measuring both pain and distress, it is postulated that the VAT can be used to measure distress in burn patients. Anxiety was mostly assessed by a VAS (6x) and the state trait anxiety inventory (STAI) (5x). Taal and Faber argued that the STAI is not the most appropriate instrument for use in a clinical setting and introduced the burn specific pain anxiety scale (BSPAS), which was suggested to be a reliable and valid measure [63, 64]. The use of the BSPAS to assess anxiety as well as the VAT to assess pain and distress in future effect studies is discussed more extensive by De Jong and Gamel [65]. In order to measure the aforementioned parameters in a reliable and valid way, it is important to use the available instruments until other instruments are introduced.

4.7 Data collection points

Diversity was seen as far as the initiation, timing within wound care and continuation of data collection, as is shown in Table 2. Post burn date of measurement is only described in four studies. The range of the data collection points varied between 1 and 76 days post burn which limits the comparability between studies. In our opinion, the burn field would benefit from an international agreement on when to measure pain. However, in the meantime it was recommended that instruction in the use of an intervention and the associated data collection should start as soon as possible following admission and continue throughout the first two weeks of admission [65]. It is supposed that it can avoid unjust assignment of an effect to an intervention as the proceeding of wound healing could also have contributed to results. Besides, it can avoid excessively divergent post burn dates of measurement which creates unnecessary heterogeneous groups.

Another topic of discussion concerning data collection is when to measure procedural pain and anxiety. Wound care procedures are long lasting with fluctuations in pain. Pain intensity and distress should therefore be measured directly following wound care because this report represents an accurate, overall experience of the procedure. In contrast, procedural anxiety reports should be taken directly before wound care because procedural pain concerns anxiety preceding wound care. Furthermore, we would propose that data should be collected throughout the first two weeks of admission and at three different occasions: pre test measurements without

intervention, post-test measurements while the nurse provides guidance when the intervention requires this, and post-test measurements once guidance, if applicable, has stopped. Pre-test measurements can be taken during the first three days after enrolment into the study. On the third day, the intervention is taught or explained during a period of rest. The following three days measurements are taken when patients receive guidance in the application of the technique during wound care. Finally, spread over the second week, three measurements should be taken while the patient uses the technique independently, in order to assess if the patient uses and/or is able to use the intervention independently.

5. Conclusion

This study included experimental, quasi-experimental and non-experimental research. The number of experimental designs which provide the strongest evidence was, overall and especially per intervention, scarce. Another limitation of this study is that unpublished studies were not sought, which might make this review incomplete.

With this review however, an attempt was made to gain insight into the current state of research concerning non-pharmacological nursing interventions to relieve pain in adults with burns. Additionally, we have tried to identify current gaps in burn intervention research with the aim to pay attention to confounders and to enhance standardization. Currently, active hypnosis [14], RIA [17] and distraction relaxation [22] were tested in an experimental design during wound care and can be considered as effective interventions to reduce pain intensity. Although these interventions require trained nurses or equipment, they can be used independently by nurses and seem, in spite of the study limitations, interventions with the best available evidence.

Adverse effects of the reviewed interventions were however not reported. They are low risk interventions and show promise in enhancing non-pharmacological pain management. Adequate trained nurses can use many of these interventions in order to perform best practice, until additional research findings are available. No evidence was found that indicated the need to stop using them until further research provides a stronger evidence base of the effect of an intervention. Besides using these interventions, nurses should by preference give preparatory and sensory information prior to the procedure and should measure and evaluate pain. In the future, research should focus on increasing psychological comfort by refocusing from pain. It may benefit from a theoretical framework such as the self-regulation theory. Continuing critical evaluation of the efficacy of available non-pharmacological interventions is recommended for future research.

Prior to undertaking an effect study, additional basic research is needed. This research should focus on assessment of the importance of patient characteristics as anxiety, coping style and locus of control when selecting an intervention, and on development of an instrument to match

these characteristics, if they are of importance, with suitable interventions. Also, development of instruments to assess easiness to learn an intervention and sensitivity to interruption should be aimed. Besides, clarification of the proposed number and duration of sessions that are necessary to learn to use an intervention should be pursued. Once these issues are resolved, the following methodological aspects should be taken into consideration for further effect studies: the use of an experimental design with pre- and post-tests and time series, large sample sizes, of which the size is assessed by a priori power analysis, and providing standard care to the control group. Furthermore, procedural pain, anxiety and distress should be measured with reliable and valid instruments developed for patients with burns, the adequacy of the proposed data collection points should be clarified and only patients with VAT scores of 5 or more should be included in the study.

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‘Begin with the end in mind.’

Stephen Covey (1997) [1].

Chapter 9

Discussion and future perspectives

1. Introduction

Many research reports start with the statement that pain is a major problem in burn care, but can't we expect, given the latest developments and insights in general pain management, any progress in effective treatment of burn pain today? It is remarkable that Perry [2] reported in 1984 that pain is undertreated, that 17 years later, Choinière [3] stated that this situation has changed little and that currently, in the 2010s, adults with burns still experience considerable procedural pain. Mean visual analogue scale (VAS) scores of ≥ 4.5 [4], 0 to 10 Likert scale means of 5.6 [5], median verbal numeric rating scale scores (VNRS) of 4 [6], numeric rating scale scores of ≥ 5 [7] and VAS scores of > 6 [8] were reported. Also, on average, many children still seem to exhibit moderate and severe pain behaviour during wound care (chapter 5). Is that due to a lack of adequate pain evaluation? Or is there a lack of adequate pain treatment? Or is burn pain just an insurmountable problem and too complex to control and to investigate?

Burn pain is indeed not only difficult to control, but is also complicated to investigate because of its unique characteristics, its multiple components, and its changing patterns over time. Furthermore, a limited number of beds in burn centres that are often occupied for long periods by critically ill patients, of whom many are unable to communicate, due to for example artificial respiration or delirium, may result in small sample sizes. Multicentre studies might solve this problem, but unfortunately, wound and pain treatment vary amongst burn centres, which makes these studies difficult to conduct [3].

In an effort to omit above mentioned factors that can cause flaws in research design and to make multicentre research more efficient, an important step to evaluate the effect of any intervention on pain may be definite pain measurement. A prerequisite to streamline adequate burn pain research is that pain should be measured appropriately and unambiguously. Furthermore, if there would be a lack of appropriate pain treatment, the latest insights should be revealed and be made accessible to daily practice. Especially, the best evidence on non-pharmacological interventions during wound care should be disclosed. Since patients experience pain in spite of the use of medication, non-pharmacological methods can be implemented by nurses as adjunct pain interventions.

This thesis consists of two parts. Subject of the first part is the measurement of pain, in particular testing pain behaviour observation measurement instruments on reliability and validity, and comparing self-report scales to allow interchangeable use. The second part aimed to review non-pharmacological pain interventions that can be used independently by nurses in daily burn care practice. The ultimate aim of this thesis is to contribute to adequate pain measurement by optimising standardisation of pain measurement in young children and adults with burns, but also to improve daily practice by revealing the best evidence for non-pharmacological nursing interventions.

2. Pain measurement

Measurement is an essential component of scientific research and daily practice. Measurement of subjective constructs like pain requires rigorously developed and tested measurement instruments in order to obtain data of the highest possible quality. Pain measurement with instruments having sufficient psychometric properties is a prerequisite for individualized pain management.

2.1 Pain measurement instruments for young children

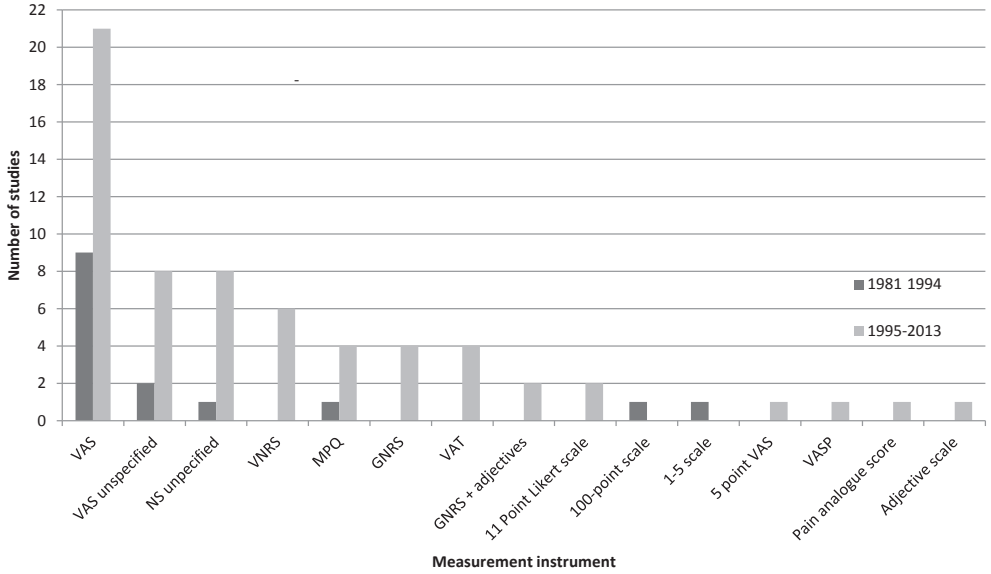
Since Anand and Hickey [9] stated that premature babies have the ability to perceive pain, pain in young children has received increased attention. Researchers agreed about the assessment of pain in young children unable to provide self-reports, namely by behavioural observation. In the following decades, pain behaviour observation instruments for pain assessment in young children have been developed and tested [10-18]. Before the introduction of the pain observation scale for young children (POCIS) and the COMFORT behaviour scale (COMFORT-B) in the Netherlands by Boelen-van der Loo et al. [16] and Van Dijk et al. [18] respectively, pain of young children with burns up to four years old, representing approximately 30% of the admitted patients [19], was assessed by personal judgments of nurses and physicians. Two of the studies in this thesis (chapter 2 and 3) revealed that when two or more nurses used the nurse observational visual analogue scale (VAS obs) to simultaneously assess pain of a 0-4 years old child, the ratings corresponded less well when compared to ratings obtained with structured behavioural observation [20, 21]. In other words, inter-rater reliability coefficients of ratings obtained with the VAS obs were often below the criterion of ≥ 0.75 [22], while ratings obtained by structured behavioural observation did meet this criterion. The VAS obs, when used by nurses as a global rating scale to report the child's pain, turned out to be insufficiently reliable, probably because nurses are unable to unambiguously express the patients' pain on a global rating scale as a 10-cm line. According to the literature, several factors may influence the nurses' impression of the patients' pain. For example, nurses may differ in selecting a specific behaviour as an indicator of pain. One nurse may base her rating on the extent of crying, whereas another founds her rating on facial grimace. Furthermore, the relationship of the nurse to the child may affect her assessment. A nurse who is familiar with the child's behaviour may interpret altered behaviour differently than a nurse less familiar with the child [23]. Also, the paradoxical position of nurses as inflictors of pain, and at the same time the providers of pain relief, may influence their global pain ratings. It has been suggested that nurses with less experience in burn care are more emotionally affected by the patients' pain and, therefore, tend to assume more pain than the nurse with more experience. More experienced nurses with repeated exposure to severe pain may develop some sort of defense mechanism and become hardened to pain complaints [24]. Accordingly, based on the results of our studies (chapter 2 and 3) [20, 21], and supported by the literature, a global rating scale as the VAS obs is not recommended as outcome measure for pain in young children. Therefore, pain behaviour observation instruments with sufficient clinimetric properties like the POCIS and COMFORT-B

should be used for research and daily practice. Moreover, the POCIS and COMFORT-B were further explored by Rasch analysis (chapter 4) [25]. The results provided support for construct validity. Although both instruments are supposed to be reliable and valid and can thus be used in daily practice, nurses preferred to utilize the COMFORT-B above the POCIS (chapter 3). Since the three Dutch burn centres accordingly implemented the COMFORT-B, we determined cutpoints of this scale using Rasch analysis. By means of these studies, that are among the first in the burn field to examine different aspects of pain behavioural observation scales, we are now able to reliably evaluate pain in young children. Furthermore, we have determined the levels at which the observed pain needs consideration for adapted treatment.

2.2 Pain measurement instruments for adults

According to the definition of pain: 'Whatever the experiencing person says it is, existing whenever he says it does' [26], patients' self-report of pain seems the most appropriate manner of pain assessment. However, many different self-report instruments are used in burn care, which prevents reliable comparisons across studies. Figure 1 shows this variety of pain measurement self-report tools that are used in previous procedural pain research in burn care. Figure 1 is divided in two time frames by the year 1994, wherein the landmark article of Choinière et al. [79] on self-reported pain measurement by the visual analogue thermometer (VAT) was published. Figure 1 shows, that despite this article, many unspecified measures are still used. Unfortunately, there is often a lack of a precise description of the scales. Frequently, it is unclear if graphic numeric rating scales, horizontal or vertical, or verbal numeric rating scales are used. Often, no explanation on the use of the scale is given. The conventional VAS seemed to be mostly used. This is a straight horizontal continuous 10-cm line with clearly marked terminal ends, without numerical or verbal classification along the line, but with the extreme anchor words 'no pain' at the left side of the line and 'unbearable pain' at the right side, where the patient marks his pain intensity vertically somewhere on this line [97]. Many existing so called visual analogue scales are derived from the original VAS and health-care providers may use these variations. These tools however may not meet the conceptual VAS design and clinimetric properties are often not described. It is however important and efficient to have the possibility to compare research results, nationally and internationally, even when a variety of pain measures are used. Also for daily practice, to evaluate the adequacy of pain treatment, it may be useful if several measures could be offered to patients to match with their preference for a specific instrument. This, however, stresses the need to gain insight into the comparability of the various scales, to enable interchangeable use of self-report instruments. This issue was explored in chapter 6.

Figure 1. Self-report instruments used for procedural pain measurement in research in adults with burns



1981-1994: before and 1995-2013: after landmark article of Choinière et al. [79] on self-reported pain measurement by VAT.
VAS: 0-10 visual analogue scale [4, 7, 27-54]; VAS unspecified: unspecified visual analogue scale [8, 55-63]; NS: 0-10 unspecified numeric scale [64-72]; VNRS: 0-10 verbal numeric rating scale [6, 7, 73-76]; MPQ: McGill pain questionnaire [42, 45, 57, 77, 78]; VAT: visual analogue thermometer [79-82]; GNRS: 0-10 graphic numeric rating scale [83-86]; GNRS: graphic numeric rating scale + adjectives [87, 88]; 11 Point Likert scale [89, 90]; 100-point scale [91]; 1-5 scale [92]; 5 point VAS: 5 point visual analogue scale [93]; VASP: visual analogue pain scale 20 cm vertical line [94]; Pain analogue score [95]; Adjective scale [96].

The VAT is a self-report pain measurement instrument with appropriate clinimetric properties for the use in burn care [79]. The graphic numeric rating scale (GNRS) is often used in research in the burn field. The difference between the GNRS and the VAT is that the patient converts pain in a rational number instead of in an amount of red colour. Since their interchangeable use was unclear, we compared the GNRS to the VAT (chapter 6). We compared self-reported pain scores obtained with both scales, their ability to differentiate background from procedural pain and we compared cutpoints. Self-reports obtained with the VAT turned out to be statistically significantly lower than when obtained with GNRS. However, both scales were comparable in their ability to differentiate background from procedural pain and seemed to show a similar cutpoint. The results suggested that when comparing studies, or when using the two scales in practice, these instruments cannot be used interchangeably without taking their differences into account. The higher numeric rating scale scores have consequences for the interchangeable use of the scales between and within patients and for developing pain treatment protocols.

3. Pain treatment

The state of art is that adequate management of burn pain should consist of early treatment starting at the referring hospital [98] and of an individualized multimodal approach, i.e., using two or more drugs with different mechanisms of action, combined with non-pharmacological interventions [3, 99-101]. However, it seems that in daily practice, burn pain management may be based more on tradition, personal or institutional preference than on a systematic, scientific approach [102]. In addition to the reviews that were published in 2006 and 2007 (chapter 7 and 8), providing the best evidence for the non-pharmacological interventions active hypnosis, rapid induction analgesia and distraction relaxation in adults, an update of the literature is presented below. This update is divided into non-pharmacological interventions for children and for adults. Also, although it was not the focus of this thesis, some pharmacological aspects are discussed.

3.1 Non-pharmacological pain interventions

Patients may experience pain in spite of the use of medication. When non-pharmacological methods are used in combination with pharmacological interventions, a positive effect on pain relief can be seen [33, 103]. In addition, nurses can independently implement non-pharmacological interventions. Nurses would be properly equipped to help their patients if they had research evidence about non-pharmacological interventions that are effective for patients with burns. There are various effective non-pharmacological interventions, as described below. Important considerations when selecting a non-pharmacological intervention for patients with burns are: simplicity, immediate usability and minimal expenditure of time and effort during use [104].

3.1.1 Non-pharmacological pain interventions for children

Distraction seems to be the most frequently used intervention to guide children's attention away from the painful stimuli and to reduce pain and anxiety. Distraction techniques can be provided by nurses, parents and/or child life specialists. Cognitive distraction interventions that are often used in daily burn care practice are counting, listening to music, non procedure related talk, blowing bubbles, reading books, singing, imagery and preparatory information. Behavioural interventions are games, television, breathing exercises, non nutritive sucking and positive reinforcement, like positive statements or gifts like stickers or toys [105].

However, studies that demonstrated the effectiveness of above mentioned interventions with evidence are scarce. An overview of studies of the past 15 years examining procedural pain and non-pharmacological interventions is presented in Table 1. In these well designed studies, statistically significant reduction of pain was found in patients receiving massage therapy, augmented reality, multi-modal distraction and virtual reality. However, mostly older children were included, while our specific interest group that is largely represented in the burn centre consists of children 0-4 years. For this age group, massage therapy [107] seemed to be the non-pharmacological intervention with the best available evidence. However, given the limited number of studies in the specific age group of children 0-4 years, more intervention research should be carried out in order to found nursing practice on the best available evidence.

Table 1. Studies on non-pharmacological interventions for procedural pain in children with burns (1998-2012)

Authors	Sample			Design	Intervention	Outcomes	Measurement instruments	Data collection	Statistically significant findings
	N	Age (years)	TBSA (%)						
Foertsch et al. (1998) [106]	23	Mean 6	Mean 11	Experimental (control group and randomization)	Imagery or social support	Pain	Self-report by VAS and Faces scale	Not reported	None
Hernandez-Reif et al. (2001) [107]	24	Mean 2.5	< 25	Experimental (control group and randomization)	Massage therapy and standard care or standard care only	Pain	Children Hospital of East Ontario Pain Scale (observational)	After wound care	Reduction of pain in massage group
Landolt et al. (2002) [108]	13	Mean 8	Mean 7	Experimental (control group and randomization)	Cartoon viewing and standard care or standard care only	Distress	Observational scale of behavioural distress	During wound care	None
Das et al. (2005) [109]	7	Mean 11	> 3	Experimental (control group and randomization)	Virtual reality or standard care	Pain	Self-report by Faces scale	After wound care	None
Whitehead-Pleaux et al. (2006) [110]	14	6-16	Reconstructive surgery	Experimental (control group and randomization)	Music therapy (live music) and standard care or support and distraction and standard care	Pain	Self-report by Wong Baker Faces Pain Rating Scale Nursing Assessment of Pain Index (observational)	Before, during and after wound care	None
						Anxiety	Fear thermometer		
Mot et al. (2008) [111]	42	Median 9	Median 5	Experimental (control group and randomization)	Augmented reality distraction (virtual image overlaid onto physical world instead of immersion into artificial virtual world) or basic cognitive therapy	Pain	Self-report by Faces scale revised and VAS FLACC (observational)	Before, during and after wound care	Reduction of pain in augmented reality group with all measures when compared to basic cognitive therapy

Table 1. Studies on non-pharmacological interventions for procedural pain in children with burns (1998-2012) (Continued)

Authors	Sample			Design	Intervention	Outcomes	Measurement instruments	Data collection	Statistically significant findings
	N	Age (years)	TBSA (%)						
Miller et al. (2010) [112]	80	Mean 6	Mean 3	Experimental (control group and randomization)	Multi-modal distraction (hand held interactive device with programs designed to inform child about wound care and to distract child during wound care) or standard distraction or hand held video games	Pain	Self-report by Wong Baker Faces picture scale VAS (observational) FLACC (observational)	Directly before and after wound care	Reduction of pain on Wong Baker scale in multi-modal distraction group when compared to standard distraction and on FLACC when compared to video games and standard distraction
Parlak Gürol et al. (2010) [62]	63	Mean 14	11-25	Experimental (control group (intragroup comparison))	Massage therapy or standard care	Pain Anxiety	Self-report by VAS State Trait Anxiety Inventory	Not reported	Reduction of pain and anxiety in massage group when first day was compared to last day
Miller et al. (2011) [113]	40	Mean 6	Mean 2.5	Experimental (control group and randomization)	Multimodal distraction or standard care	Pain	Self-report by Wong Baker Faces Pain Rating Scale VAS (observational) FLACC (observational)	Before and during wound care	Reduction of pain in multimodal distraction group with all measures when compared to standard care
Schmitt et al. (2011) [114]	54	Mean 12	1.5-50	Experimental (control group (within-subject) and randomization)	Virtual reality or standard care	Pain	Self-report by Graphic numeric rating scale	After physical therapy	Reduction of worst pain in virtual reality group when compared to standard care
Kipping et al. (2012) [115]	41	Mean 13	Mean 5	Experimental (control group and randomization)	Virtual reality or standard distraction	Pain	Self-report by VAS VAS (observational) FLACC (observational)	Before and after wound care	Reduction of pain in virtual reality group on FLACC when compared to standard distraction

A specific non-pharmacological intervention is the presence of parents during wound care. In chapter 5, in an effort to detect factors that may influence procedural pain, parental presence showed a tendency to reduce pain behaviour, but this was not statistically significant. Although there are several other assumptions of beneficial effects [116], currently available studies in burn care [117, 118] do not provide evidence for or against parental presence. However, Blount and colleagues [119] reported that in other settings, the presence of parents during painful procedures is beyond questioning. More important is to examine what type of behaviour of parents could be helpful and what preparation is appropriate for parents to maximize helping their children during wound care. For example, it was reported that verbal reassurance by adults increased child distress, whereas other adult distracting behaviour decreased child distress [119].

3.1.2 Non-pharmacological pain interventions for adults

A literature review on relaxation techniques by Kwekkeboom and Gretarsdottir [120] was published in 2006, simultaneously with the reviews presented in chapter 7 and 8 [121, 122]. Studies on acute and chronic pain were included, while studies on burn pain were not. Exclusion of the burn studies can be explained by the time frame in which studies were located: Kwekkeboom and Gretarsdottir [120] limited their search from 1996 to 2005, while one of our studies [121] also included older publications. The most frequently supported technique was progressive muscle relaxation [120], but this intervention is not appropriate for patients with burns [121]. Furthermore, the investigators reported support for jaw relaxation and for systematic relaxation for relieving postoperative pain. No support for rhythmic breathing or other relaxation techniques was found, including the combination of jaw relaxation with rhythmic breathing. This is in accordance with our own review, where we concluded that, although we found evidence that supported this intervention in other settings, it was not possible to base decisions on research that specifically examined our patient group [121]. More recent, Seers et al. [123] compared body relaxation, jaw relaxation, attention control and standard care in 118 patients undergoing elective surgery. The mean age was 66 years. They used an experimental design with a control group and randomization and found no statistically significant differences in pain between the groups. However, five years later, Mohammadi Fakhar et al. [124] and Park et al. [4] investigated jaw relaxation and relaxation breathing, respectively, as individual interventions for adults with burns during wound care in well designed studies (Table 2). Both studies showed statistically significant reduction of pain and anxiety for pain, suggesting that substantial evidence for these interventions is now obtained and that these interventions can be implemented.

The best available evidence for other non-pharmacological interventions was found for active hypnosis, rapid induction analgesia and distraction relaxation [122]. To update the state of art, studies on non-pharmacological interventions for procedural pain in adults with burns were searched from January 2006 onwards and are presented in Table 2. More evidence is now available for virtual reality, which shows promising results, although there are some limitations.

Table 2. Studies on non-pharmacological interventions for procedural pain in adults with burns (2006-2013)

Authors	Sample			Design	Intervention	Outcomes	Measurement instruments	Data collection	Statistically significant findings
	N	Age (years)	TBSA (%)						
Van Twillert et al. (2007) [82]	19	Mean 30	Mean 7	Quasi- experimental (control group (within subject))	Immersive virtual reality or self-chosen distraction or standard care (no distraction)	Pain Anxiety	Visual analogue thermometer State trait anxiety inventory	During wound care	Reduction of pain in virtual reality and self-chosen distraction group (television) when compared to standard care
Carrougher et al. (2009) [87]	39	Mean 35	Mean 18	Experimental (control group (within subject) and randomization)	Immersive virtual reality or standard care	Pain	Graphic numeric rating scale	During physical therapy	Reduction of pain in virtual reality group when compared to standard care
Konstantatos et al. (2009) [52]	86	Mean 37	Mean 15	Experimental (control group and randomization)	Virtual reality plus intravenous morphine patient controlled analgesia (PCA) or PCA only	Pain Anxiety	Visual analogue scale State trait anxiety inventory	During and after wound care	Reduction of pain in PCA only group when compared to virtual reality and PCA
Tan et al. (2010) [90]	29	Mean 41	Mean 12	Experimental (control group (crossover) and randomization)	Music therapy or standard care	Pain Anxiety Muscle tension	11-point numeric rating scale 11-point numeric rating scale Muscle tension inventory scale	Before, during and after wound care	Reduction of pain, anxiety and muscle tension in music therapy group when compared to standard care
Maani et al. (2011) [88]	12	Mean 22	Mean 21	Experimental (control group (within subject) and randomization)	Virtual reality or standard care	Pain	0-10 graphic rating scale with adjectives	During wound care	Reduction of worst pain in virtual reality group when compared to standard care
Mohammadi Fakhar et al. (2013) [124]	100	18-60	9-35	Experimental (control group and randomization)	Jaw relaxation or standard care	Pain anxiety	Burn specific pain anxiety scale	Before and after wound care	Reduction of pain anxiety in jaw relaxation group when compared to standard care
Park et al. (2013) [4]	60	Mean 45	Mean 11	Quasi-experimental (control group (pretest-posttest))	Relaxation breathing or standard care	Pain anxiety	VAS VAS A	Before and after wound care	Reduction of pain and anxiety in relaxation breathing group when compared to standard care

Children included in the samples caused heterogeneous samples, resulting in limitations for generalization [82]. Besides, worst pain instead of overall pain was measured [52, 87, 88], while adaptation of pain treatment in daily practice should be based on overall procedural pain. Also, a reverse effect was reported: patients receiving virtual reality in combination with patient controlled analgesia (PCA) reported more pain than patients in the PCA only group [52]. Also, virtual reality is expensive and not all burn centres are able to bear such costs. Finally, statistical significance does not always parallel clinical significance, but we have not examined this issue while investigating the literature.

3.2 Pharmacological pain interventions

Although pharmacological pain management, but also the type of wound care products, are important elements in the multimodal approach, they are not the focus of this thesis, since they fall primarily within the realm of medical decision-making. Nevertheless, several aspects may need some attention.

Inadequate pain treatment for an initial painful procedure in children conditions anxiety, heightens arousal for subsequent procedures and reduces the effectiveness of analgesia for subsequent procedures [125, 126]. This suggests that an adequate method to treat paediatric burn pain is to address it effectively during the first painful procedure. Results presented in chapter 5 suggested that pharmacological factors may influence the extent of pain behaviour. Early administration of acetaminophen by the referring hospital and continuation of administration in the burn centre namely might reduce pain behaviour in the first week of admission. The study also suggested that a considerable percentage of children, despite medication, exhibited moderate and even severe procedural pain behaviour, indicating that there is room for improvement regarding the approach of procedural pain. The ideal paediatric analgesic for procedural pain should be effective and have a quick onset, short duration of action, acceptable route of administration, and minimal side effects [127].

Regarding adults, currently used pharmacological interventions may need evaluation because patients reported a large variation in pain scores between 0 and 10, meaning that unfortunately, high pain levels did also occur. Although opioids are first choice in pain management in burns, they could be used more effectively [3, 101]. It has been suggested that opioids induce hyperalgesia and that hyperalgesia may be responsible for opioid tolerance. Opioid tolerance in burns is recognized as a feature of neuropathic pain [101]. Hyperalgesia involves sensitization of peripheral receptors. Besides, it involves increased excitability through effecting nociceptive changes at the dorsal horn, centred on the so-called NMDA receptors. Another disadvantage that is reported is that morphine could alter immune response to the injury in patients with burns [128]. Opioids could be used more effectively by combining them with gabapentin, pregabalin, ketamine or newer NSAID's like cycloocygenase-2 (COX-2) inhibitors. Gabapentin and pregabalin are anti-

convulsants that affect the nociceptive process involving central sensitization and may prevent central hyperalgesia induced by burns [5, 51]. Ketamine, besides reducing procedural pain, is considered to block nociceptive changes at NMDA receptors [63, 129]. NSAID's could block nociception or inflammation by suppressing the release of prostaglandins that start circulating in the body after tissue damage and that may cause oedema, more sensible nerve endings and local inflammation [3, 101].

4. Clinical implications

Nurses play a central role in pain management among all health-care professionals involved in burn care. They are entrusted with the measurement, registration, reporting, evaluation and treatment of pain [130-132]. The results of this thesis provide knowledge to improve pain management in nursing practice by implementation of structured pain measurement and by the use of evidence based non-pharmacological interventions.

Because pain behaviour fluctuates each day, daily measurement is recommended. Adequate pain evaluation in young children with burns is now achievable with the reliable and valid COMFORT-B pain behaviour observation scale and the corresponding cutpoints, which was the preferred scale by nurses (chapter 3, 4 and 5). The classification of COMFORT-B total scores into mild, moderate and severe pain behaviour using the cutpoints may help to evaluate changes in pain behaviour severity and, most importantly, adapt pain treatment. For adults, several self-report measures like the VAT and the GNRS are available, also with an accompanying cutpoint (chapter 6).

Structured pain measurement may need attention in nursing practice. It was stated that only 58% of the nurses documented the pain of children with burns [133] and that pain assessment was performed inadequately and inconsistently by many nurses [134]. One of the reasons may be a lack of reliance on the patients' self-report. It was suggested that less than one-half of the nurses understands that the patients' self-report of pain is the most reliable indicator of pain [135]. This was supported by an interim process indicator that we calculated in one of the Dutch burn centres during our pain study in adults [136]. Only 55% of the pain measurements that should have been carried out was registered, although we organized educational sessions, presented preliminary and final results, handed out flyers and used the ward newsletter. Nurses rely on what they interpret as pain behaviour, as for example physiologic indications, and on prejudices [135]. They may presume that their own interpretation of the patients' pain is correct, while numerous studies have shown that patients and nurses reports of pain did not correspond well [20, 21, 24, 28, 31, 37, 135].

Although the process indicator was based on data from only one burn centre, we decided to assess the state of knowledge and the nature of attitude towards pain management of nurses working in Dutch and Belgian burn centres, to explore the general state of knowledge and if the cause of

the moderate process indicator was due to a lack of knowledge or to a negative attitude. After analyzing the questionnaire [137] that was filled in by 131 burn care nurses, it seemed that nurses showed sufficient knowledge and a positive attitude toward pain measurement. We concluded that the moderate process indicator was rather a problem of behaviour than of knowledge and attitude [136]: the existing knowledge and the positive attitude were not sufficiently converted into structured pain measurement and/or registration.

The development of an educational program can be considered to attain successful implementation of pain measurement [135, 137]. Since nurses are already provided with the latest knowledge by educational sessions related to studies, flyers and newsletters, this training should above all focus on several areas that may change behaviour. By means of standardized documentation and repetitive training in pain management, nurses need clarification of the fact that the patients' self-report of pain is the single reliable indicator of pain and that no research has shown that for example the patients' behaviour, vital signs, or life-style are better indicators of pain than the patients' self-report. However, education and information only lead to short-term effects on behaviour, while multifaceted interventions lead to longer lasting effects on practice and outcomes [138]. Accordingly, the development of a pain management protocol is recommended in order to connect it to the patients' self-report. This implies that nurses can interact on a patient self-report score by using an algorithm and adapting pain medication independently. Nursing staff may respond positively to the introduction of the nursing-driven protocol for analgesia in burn patients [76, 139]. Naturally, within the framework of the multimodal approach, non-pharmacological interventions are incorporated in such a protocol or flowchart.

The best available evidence for non-pharmacological interventions was found for jaw relaxation [124], relaxation breathing [4], active hypnosis, rapid induction analgesia, distraction relaxation [122] and virtual reality [82, 87, 88]. They can be used in daily practice, on the condition that the interventions are standardized and that nurses are trained. With regard to the reviewed interventions with less evidence, adverse effects were not reported. They are low risk interventions that show promise in enhancing pain management. Adequate trained nurses can use many of these interventions in order to perform best practice, until additional research findings are available. Continuing critical evaluation of the efficacy of available non-pharmacological interventions is recommended.

5. Future research

Future research in the field of burn nursing should focus on pain measurement instrument testing for specific groups of patients admitted in the burn centre, especially for older children able to give self-reports, and for adults unable to provide self-reports. Furthermore additional research in relation to non-pharmacological interventions might be considered.

5.1 Pain measurement

Although reliable and valid pain measurement instruments are available for the largest groups of patients represented in the burn centres, there is a lack of appropriate instruments for some other groups, like older children capable to give self-reports and adults unable to provide self-reports. Adults unable to provide self-reports are artificially ventilated ICU patients and elderly patients suffering from delirium or dementia. Also, cutpoints for these missing measures (self-report measures for children and observational instruments for adults) could be helpful for daily practice.

5.1.1 Pain measurement instruments for older children

Self-report tools for children too old for behavioural observation (5-18 years) are not yet investigated for children with burns. Based on the best available clinimetric evidence from other populations, the faces pain scale revised (FPSR) (Table 1) and the VNRS are recommended for research into their ability to measure background and procedural pain. The FPSR is a self-report measure that consists of six cartoon-like faces that, from left to right, show increased pain intensity. The child has to choose the face that best reflected his level of pain intensity. A numeric value from 0 to 10 (0-2-4-6-8-10) is assigned to each face, but these numbers are not seen by the child. The anchor words of the scale are 'no pain' and 'very much pain' [140-142]. The 0-10 VNRS is also widely used to assess pediatric pain [143, 144]. Validity of the VNRS, when compared to the FPSR, was established when used with children and adolescents suffering postoperative pain [145]. Children preferred the faces scale above the VNRS [143]. Since there is no screening tool to establish which scale is most appropriate for specific age groups [146], it seems likely that more children in the 5-18 years group are able to use the FPSR and that the VNRS may be more difficult for younger children. To limit the number of scales for the different age groups, the FPSR should be the first choice scale for 5-18 year old children, and validity can be assessed by using the VNRS and VAT as gold standard.

5.1.2 Pain measurement instruments for adults unable to provide self-reports

Not all patients are capable of providing health-care professionals with self-reports of pain, for example ICU patients with burns that are artificially ventilated. For these patients, a pain behaviour observation tool should be used. The critical care pain observation tool (CPOT) evaluates four behavioural domains (facial expressions, movements, muscle tension, ventilator compliance). Each domain is scored 0 to 2 and the total score can range from 0 (no pain) to 8 (most pain). The CPOT was investigated for the use in ICU patients to measure background and procedural pain in patients without burns and showed promising clinimetric properties [147]. In patients with burns, the CPOT turned out to be internally consistent. However, the scale had poor inter-rater reliability [148]. Reliability and validity of the CPOT should be tested for ICU patients with burns in future research.

Pain behaviour observation may also be helpful among elderly patients with burns [100], since they represent a growing group. It has been considered that undertreated post-operative pain increased the incidence of delirium in the elderly [149]. Since delirium, but also dementia, regularly present in this group, may decrease the ability to provide self-reports, pain behaviour should be observed. There is a need to investigate instruments for use in this group. Several instruments, of which Dutch translations are available, are proposed: the Rotterdam elderly pain observation scale (REPOS) [150], the DOLOPLUS-2 [151] and the pain assessment checklist for seniors with severe dementia (Pacslac) [152].

5.2 Non-pharmacological interventions

There is little evidence on effects of non-pharmacological interventions for 0-4 years old children. Future pain research should focus on comfort-increasing interventions, such as attention and distraction techniques, in children exhibiting moderate and severe pain behaviour. With regard to parental presence, renewed research is needed to increase our understanding of this intervention. It should focus on what type of parent behaviour is helpful and what preparation is appropriate for parents to maximize helping their children during wound care. But also responses of parents like stress, child response per age group and staff response could be examined by using suitable research methods.

With regard to non-pharmacological interventions for adults, further research may not focus on the effects of the specific interventions but rather on remaining issues from our reviews. Remaining issues for future research for relaxation interventions are questions about the dose-response relationship (manner and duration of giving instruction and guidance), the number of sessions necessary to learn to use a technique, the duration of effects, and individual characteristics that influence responses to relaxation. Furthermore, research should focus on assessment of the importance of patient characteristics when selecting an intervention, to create the best match between characteristics and suitable interventions.

6. Conclusion

Pain remains a challenging health-care problem in the burn field. Managing this problem requires adequate pain measurement since this is of substantial importance to improve individualized outcomes, and requires a multimodal approach, including non-pharmacological interventions. The aim of this thesis was to contribute to adequate pain measurement by optimising standardisation of pain measurement, but also to improve daily practice by revealing best evidence for non-pharmacological nursing interventions. Conclusions derived from this thesis, with regard to pain measurement, are that the reliable and valid pain measurement instrument arsenal is enlarged with pain behavioural observation instruments for young children with burns and that pain measurement instruments are now accompanied with cutpoints. This implies that pain

measurement is currently feasible for a considerably larger group of patients with burns and that cutpoints can be used for developing flowcharts for treatment protocols. Conclusions with regard to non-pharmacological nursing interventions that can be used independently by nurses in daily burn care practice are that the best available evidence is revealed. The best available evidence is found for active hypnosis, rapid induction analgesia and distraction relaxation. Recently, evidence for jaw relaxation and relaxation breathing as individual interventions for adults was described and promising results for virtual reality are reported.

Finally, future research should focus on testing self-report pain measurement instruments for older children and on observational instruments for adults unable to provide self-reports, like artificially ventilated ICU patients and elderly patients suffering delirium or dementia. Also assessing cutpoints for these measures could be helpful for daily practice. Future pain research should also concentrate on non-pharmacological comfort-increasing interventions for 0-4 years old children exhibiting moderate and severe pain behaviour, in particular with regard to parental presence. With respect to non-pharmacological interventions for adults, investigation of patient characteristics in relation to selecting an intervention may help to find the best match between characteristics and suitable interventions.

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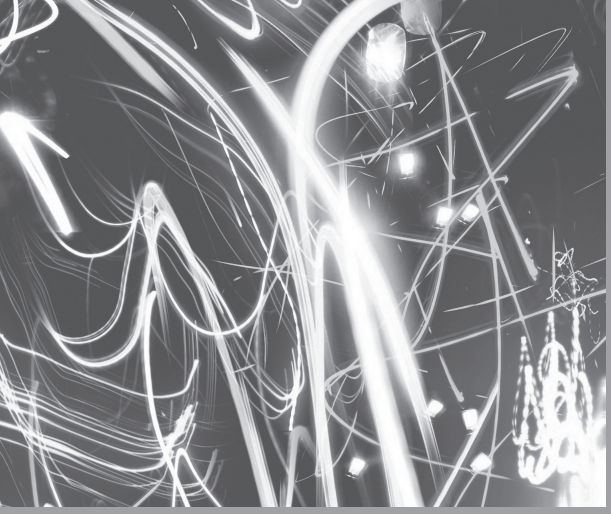

Addendum

Summary

1. Introduction

Management of burn pain is important for many reasons. Inadequate pain management decreases pain resistance, increases analgesic requirements, and triggers mechanisms that may lead to increased sensitivity to pain over time, with neuropathic pain as a result. Inadequate pain treatment may also delay wound healing, predicts suicidal ideation after discharge and increases the development of delirium in ICU patients. Besides, procedural anxiety predicts posttraumatic stress symptoms one year after the burn event. Furthermore, inadequate pain treatment for initial painful procedures in children conditions anxiety, heightens arousal and reduces the effectiveness of analgesia for subsequent procedures, and causes long-term changes in pain perception and related behaviours.

Efforts should be made to avoid these consequences as much as possible. An important step to adequate pain management is to evaluate the effect of any intervention on pain by definite pain measurement. Another step is to reveal the latest insights on pain management and make them accessible to daily practice. Especially, the best evidence on simple non-pharmacological interventions as adjunct pain interventions during wound care should be disclosed from the literature. In these two steps, burn care nurses, confronted with pain on a daily basis, play a central role. Within the multidisciplinary approach, they have an important task in pain management. They are responsible for the measurement, registration, reporting and evaluation of pain and for the treatment of pain by implementing non-pharmacological pain interventions. By means of this thesis, the above mentioned steps are taken. This thesis consists of two parts: one on pain measurement in children and adults, and the second on non-pharmacological interventions.

2. Pain measurement

Measurement instruments with good clinimetric properties for children are necessary to evaluate pain behaviour. Chapter 2 describes reliability and validity testing of pain scales for children unable to provide self-reports: the pain observation scale for young children (POCIS) and the nurse observational visual analogue scale (VAS obs), to measure procedural and background pain in burned children aged 0-4 years. The POCIS comprises seven behavioural items, of which the absence or presence of each item is scored 0 or 1. The VAS obs provides a rating of the observers' global impression of the patients' pain Burn care nurses (n = 73) rated pain from 24 fragments of videotaped children using the POCIS and the VAS obs. It appeared that, when two or more nurses used the VAS obs to simultaneously assess pain, ratings corresponded less well when compared to ratings obtained with structured behavioural observation by the POCIS.

Chapter 3 illustrates whether the pain observation scales POCIS, COMFORT behaviour scale (COMFORT-B), that comprises six behavioural items with five response categories for each item, and the VAS obs are reliable, valid and clinically useful instruments to measure pain in young

children with burns. Nurses (n = 102) rated pain of 154 children during hospitalization. Two trained nurses simultaneously assessed pain by using the previous mentioned measures. The study confirmed that structured behavioural observation by the POCIS and COMFORT-B yields more agreement between nurses than global ratings by VAS obs. Although both instruments are found reliable and valid and can thus be used in daily practice, nurses preferred to utilize the COMFORT-B above the POCIS.

Chapter 4 exhibits construct validity research of the POCIS and COMFORT-B by using Rasch analysis. In the Rasch model, data should meet the model expectations: the model assumes that an instrument measures one unidimensional construct. A total of 102 nurses observed 154 children which resulted in amply 1940 POCIS and COMFORT-B scores. The results provided support for construct validity.

In Chapter 5, cutpoints of the COMFORT-B, the levels at which the observed pain needs consideration for adapted treatment, were assessed. Nurses collected pain behaviour data in 168 children. Cutpoints of COMFORT-B scores were assessed as follows: 6-13 (mild pain), 14-20 (moderate pain) and 21-30 (severe pain). Adequate daily pain evaluation in young children with burns is now achievable with the reliable and valid COMFORT-B pain behaviour observation scale and the corresponding cutpoints. Cutpoints may help to evaluate changes in pain behaviour severity and, most importantly, adapt pain treatment. Also, the extent and course of pain in young children with burns and factors that may influence procedural pain were examined in a selection of 80 children with three or more pain behaviour observations. It turned out that mean background pain behaviour did not exceed the mild pain range and remained stable over time. Mean procedural pain behaviour scores did not exceed moderate pain behaviour and were also stable over time. With respect to the number of children, the majority (72%) exhibited mild background pain behaviour. Regarding procedural pain, the majority (66%) suffered from moderate procedural pain and severe pain was also observed (25%). Concerning the course of pain, fluctuations within and between children as well as between the mild, moderate and severe pain behaviour ranges were seen. Furthermore, the analgesic acetaminophen was identified as statistically significantly related to the course of pain: children receiving this analgesic at the referring hospital exhibited a higher decrease in pain scores over the first 8 days when compared to children not receiving acetaminophen. Also, a modern wound care product such as hydrofiber was statistically significantly related to the baseline pain scores and the course over time. Children treated with hydrofiber exhibited statistically significantly lower pain scores on the first postburn day, but exhibited an increase in pain behaviour over the following 8 days.

Chapter 6 describes the comparison between the self-report visual analogue thermometer (VAT) and the graphic numeric rating scale (GNRS) when used by adults with burns. The VAT is a frequently used instrument for self-reports of pain in patients with burns with good clinimetric

properties. The aluminium and plastic endurable tool, with on the left the anchor word 'no pain' and on the right extremity 'unbearable pain', has a red band that can slide from left to right, showing an increasing intensity of pain. On the back is a 10-cm ruler corresponding to the red band, where the numerical value associated with the by the patients' marked point can be read. The 0 to 10 GNRS is a brief, simple and easy to use tool for the assessment of pain expressed by the numbers 0 to 10 that are placed at equal distance on a line. To legitimate their interchangeable use in practice and reliable comparisons across studies, the aim was to compare self-reports obtained with both scales, to evaluate their ability to differentiate background from procedural pain, and to compare cutpoints of both scales. A total of 319 patients participated in the study and yielded 7142 VAT and 4639 GNRS assessments from postburn day 1 to 21. Cutpoints were determined by asking patients to classify their pain scores into the adjectives 'acceptable' or 'unacceptable'. Self-reports obtained with the VAT turned out to be statistically significantly lower than when obtained with the GNRS. However, both scales were comparable in their ability to differentiate background from procedural pain. They also seemed to share a similar cutpoint: patients indicated that a pain level of more than 2 on a 0-10 scale was unacceptable. The results suggested that these instruments cannot be used interchangeably without taking their differences into account.

3. Pain interventions

The state of art is that adequate management of burn pain should consist of early treatment starting at the referring hospital and of an individualized multimodal approach, i.e., using two or more drugs with different mechanisms of action, combined with non-pharmacological interventions. Nurses would be properly equipped to help their patients if they had research evidence about non-pharmacological interventions that are effective for patients with burns. There are various effective non-pharmacological interventions. Important considerations when selecting a non-pharmacological intervention for patients with burns are: simplicity, immediate usability and minimal expenditure of time and effort during use, since patients with burns are often too tired and ill to take the time and exert the discipline to learn complex techniques.

A specific non-pharmacological intervention for children is the presence of parents during wound care. In Chapter 5, in an effort to detect factors that may influence procedural pain, parental presence showed a tendency to reduce pain behaviour, but this was not statistically significant. Chapter 7 aimed to assess whether breathing exercises are effective in the management of procedural pain in adult patients with burns. In a literature review that included 11 studies, it was concluded that it was not possible to base decisions on research that specifically examined our patient group. However, based on the reviewed literature, slow rhythmic breathing in combination with jaw relaxation is a low risk intervention which shows promise in enhancing pain management.

A systematic review was undertaken in order to examine the implications of previous research for evidence based decisions concerning the use of non-pharmacological nursing interventions. Twenty-six studies met the inclusion criteria and were discussed. Although 17 studies showed that the intervention had a positive effect on pain outcomes and no adverse effects of the reviewed interventions were reported, the best available evidence was found for active hypnosis, rapid induction analgesia and distraction relaxation, as reported in Chapter 8. They can be used in daily practice, on the condition that the interventions are standardized and that nurses are adequately trained. Continuing critical evaluation of the efficacy of available non-pharmacological interventions is recommended.

4. Conclusion

Pain remains a challenging health-care problem in the burn field. Managing this problem requires adequate pain measurement since this is of substantial importance to improve individualized outcomes, and requires a multimodal approach, including non-pharmacological interventions. The aim of this thesis was to contribute to adequate pain measurement by optimizing standardization of pain measurement, but also to improve daily practice by revealing the best evidence for non-pharmacological nursing interventions. Conclusions derived from this thesis, with regard to pain measurement, are that the reliable and valid pain measurement instrument arsenal is enlarged with pain behavioural observation instruments for children with burns and that pain measurement instruments are now accompanied with cutpoints. This implies that pain measurement is currently feasible for a considerably larger group of patients with burns and that cutpoints can be used for developing flowcharts for treatment protocols. Conclusions with regard to non-pharmacological nursing interventions that can be used independently by nurses in daily burn care practice are that the best available evidence is revealed.

Summary in Dutch

1. Introductie

Inadequaat pijnmanagement bij brandwonden verlaagt de weerstand tegen pijn, verhoogt de behoefte aan medicatie en brengt mechanismen op gang die kunnen leiden tot verhoogde gevoeligheid voor pijn op de langere termijn en tot neuropathische pijn. Inadequate pijnbehandeling zou ook de wondgenezing kunnen vertragen, een voorspeller zijn voor suïcidale gedachten na ontslag en de kans op ontwikkeling van een delier bij intensive care patiënten verhogen. Bovendien voorspelt angst voor de wondverzorging posttraumatische stress symptomen een jaar na het ongeval. Daarnaast verhoogt onvoldoende pijnbehandeling bij de eerste wondverzorgingsprocedures van kinderen angst en prikkelbaarheid en is het effect van pijnmedicatie bij volgende procedures lager. Ook veroorzaakt het veranderingen in pijnperceptie en hieraan gerelateerd gedrag op de lange termijn.

Inadequaat pijnmanagement moet dus zoveel mogelijk voorkomen worden. Een belangrijke stap hierin is het evalueren van effecten van elke interventie op pijn door gestructureerde pijnmeting. Een andere stap is het aan het licht brengen van de laatste inzichten op het gebied van pijnmanagement, zodat ze geïmplementeerd kunnen worden in de dagelijkse praktijk. Vooral de studies met de beste 'evidence' voor eenvoudige, niet-farmacologische aanvullende pijninterventies tijdens de wondverzorging zouden getraceerd moeten worden. In bovenstaande twee stappen spelen, binnen de multidisciplinaire benadering, brandwondverpleegkundigen een belangrijke rol. Zij worden dagelijks met pijn geconfronteerd. Ze zijn verantwoordelijk voor het meten, registreren, rapporteren en evalueren van pijn en voor de behandeling van pijn door middel van implementatie van niet-farmacologische interventies. Met dit proefschrift is een begin gemaakt met het nemen van deze stappen. Dit proefschrift bestaat uit twee delen: het eerste deel betreft het meten van pijn, het tweede deel gaat over niet-farmacologische interventies.

2. Pijnmeting

Belangrijke criteria waaraan een meetinstrument moet voldoen zijn de klinimetrische eigenschappen betrouwbaarheid (het instrument geeft bij herhaalde metingen dezelfde waarden) en validiteit (het instrument meet wat het beoogt te meten). Meetinstrumenten met goede klinimetrische eigenschappen voor het vaststellen van pijn bij kinderen van 0 t/m met 4 jaar met brandwonden, die niet in staat zijn zelfrapportages van pijn te geven, zijn noodzakelijk om pijngedrag te kunnen evalueren. Hoofdstuk 2 beschrijft hoe de betrouwbaarheid en validiteit van de pijnobservatie schaal voor jonge kinderen (POKIS) en van de 0 tot 10 visueel analoge schaal (VAS obs) zijn onderzocht. De POKIS bestaat uit zeven gedragsitems, waarvan de aan- of afwezigheid van het item wordt beoordeeld met respectievelijk het cijfer 1 of 0. Met de VAS obs geeft de verpleegkundige een globale inschatting van de pijn van het kind. Brandwondverpleegkundigen (n = 73) bekeken 24 videofragmenten van jonge kinderen met brandwonden in rustige situaties of tijdens de wondverzorging en beoordeelden hun pijn met behulp van de POKIS en VAS obs.

Wanneer meerdere verpleegkundigen gelijktijdig de VAS obs gebruikten om pijn vast te stellen bij deze kinderen kwamen hun beoordelingen minder goed overeen dan wanneer zij waren verkregen door middel van gestructureerde observatie van pijngedrag met behulp van de POKIS.

Hoofdstuk 3 licht toe in welke mate de observatieschalen van pijngedrag, de POKIS, de COMFORT gedragsschaal (COMFORT-B), die bestaat uit zes gedragsitems met vijf antwoordcategorieën per item, en de VAS obs, betrouwbare, valide en klinisch bruikbare instrumenten zijn om pijn te meten bij jonge kinderen met brandwonden. Verpleegkundigen (n = 102) observeerden achtergrond en procedureel pijngedrag bij 154 kinderen gedurende hun opname in het brandwondencentrum. Twee verpleegkundigen stelden gelijktijdig pijn vast met de genoemde schalen. Deze studie bevestigt dat gestructureerde observatie van pijngedrag met POKIS en COMFORT-B meer overeenstemming oplevert tussen verpleegkundigen dan een eigen inschatting van pijn met de VAS obs. Hoewel de POKIS en COMFORT-B beide betrouwbaar en valide zijn bevonden en dus gebruikt kunnen worden in de dagelijkse praktijk, verkozen verpleegkundigen de COMFORT-B.

Hoofdstuk 4 presenteert onderzoek naar construct validiteit van de POKIS en COMFORT-B door middel van Rasch analyse. In deze analyse moeten de gegevens in een model passen dat veronderstelt dat een instrument één construct meet. In deze analyse wordt de nadruk gelegd op de items van de instrumenten in plaats van op de schaal als geheel. Verpleegkundigen (n = 102) observeerden 154 verschillende kinderen. Dit leverde ruim 1940 POKIS en COMFORT-B scores op. De resultaten van deze analyse onderbouwen construct validiteit voor de POKIS en COMFORT-B. In Hoofdstuk 5 komt het vaststellen van afkappunten van de COMFORT-B aan de orde. Dit zijn de niveaus waarop moet worden overwogen de geobserveerde pijn en de behandeling van deze pijn op elkaar af te stemmen. De totale COMFORT-B scores kunnen variëren van 6 tot 30. Afkappunten volgens de Rasch analyse zijn: 6-13 (milde pijn), 14-20 (matige pijn) en 21-30 (ernstige pijn). Samenvattend blijkt uit Hoofdstuk 3, 4 en 5 dat adequate dagelijkse evaluatie van pijn en daarmee het aanpassen van pijnbehandeling bij jonge kinderen nu mogelijk is met de betrouwbare en valide COMFORT-B en de bijbehorende afkappunten.

Daarnaast zijn in Hoofdstuk 5 de mate en het verloop van pijn bij jonge kinderen en factoren die pijn mogelijk beïnvloeden onderzocht bij een selectie van 80 kinderen waarbij minimaal 3 observaties van pijngedrag waren uitgevoerd. Het bleek dat de gemiddelde COMFORT-B scores van achtergrond pijngedrag het afkappunt voor milde pijn (13) niet overschreden en dat dit gemiddelde stabiel bleef gedurende de opnameperiode. Gemiddelde procedurele pijn scores waren niet hoger dan het afkappunt voor matige pijn (20) en bleven ook stabiel over de opnameperiode. Wat het aantal kinderen betreft vertoonde de meerderheid (72%) mild achtergrond pijngedrag. Een aanzienlijk aantal kinderen echter vertoonde matige procedurele pijn (66%), en zelfs ernstige pijn werd geobserveerd (25%). Bij het verloop van pijn werden fluctuaties per kind en tussen de kinderen, en tussen milde, matige en ernstige pijn gezien. Wat beïnvloedende factoren betreft

werd geconstateerd dat paracetamol statistisch significant gerelateerd was aan het verloop van pijn. Kinderen die deze pijnstiller kregen toegediend door het insturend ziekenhuis vertoonden meer afname van pijngedrag over de eerste acht dagen van opname als ze werden vergeleken met kinderen die geen paracetamol kregen toegediend door het insturend ziekenhuis. Ook een moderne wondbedekker als een hydrofiber was statistisch significant gerelateerd aan pijn aan het begin van opname en aan het verloop van pijn gedurende de opname. Kinderen die behandeld werden met hydrofiber vertoonden minder pijngedrag aan het begin van de opname maar leken meer pijn te hebben na een week.

Hoofdstuk 6 beschrijft de vergelijking tussen de visueel analoge thermometer (VAT) en de grafische numerieke schaal (GNRS) wanneer deze worden gebruikt als zelfrapportage schalen door volwassenen met brandwonden. De VAT is een veelgebruikt instrument met goede klinimetrische eigenschappen. De VAT is een aluminium instrument met op de uiteinden de ankerwoorden 'geen pijn' en 'ondraaglijke pijn'. Een rode strip in het midden van het instrument kan richting de ankerwoorden geschoven worden waarmee de pijnintensiteit wordt aangegeven. Aan de achterkant van de VAT kan vervolgens de bijbehorende numerieke waarde van 0 tot 10 met een decimaal achter de komma worden afgelezen door de verpleegkundige. De GNRS is een eenvoudig en gemakkelijk te gebruiken instrument waarbij pijn wordt uitgedrukt in een getal van 0 tot 10. De getallen zijn met onderling gelijke afstand op een lijn geplaatst en de patiënt omcirkeld het getal dat van toepassing is. Om hun uitwisselbaarheid te legitimeren in de praktijk en om studieresultaten van verschillend pijnonderzoek te kunnen vergelijken, werden zelfrapportages bekeken die waren verkregen met beide schalen. Ook werd hun vermogen tot onderscheiden van achtergrond en procedurele pijn onderzocht, evenals hun afkappunten. In totaal deden 319 patiënten mee met de studie en zij rapporteerden pijn 7142 keer met de VAT en 4639 keer met de GNRS in de eerste drie weken van opname. Afkappunten werden vastgesteld door patiënten te vragen hun pijnscore te classificeren in 'acceptabel' of 'onacceptabel'. Zelfrapportages verkregen met de VAT bleken statistisch significant lager te zijn dan wanneer ze werden verkregen met de GNRS. Beide schalen waren echter vergelijkbaar in hun vermogen onderscheid te maken tussen achtergrond en procedurele pijn. Ook deelden ze eenzelfde afkappunt: patiënten gaven aan dat een pijnscore van meer dan 2 op de 0 tot 10 schalen onacceptabel was. De resultaten suggereren dat de VAT en de GNRS niet door elkaar gebruikt kunnen worden zonder rekening te houden met de verschillen.

3. Pijninterventies

Het optimaal bestrijden van pijn bij patiënten met brandwonden bestaat uit het zo vroeg mogelijk starten met geïndividualiseerde pijnbehandeling, bij voorkeur al door het insturend ziekenhuis, en uit het toedienen van twee of meer soorten pijnstillers met verschillende werkingsmechanismen, gecombineerd met niet-farmacologische interventies. Verpleegkundigen

kunnen bijdragen aan pijnmanagement als zij beschikken over onderzoeksgegevens met betrekking tot de meest effectieve niet-farmacologische interventies die ingezet kunnen worden tijdens de wondverzorging. Er bestaan verschillende niet-farmacologische interventies. Belangrijke criteria voor het selecteren van een niet-farmacologische interventie zijn eenvoud en gebruiksgemak. Patiënten met brandwonden zijn namelijk vaak te moe en te ziek om de tijd te nemen en de discipline op te brengen om ingewikkelde interventies toe te passen.

Een specifieke niet-farmacologische interventie voor kinderen is de aanwezigheid van ouders tijdens de wondverzorging. In Hoofdstuk 5, in een poging factoren te vinden die procedurele pijn kunnen beïnvloeden, wordt beschreven dat de aanwezigheid van ouders een tendens laat zien van minder pijngedrag, maar dit was niet statistisch significant. In Hoofdstuk 7 is het doel een antwoord te vinden op de vraag of eenvoudige ontspanningsoefeningen effectief zijn als aanvullende interventie bij de behandeling van procedurele pijn bij volwassenen met brandwonden. De conclusie van een literatuurstudie waarin 11 artikelen werden beoordeeld, was dat het niet mogelijk is om een ontspanningsoefening als concentratie op de ademhaling in combinatie met kaakontspanning te implementeren in de praktijk op basis van onderzoeksgegevens. Er is geen onderzoek uitgevoerd ten aanzien van deze interventie dat is toegespitst op patiënten met brandwonden. Deze interventie is echter, volgens de literatuur, een interventie die weinig risico met zich meebrengt. Daarom is het een veelbelovende techniek bij de behandeling van pijn.

Een andere literatuurstudie werd uitgevoerd om te achterhalen wat de implicaties zijn van eerder uitgevoerd onderzoek voor 'evidence based' beslissingen met betrekking tot het gebruik van niet-farmacologische interventies, exclusief eenvoudige ontspanningsoefeningen, bij procedurele pijn bij volwassenen. In Hoofdstuk 8 worden 26 studies beoordeeld die aan de inclusiecriteria voldeden. Hoewel 17 studies lieten zien dat de onderzochte interventie een positief effect had op diverse uitkomstmaten van pijn en dat ze geen bijwerkingen bleken te hebben, is de beste 'evidence' gevonden voor drie interventies, namelijk hypnose, voor een snelle vorm van hypnose ('rapid induction analgesia') en voor een afleidings-ontspanningsinterventie in de vorm van een videofilm. Ze kunnen gebruikt worden in de dagelijkse praktijk, op voorwaarde dat ze zijn gestandaardiseerd en dat verpleegkundigen zijn getraind in het gebruik. Continue kritische evaluatie van de uitwerking van beschikbare niet-farmacologische interventies is aanbevolen.

4. Conclusie

Pijn is een hardnekkig probleem in de brandwondenzorg. De aanpak van dit zorgprobleem vereist adequate meting van pijn, omdat dit van substantieel belang is om individuele pijnbehandeling te verbeteren. Ook zou de farmacologische behandeling moeten worden aangevuld met niet-farmacologische interventies. Het doel van dit proefschrift is bij te dragen aan adequate pijnbehandeling door pijnmeting te standaardiseren, maar ook door de laatste inzichten op het

gebied van niet-farmacologische interventies aan het licht te brengen. Conclusies met betrekking tot pijnmeting zijn dat het betrouwbare en valide pijnmeetinstrumenten arsenaal is uitgebreid en dat instrumenten voorzien zijn van afkappunten. Dit betekent dat het meten van pijn nu mogelijk is voor een grotere groep van patiënten met brandwonden en dat afkappunten gebruikt kunnen worden voor het ontwikkelen van stroomdiagrammen voor behandelprotocollen. Conclusies met betrekking tot niet-farmacologische interventies zijn dat hypnose, een snelle vorm van hypnose ('rapid induction analgesia') en een afleidings-ontspanningsinterventie geïmplementeerd kunnen worden in de verpleegkundige praktijk en zelfstandig door verpleegkundigen kunnen worden uitgevoerd.

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Marieke Schuurmans is ook professor, maar van een andere universiteit en daarom heeft ze een andere toga dan Esther. Hoewel ze niet op het brandwondencentrum werkt zijn haar vakgebied en dat van mij hetzelfde en dat was handig om het boekje vanuit de verpleegkunde te schrijven. Dat leek me belangrijk voor de wetenschappelijke kaart van de beroepsgroep. Toen Marieke professor werd was ik er ook bij en ook toen voelde ik mij trots. Ze noemde in haar presentatie

om professor te worden dat zij een promovendus had, iemand die een proefschrift schrijft, buiten haar eigen universiteit, en dat die in het brandwondencentrum van Beverwijk werkte. Dat was ik dus. Bij Marieke kwam ik weer uit waar veel begonnen was: in Utrecht, waar ik had geleerd hoe verpleegkundigen onderzoek moeten doen. Marieke is enthousiast en praktisch ingesteld en dat was heel waardevol in de eindsprint naar het afronden van dit boek.

Nancy van Loey is mijn supervisor. Ze zorgt ervoor dat alles geregeld wordt, van voor tot na het onderzoek. Eerst zorgt ze ervoor dat we geld krijgen om onderzoek uit te voeren en bedenkt ze hoe het onderzoek moet lopen. Ze doet ook nog heel veel onderzoek door elkaar en haalt niets door de war. Door Nancy hebben alle onderzoeken ook nog met elkaar te maken. Op een hoofdstuk na heeft ze me geholpen met alle hoofdstukken waaruit dit boek bestaat. Ik ken niemand die zo snel op email reageert als Nancy, ook in het weekend en 's avonds laat en door dat intensieve, snelle en efficiënte samenwerken kon ik goed doorwerken. Nancy is iemand die én goed is in taal én goed in wiskunde en die met veel geduld statistiek (het rekenwerk) kan uitleggen. Nancy brengt ook veel partijen die zich met onderzoek bezighouden samen. Daardoor hebben we regelmatig een reis naar België gemaakt. Onderweg bespraken we dan onze successen en teleurstellingen, die we uiteindelijk weer konden relativeren. Hopelijk kunnen we in de toekomst samen blijven werken aan nieuwe projecten.

Wim Tuinebreijer was vroeger chirurg en daarom weet hij goed hoe het eraan toegaat in een ziekenhuis, en ook op het brandwondencentrum. Dat is belangrijk als je onderzoek doet, het moet wel in verbinding met de praktijk blijven. Hij heeft zich verdiept in hoe je ingewikkelde dingen als pijn kunt meten en in alle berekeningen die daarvoor nodig zijn. Wim was meteen bereid te helpen met het analyseren van gegevens toen ik hem dat vroeg. Wim heeft veel geduld gehad want het duurde best lang voordat ik alle berekeningen begreep. Ook vond hij heel snel de juiste literatuur wanneer ik die nodig had. Met zijn hulp is het gelukt om een paar hoofdstukken in belangrijke tijdschriften gepubliceerd te krijgen.

Verplegingswetenschapper en mijn collega-onderzoeker voor lange tijd uit Groningen is Marco Bremer. Met Marco kun je goed sparren over het onderwerp van dit boekje, pijn, en vooral over hoe je dat kunt meten. Hij kent daarover ook alle literatuur. Marco bouwt enorme bestanden waarin we alle gegevens kwijt kunnen en bedenkt de moeilijkste formules om deze gegevens te analyseren. Voordat we ons bezig hielden met verplegingswetenschappen kenden we elkaar al van de WCS en van de beroepsgroep voor brandwondverpleegkundigen, die Marco heeft opgericht.

Voordat ik al dat onderzoek deed, maar na het afronden van mijn studie, heeft Jolan Leeman zich, samen met Esther, ingespannen voor het opzetten van de functie verpleegkundig onderzoeker voor het brandwondencentrum. Dat is best bijzonder want de wetenschap hoort meestal bij academische ziekenhuizen. Zonder die functie had ik dit boek niet kunnen schrijven. Samen met

Esther hadden we regelmatig overleg om te checken of ons onderzoek goed liep en of het goed paste bij het werk van verpleegkundigen.

Voordat ik onderzoek deed heb ik dus gestudeerd. Eerst moest ik een toelatingsgesprek hebben met Francis Mensink. Zij had de leiding over de studie Master of science in nursing en heeft me toegelaten tot die studie, waarna er een wereld voor mij openging. Ik had nooit geweten dat de verpleegkunde zo'n groot gebied was en dat er binnen dat gebied al zoveel onderzoek was gedaan. Van Francis heb ik geleerd dat 'empowerment' (elkaar overtuigen dat er veel mogelijk is en elkaar aanmoedigen om iets te bereiken) een vaste plek zou moeten hebben in de verpleegkundige praktijkvoering. Zowel Francis als Claudia Gamel hebben een 'switch' in mijn denken tot stand gebracht. Dat is knap als je dat kunt. Claudia was een van mijn docenten die mij begeleidde in de laatste fase van de studie. Ze heeft mij voorgedragen om lid te worden van de Nursing Honor Society (een internationale club van verpleegkundigen die iets te zeggen hebben) en heeft mij aangemoedigd na de studie een artikel te schrijven. Aan dat artikel heeft Claudia een grote bijdrage geleverd. We hebben er een prijs mee gewonnen. Dat was het startpunt van mijn carrière als onderzoeker.

Wat geholpen heeft bij de toelating tot de studie was dat ik een artikel had meegenomen dat ik voor WCS Nieuws had geschreven. Ze vonden het belangrijk dat je wat schrijfervaring had. Het was een idee van René Baljon om een serie 'Brandwonden over de grenzen te schrijven'. Rene is de voorzitter van WCS Kenniscentrum Wondzorg. Hij vroeg of ik de serie wilde schrijven, terwijl ik helemaal geen schrijfervaring had, maar ik heb het toch maar geprobeerd.

Er zijn ook veel collega-verpleegkundigen van de brandwondencentra die hebben geholpen met dit boek. Zij verzamelden gegevens door het meten van pijn en/of zorgden dat de gegevens in het bestand van Marco kwamen te staan. Daarvan ken ik Helma Hofland al heel lang, maar Anita Boekelaar ken ik het langst van iedereen: als sinds de opleiding voor verpleegkundige. De Beverwijkse brandwondverpleegkundigen gedogen dat ik een kantoorbaan heb maar ze moeten weten dat ik de praktijk best mis en me toch teamlid voel. In Rotterdam staat Rob van Komen vooraan om de onderzoeksresultaten uit dit boek in de praktijk te gebruiken. Ook alle co-auteurs hebben mij geholpen, en Tako Bos. Roel Paauw, Anne Bakker en Ed Visser wierpen nog een laatste blik op de teksten. Meneer Tomy Schmitt moet ik bedanken voor de inspanning mij als leerling op het brandwondencentrum te laten werken, waar het allemaal begonnen is.

Ellen, Marike, Sonja, jullie kennen ze maar al te goed, en weten hoe blij ik met ze ben. Wij weten elkaar goed te vinden, om te 'vieren', en om door 'druistige' tijden te manoeuvreren. Ik heb bewondering voor de manier waarop mijn 'meisjes' hun eigen weg gaan.

Dan is er nog pappa. Jeans steun houdt nooit op en hij heeft er altijd het volste vertrouwen in dat iets goed afloopt. Volgens hem is de vraag nooit 'of', maar 'wanneer', en eigenlijk zijn er helemaal geen vragen, alleen antwoorden. Ik denk wel dat hij het allemaal best lang vond duren en van de werkprocessen begreep hij niet zo veel. Maar zijn niet-zichtbare bijdrage is groot. Van een partner van een promovendus wordt veel flexibiliteit verwacht en het is fijn dat ik de tijd en ruimte kon nemen om de dingen te doen die ik wilde. Bovendien lijkt door pappa's brede schouders tegenslag helemaal niet te bestaan en benadrukt hij keer op keer dat er meer is dan werk alleen. Daar wil ik in de toekomst samen nog lang van genieten.

Nou, zo is het gegaan, het schrijven van dit proefschrift, en nu kennen jullie de mensen die mij hebben geholpen en die ik wil bedanken. Eva en Aimée, mijn lieve mooie dochters, wat heb ik het met jullie getroffen. Jullie hebben ook meegewerkt aan dit boek. Gewoon door er te zijn. En nu gaan we dansen.

Curriculum vitae

Alette de Jong was born in Krommenie, the Netherlands on the 14th of December 1962. After finishing secondary school at Bertrand Russell College in Krommenie in 1980, and after working as an au pair for one year in Geneva, Switzerland, she started studying nursing at the in-service education of the Red Cross Hospital at Beverwijk, the Netherlands in 1981. During this training, the mysteriously appealing but for nursing students inaccessible burn centre aroused her interest. After negotiating with the manager in chief of the nursing school, she started working at the burn centre in 1984 as a fourth year student and has not left since. Following her graduation in 1985 as a registered nurse, she achieved burn care and intensive care specialization diplomas. Since 2001, she has been working as a nurse researcher, after obtaining a master of science in nursing degree from the University of Wales in Cardiff. She was awarded for a publication based on her dissertation in 2003 and won a prize for best paper at the congress of the European Burns Association in 2005. Under the authority of the Red Cross Hospital and the Association of Dutch Burn Centres, she initiates and coordinates research in the field of burn nursing in order to improve the quality of nursing care. Her research topics are mainly focused on pain management, in particular measurement instrument testing and pain treatment. Alette de Jong is chair of the Nursing Committee of the International Society for Burn Injuries. She is a board member and the editor in chief of the Dutch knowledge translation centre for wound care WCS. She is vice-chair of the Nursing Advisory Board of the Red Cross Hospital and is a member of the Nursing Honor Society Sigma Theta Tau International.

Alette de Jong is geboren op 14 december 1962 te Krommenie. Na het behalen van haar HAVO diploma op het Bertrand Russell College te Krommenie in 1980, en na een jaar als au pair gewerkt te hebben in Genève in Zwitserland, begon zij in 1981 met de in-service opleiding voor A-verpleegkundige in het Rode Kruis Ziekenhuis te Beverwijk. Tijdens deze opleiding ontstond de wens om op het brandwondencentrum te werken, een afdeling met een bepaalde, niet te specificeren aantrekkingskracht, waar leerling-verpleegkundigen niet werden toegelaten. Na aandringen bij het hoofd Opleiding mocht zij in 1984 als vierdejaars leerling op het brandwondencentrum werken en is daar sindsdien gebleven. Na haar diplomering als A-verpleegkundige specialiseerde zij zich verder als brandwond- en IC-verpleegkundige. Sinds 2001 werkt zij als verpleegkundig onderzoeker op het brandwondencentrum, na het afronden van haar studie Verplegingswetenschappen aan de Universiteit van Wales in Cardiff. Ze heeft in 2003 een prijs gewonnen voor een publicatie gebaseerd op haar afstudeeronderzoek en won een prijs voor de beste presentatie op het congres van de European Burns Association in 2005. Voor het Rode Kruis Ziekenhuis en de Vereniging Samenwerkende Brandwondencentra Nederland initieert en coördineert zij onderzoek op het gebied van de brandwondverpleegkunde om de kwaliteit van de verpleegkundige zorg te verhogen. Haar onderzoeksonderwerpen richten zich vooral op pijnmanagement, in het bijzonder op pijnmeting en pijnbehandeling. Alette de Jong is voorzitter van de Nursing Committee van de International Society for Burn Injuries. Ze is bestuurslid en hoofdredacteur van WCS Kenniscentrum Wondzorg. Daarnaast is ze vicevoorzitter van de Verpleegkundige Advies Raad van het Rode Kruis Ziekenhuis en is toegelaten tot de Nursing Honor Society Sigma Theta Tau International.

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