

*Digital Comprehensive Summaries of Uppsala Dissertations  
from the Faculty of Medicine 2026*

# Nutritional therapy post-burn injury

*Adherence to guidelines and an analysis of nutritional  
interventions and barriers*

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ACTA UNIVERSITATIS  
UPSALIENSIS  
2026



UPPSALA  
UNIVERSITET

Dissertation presented at Uppsala University to be publicly examined in H:son Holmdahlsalen, Uppsala University hospital, entrance 100, 2nd floor, Dag Hammarskjölds väg 8, Uppsala, Friday, 6 March 2026 at 09:15 for the degree of Doctor of Philosophy (Faculty of Medicine). The examination will be conducted in English. Faculty examiner: Associate professor Ingvild Paur (UiT The Arctic University of Norway).

### **Abstract**

Dimander, J. 2026. Nutritional therapy post-burn injury. Adherence to guidelines and an analysis of nutritional interventions and barriers. *Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Medicine* 2226. 82 pp. Uppsala: Acta Universitatis Upsaliensis. ISBN 978-91-513-2717-4.

**Objective:** Insufficient nutritional intake can impair wound healing and increase the risk of complications post burn. The overall aim of this thesis was to examine nutritional therapy post burn in relation to the extent of the burn. This was accomplished by examining adherence to nutritional guidelines (Study I), documented interventions and barriers (Study II), and symptoms affecting appetite and eating post injury (Study III-IV).

**Methods:** Study I evaluated documented nutritional therapy in relation to guidelines during first 12 days post burn by conducting medical record review. Study II explored differences in documentation of nutritional interventions and barriers between patients post-minor and major burn by performing medical record review and content analysis. Study III modified questionnaires Disease Related Appetite Questionnaire (DRAQ) and Eating Symptom Questionnaire (ESQ) to measure nutrition impact symptoms (NIS) 6-12 months post burn by undertaken expert panel review, cognitive interviews and expert consultation on terminology. Study IV investigated the differences in prevalence of NIS using questionnaires DRAQ-burn and ESQ-burn.

**Results:** Study I found low adherence to nutritional guidelines and low adequacy of intake compared to individual goals, particularly after minor burns. Study II showed that interventions targeting meal and meal support were rarely documented compared to medical nutritional therapy, despite most patients having oral intake. Barriers to nutritional therapy were common with fasting and gastrointestinal symptoms being the most frequently documented. Significantly more interventions and barriers were documented for patients post-major burn compared to post-minor burn. In Study III high expert consensus on the adapted questionnaires DRAQ-burn and ESQ-burn was achieved. Study IV revealed prevalences of median 1-2 NIS at 6 months that persisted up to 12 months post injury. There was no difference in the prevalence of NIS post-minor compared to post-major burn.

**Conclusions:** The overall low adherence to nutritional guidelines, inadequate achievement of individual intake goals, the frequent documentation of barriers to nutritional interventions, and the persistent prevalence of nutrition impact symptoms indicate a risk of insufficient nutritional therapy following burn. The findings highlight the need for continuous nutritional assessment, evaluation and monitoring of nutritional therapy throughout the burn care trajectory regardless of burn extent.

*Keywords:* Burn, Nutrition, Nutritional therapy, Intervention, Barrier, Nutrition impact symptom, guideline

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ISSN 1651-6206

ISBN 978-91-513-2717-4

URN urn:nbn:se:uu:diva-576103 (<http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-576103>)

“It turns out that an eerie type of chaos can lurk just behind a facade of order - and yet, deep inside the chaos lurks an even eerier type of order.”

Douglas R. Hofstadter

*Cover illustration, Figure 1a and Figure 1b was adapted by Josefin Dimander from an AI-generated illustration created using Microsoft Copilot (GPT-5).*

*To my family*



# List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

- I. Dimander J, Andersson A, Lindqvist C, Miculescu A, Huss F. Documented nutritional therapy in relation to nutritional guidelines post burn injury - a retrospective observational study. *Clin Nutr ESPEN*. 2023;56:222-229.
- II. Dimander J, Andersson A, Huss F, Lindqvist C. Nutritional interventions and barriers for patients early after burn injury: A retrospective evaluation of medical records. *Clin Nutr Open Sci*. 2025;62:218-232.
- III. Dimander J, Andersson A, Miculescu A, Huss F. Two Modified Questionnaires for the Assessment of Nutrition Impact Symptoms in the Rehabilitation Phase after Burn Injury: A Content Validation Study. *Eur Burn J*. 2022 Feb18;3(1):156-164.
- IV. Dimander J, Andersson A, Lindqvist C, Huss F. Nutrition impact symptoms 6-12 months post-burn injury – a single-cohort longitudinal study. (manuscript submitted to *Burns*)

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# Abbreviations

|           |  |
|-----------|--|
| ASPEN     | American Society for Parenteral and Enteral Nutrition      |
| BIA       | Bioelectrical Impedance Analysis                           |
| BMI       | Body Mass Index  |
| CT        | Computed Tomography  |
| DXA       | Dual-energy X-ray Absorptiometry                           |
| DRAQ      | Disease Related Appetite Questionnaire                     |
| DRAQ-burn | Disease Related Appetite Questionnaire burn, revised       |
| EBA       | European Burn Association                                  |
| EN        | Enteral Nutrition  |
| ESPEN     | The European Society for Clinical Nutrition and Metabolism |
| ESQ       | Eating Symptom Questionnaire                               |
| ESQ-burn  | Eating Symptom Questionnaire burn, revised                 |
| GLIM      | Global Leadership Initiative on Malnutrition               |
| I-CVI     | Item Content Validity Index                                |
| NIS       | Nutrition Impact Symptoms                                  |
| NCP       | Nutrition Care Process                                     |
| eNCPT     | electronic Nutrition Care Process Terminology              |
| ONS       | Oral Nutrition Supplements                                 |
| S-CVI/Ave | Scale Content Validity Index Average                       |
| SCCM      | Society for Critical Care Medicine                         |
| TBSA      | Total Body Surface Area                                    |
| PN        | Parenteral Nutrition                                       |



# 1 Preface

I met my first patient with a major burn injury over 20 years ago during my first year working as a clinical dietitian. I have seldom felt so unprepared. Ten years later, when I had the opportunity to begin working at the Burn Centre within the role of my employment at Uppsala University Hospital, I was hesitant. My first encounter was marked by a mix of emotions, curiosity and uncertainty about the forthcoming challenges in nutritional therapy but also a deep admiration and respect for the burn care team's exceptional competence and dedication to their work. I wanted to know more. When I delved into nutritional therapy post burn, new guidelines on the management of nutrition post-major burn had just been published and it was obvious how important nutritional therapy was for the outcome. I was, however, surprised about the lack of data or guidelines on nutritional therapy for patients post-minor burn. Our experience was that these patients also seemed to have nutritional problems for an extended period of time after injury. We therefore conducted a small development project where patients post-minor burn, who would not otherwise have met a dietitian, underwent a nutritional assessment by a dietitian. The results showed that many of the patients had a nutritional diagnosis. We concluded that more research was needed. Together with and supported by the head of research at the Burn Centre, Associate Professor Fredrik Huss, an idea for a PhD project started to grow. What a journey that idea became. I have had the privilege of working clinically as a dietitian alongside my doctoral studies. This thesis highlights the importance of nutritional therapy including appropriate nutritional monitoring and evaluation regardless of burn extent. Hopefully, the contents of this thesis will be valuable also to healthcare professionals in their clinical practices and beneficial for patients post burn.



## 2 Introduction

In this thesis several aspects of nutritional therapy after burns are examined in relation to extent of the burn. This work acknowledges the gap between nutritional therapy in relation to nutritional guidelines and identifies nutritional interventions and barriers related thereto for patients early after a burn injury. It also highlights symptoms that can negatively affect appetite and intake 6-12 months post trauma, warranting particular attention during follow-up assessments regardless of the extent of the burn. Since patients with minor burn injuries are the largest patient group in burn care (1–3) and have been relatively unexplored when it comes to nutritional therapy, all study data in this thesis were divided into two groups in the analyses, minor burns (total body surface area, TBSA < 20%) and major burns (TBSA  $\geq$  20%). The studies presented in this thesis fall within the discipline of clinical nutrition and have contributed to the body of research on nutritional therapy following burn injury, with particular emphasis on also including patients post-minor burns.

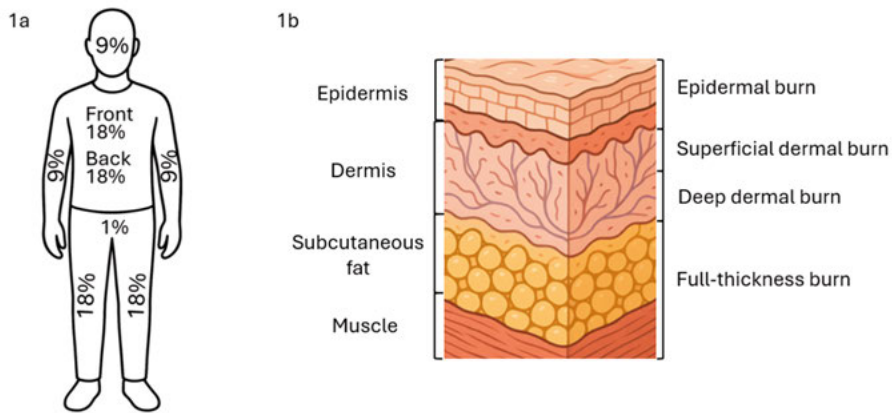
### 2.1 Burn care

Burns are injuries to the skin or other tissues (4,5). They occur when tissue cells are destroyed by hot liquids, solids, or flames. Burns may also result from radiation, electricity, friction, chemicals or radioactivity (4,5). Most burns occur unexpectedly and unintentionally, typically in domestic or occupational settings (6,7). A small proportion, however, results from intentional acts, either self-inflicted (such as self-harm or suicide attempts) or inflicted by another person through assault (8).

Every year about 13 million patients worldwide seek medical attention due to a burn; the majority are treated in outpatient clinics (3,9). In Europe, the annual incidence of severe burn injuries is estimated to be 0.2 to 2.9/10 000 inhabitants (10). In Sweden, the number of patients hospitalised for burns is comparatively low relative to several other European countries, with an annual incidence of approximately 1 400 cases (2,11,12). When adjusted for population size, this equates to about 1.6 patients per 10 000 inhabitants per year in Sweden (2).

### 2.1.1 Extent and depth of the burn

A burn is a complex trauma often needing interprofessional specialist therapy. The degree of impact on the patient is proportional to the extent and depth of the burn and subsequent complications. The burn extent is often estimated using Wallace's rule of nines (13), dividing the body into sections roughly representing 9% of the total body surface area (TBSA), e.g., each arm representing 9%, (Figure 1a). For smaller burns, the rule of palm has been practised, using the patient's hand, (palm and fingers) which approximates to 1% TBSA (14). In specialised care the Lund-Browder chart is often used where the clinician outlines the burn areas on a body chart, estimates the percentage affected based on age-specific references and calculates the TBSA accordingly (15).



**Figure 1.** Figure 1a. Wallace's rule of nines for the assessment of burn extent, figure adapted from Wallace 1951 (13). Figure 1b. The skin's layers and the various burn depths.

The depth of the burn will affect the treatment and outcome. Burn depth is characterised and named, depending on how much of the skin's layers are damaged, Figure 1b. Thus, a superficial burn only affects the epidermis. If the burn extends into the dermis, but only affects the more superficial papillary dermis, it is called a superficial dermal burn. When also the deeper reticular dermis is involved, it is a deep dermal burn. When the whole of epidermis and dermis is damaged and the burn extends into the subcutaneous tissue or even muscles and bones it is characterised as a full-thickness burn. Superficial and superficial dermal burns have the potential to heal without scarring within 14 days by conservative wound care (cleaning and protecting the wound as well as addressing potential complications). Deep dermal and full-thickness burns typically requires surgical intervention for healing. The treatment includes (surgical) removal of necrotic tissue and eventually reconstitution of the skin

by e.g. autologous split-thickness skin grafts – a procedure involving transplanting healthy skin from a donor site to the burn wound of the patient. Patients with more severe burn injuries may need intensive care treatment, multiple surgeries with skin grafts to cover larger wounds, months of treatment including multiple dressing changes and sometimes years of follow-up care (16,17). One hospital day per 1% TBSA is often used as a general estimate or planning tool for length of stay post burn, but since it does not take inhalation injury, comorbidities or depth of the burn into account it is a less accurate estimate for some patients (18).

### 2.1.2 Burn centres

Patients with severe burn injuries need specialist competence and are therefore referred to burn centres, which are organised for the total care of the patient. In Sweden, severe burns are defined by extent, depth, age-specific thresholds, and critical factors such as localisation, circumferential involvement, associated trauma, inhalation injury and complicating conditions. For detailed criteria and numerical thresholds see Table 1 (19). There is no international clear consensus on how to define minor, major or severe burns. The criteria for referral to a burn centre are similar globally (4,20–24). In this thesis only patients referred to our specialised burn centre are represented, which thus characterises them as severe (20). The terms minor and major burn in this thesis are defined as TBSA < 20% for minor burns and TBSA ≥ 20% for major burns. This cut-off was chosen with regards to nutritional guidelines post burn (25).

**Table 1.** Referral criteria to Swedish burn centres (19)

| <b>Criteria</b>                  | <b>Referral criteria</b>   |
|----------------------------------|--|
| <b>Extent of the burn (TBSA)</b> | > 20% (16-65 years old)<br>> 10% (> 65 or < 16 years old)<br>> 5% (< 3 years old)  |
| <b>Depth of the burn</b>         | All deep dermal or full thickness burns  |
| <b>Site of the burn</b>          | Any significant burn with critical localisation (head, face, hands, feet, genitalia, perineum and major joints)<br>Circumferential burns |
| <b>Mechanism of the burn</b>     | Serious electrical/chemical burns  |
| <b>Other factors</b>             | Burns together with other trauma/inhalation injury/complicating conditions/special needs   |

**Abbreviations:** Total Body Surface Area (TBSA)

In Sweden there are two burn centres with national responsibility of competence. At the burn centres an interprofessional approach to burn care management is essential. The burn team includes the patient and their family, assistant nurses, dietitians, nurses, occupational therapists, physicians (plastic surgeons, intensive care physicians), physiotherapists, psychologists, social workers, speech therapists, other specialised consults and more (21). Best practice guidelines states that all members of the team should actively participate in patient care during all phases of care with meetings on a regular basis to assess patients' needs, to plan, monitor and evaluate treatment interventions and to provide ongoing education and support to patients, families and staff (21). Depending on the extent and depth of the burn and subsequent complications the patients need different levels of care during treatment; intensive care (two or more organ systems in need of support and/or mechanical ventilation), high dependency care (single organ support e.g., inotropes or invasive blood pressure monitoring), ward-based care (without organ support) and outpatient care. Usually, the patients' required level of care shifts over time, both up and down. Patients with a burn greater than 15%-20% TBSA will require an early and appropriate fluid resuscitation to replace the intravascular volume lost to the subcutaneous tissues and to prevent hypovolemic shock (26).

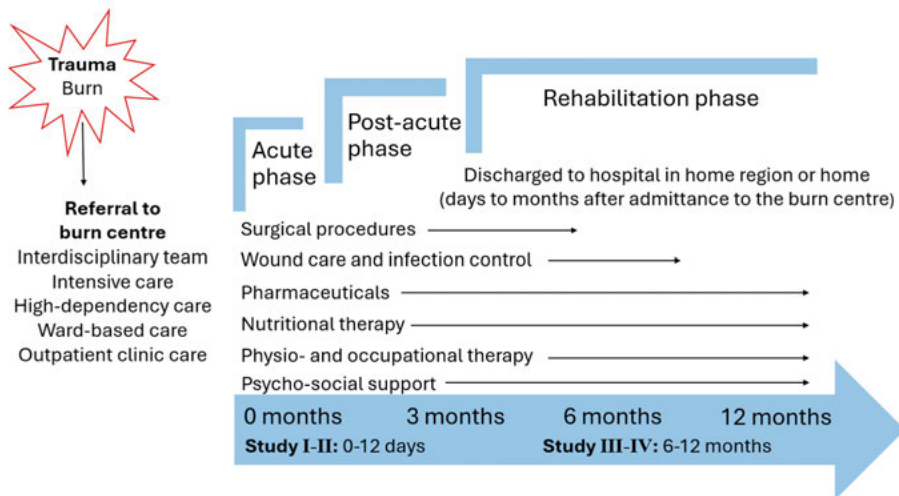
The European Burns Association, EBA recommends that a dietitian is involved with the patient daily regarding nutritional therapy (20). Involvement of a dietitian have been identified as a key concept in improving the quality of nutritional therapy in critical care (27–30). Of the 30 burn centres in Europe verified by the EBA, only eighteen have a dietitian on site and in most cases not daily. The dietitians typically divide their time between post-burn nutritional therapy and nutritional care for other medical conditions (personal communication).

### 2.1.1 Burn-induced stress response

The nutritional therapy has a critically important role in burn care management. Severe burn injuries can induce significant metabolic, endocrinological and immunological changes that drive systemic inflammation and trigger a hypermetabolic response, which may persist for several years post injury (17,31,32). The hypermetabolic response is, as in other critically ill patients, characterised by increased gluconeogenesis, increased insulin resistance, increased endogenous lipolysis, muscle wasting and loss of body weight (17,31,32). However, after major-burn injuries (TBSA  $\geq$  20%), the hypermetabolic response is more intense and lasts for a longer period compared to other critically ill patients (33). The hypermetabolic response can remain for months to years after a burn (31). Complications, for example, hypothermia,

fluid retention, infection, as well as a need for surgery, further increase the metabolic need.

Post-burn care can be divided into different phases of critical illness (34), Figure 2. Immediately after the burn, during the *Acute phase* about 1-3 days post injury, the metabolism and tissue perfusion decrease and the metabolic tolerance is limited by the severe inflammation. This results in a risk of refeeding syndrome when nutrition is reintroduced, a life-threatening condition in which the electrolytes shift from the extracellular to the intracellular compartment and risk overfeeding (35,36). The *Post-acute phase* is characterised by a hyperdynamic circulation with hypermetabolism (resting energy expenditure 10%-100% above baseline) resulting in a high risk of underfeeding (37,38). This phase starts approximately from day four post injury and persist during weeks to months post burn (34,37,38). During the *Rehabilitation phase* (convalescence phase), which can last for months to years after a burn, the metabolism slowly normalises. The normalised substrate tolerance may facilitate a metabolic shift to anabolism. However, a chronic hypermetabolism can be driven by recurrent complications (e.g., infections and sepsis) causing continued catabolism (37,38).



**Figure 2.** Timeline for patients' journeys post burn and for data collection in this thesis.

## 2.2 Nutritional therapy post burn

An adequate intake of macronutrients and micronutrients, as well as metabolic modulation and glycaemic control, is important to optimise wound healing, prevent muscle wasting, improve immune function and decrease the risk of

infection and other complications after a burn (25,39,40). Energy and protein requirements increase due to hypermetabolic and catabolic responses, especially in more severe burns (41). Earlier studies show resting energy expenditure to be elevated also post-minor burns, with reported risk of inadequate nutritional intake after both minor- and major-burn injuries (42–44). Therefore, adequate nutritional therapy is essential for survival, wound healing, lowering complication rates (e.g., sepsis and infections), to preserve lean body mass and for quality-of-life post burn (45–49). Overfeeding is also a risk considering its association with hyperglycaemia, carbon dioxide retention, fatty infiltration of organs and azotaemia (impaired kidney function causing elevated level of nitrogen-containing compounds in the blood, e.g., urea and creatinine) post burn (17).

### 2.2.1 Nutritional assessment and malnutrition

A thorough initial assessment and thereafter repeated assessments during hospitalisation of nutritional status including a general clinical assessment (e.g., pre-existing nutritional deficiencies, reports of unintentional weight loss, physical examination and general assessment of body composition) are recommended by the European Society for Clinical Nutrition and Metabolism (ESPEN) post trauma (36,47). There is no consensus on how to assess the risk for malnutrition in the intensive care setting but the use of the Nutritional Risk Screening (NRS2002) and the Nutrition Risk in Critically ill score (NUTRIC) has been proposed by the American Society for Parenteral and Enteral Nutrition and the Society for Critical Care Medicine (ASPEN/SCCM) (50–52). The NUTRIC (52–55) incorporates age, illness severity, comorbidities and time from hospital admission to need of intensive care treatment. In more recent guidelines by ESPEN, a more pragmatic approach is recommended, all patients staying for more than 48 hours in intensive care should be considered to be at risk for malnutrition (36). Therefore, these patients should be evaluated for medical nutritional therapy, defined as patients having oral nutritional supplements, (ONS), enteral tube feeding (enteral nutrition, EN) and/or parenteral nutrition, (PN) (36,56). After identifying patients at risk of malnutrition, the criteria for assessment and severity grading of malnutrition developed by The Global Leadership Initiative on Malnutrition (GLIM) (57,58) are recommended for the diagnosis of malnutrition by the National Board of Health and Welfare in Sweden (59). For the diagnosis of malnutrition one phenotypic and one aetiological criterion must be fulfilled. There are three *phenotypic* criterions for the diagnosis of malnutrition: unintentional weight loss (> 5% within past six months or > 10% beyond six months), low BMI (BMI < 20 if < 70 years old or < 22 if ≥ 70 years old) and/or low muscle mass (assessed by a

validated body composition measuring techniques e.g., Bioelectrical Impedance Analysis, BIA, Computed Tomography, CT, Dual-energy X-ray Absorptiometry, DXA). There are two *aetiological* criteria for the diagnosis of malnutrition: reduced food intake or assimilation ( $\leq 50\%$  of estimated requirement  $>$  one week or any reduction for  $>$  two weeks or any chronic gastrointestinal condition adversely impacting food absorption or assimilation) and/or occurrence of acute/chronic disease/infection/injury usually associated with inflammatory activity (e.g., burn) (57,58). Malnutrition has been associated with significant longer length of hospitalisation per percentage TBSA (44) and adverse functional and clinical outcomes (57). Being malnourished on admission have been reported in 29%-78% of patients with burn injuries (TBSA  $<$  30%) (44,60,61) with the higher prevalences for patients  $>$  65 years old. The inflammation, hypermetabolism, decreased intake and increased muscle catabolism reported post burn are risk factors for developing malnutrition or worsen already malnourished state post burn (44,57). In a population of severely injured patients in need of intensive care treatment 12% were malnourished on admission, 50% developed malnutrition during intensive care treatment which increased to 70% when taking the entire hospitalisation period into account (62). Having a protein intake  $<$  0.8 gram/kg bodyweight/day have been associated with decreased quadriceps muscle layer thickness and increased malnutrition during the first fifteen days of admission to an intensive care unit (63) If the patient is malnourished before the burn the risk of refeeding syndrome is increased and must be taken into consideration during initiation and escalation of nutritional therapy after admission (35,36). The prevalence of malnutrition before and after both minor- and major-burn injuries needs further investigation.

## 2.2.2 Nutritional therapy guidelines

Guidelines for nutritional therapy after major burn injuries were published in 2001 by the American Burn Association (ABA) (64) and in 2013 by the ESPEN (25). There are also clinical practice guidelines for patients after severe burn together with therapy guidelines for critically ill adults that have been developed by ESPEN (36,46,65,66) and by the ASPEN/SCCM (52,67) see Table 2. The latest updated guidelines emphasise the importance of nutritional status prior to injury, as well as the risk of malnutrition during stays exceeding 48 hours in the intensive care unit. These factors should be incorporated into decisions regarding progressive feeding during the *Acute phase* of critical illness (36,46). Also, for a severely malnourished patient early and progressive PN should be considered if EN is contraindicated (36,46).

To decrease the risk of energy deficit as well as to moderate the hypermetabolic response, the enteral route is preferred and EN should be initiated early; within 12 hours from admission (25,36,68). Since malnutrition is an indicator of poor outcomes, recommendations include screening patients for nutritional risk on admission day as well as calculating energy and protein requirements to set goals for nutritional therapy (36,67). When possible, indirect calorimetry should be used to measure energy requirements, as predictive equations can yield biased results (36,44,69). Reports indicate that standardised equations may underestimate energy needs by approximately 30% (69). Although the current evidence for high protein intake has been questioned (70), protein goals are still advised to be set to 1.5-2.0 gram/kg body weight/day due to cell, blood vessel and collagen proliferation (25,67). A progressive protein delivery approach, gradually increasing protein intake over the first days during intensive care treatment is endorsed (36,71).

**Table 2.** Nutritional treatment guidelines post burn/for the critically ill adult and their evidence grade (25,36,46,52).

| Categories of Variables              | Guidelines <sup>1-3</sup>   | Grading quality <sup>1-4</sup>  | Agreement <sup>1-4</sup>  |
|--------------------------------------|---|---|---|
| <b>Risk screening</b>                | Screening nutrition risk<br>Risk malnutrition: ICU ≥ 48 hours   | GPS <sup>2</sup> , GPP <sup>3,4</sup>   | Strong <sup>3,4</sup><br>Strong <sup>3,4</sup>  |
| <b>Energy</b>                        | Energy goal on admission day<br>Measurement indirect calorimetry<br>Time points for meeting goal: 80% of energy goal within 48-72 h   | GPS <sup>2</sup><br>D <sup>1</sup> , GPS <sup>2</sup> , B <sup>3,4</sup><br>GPS <sup>2</sup> , 0 <sup>3</sup>                                     | Weak <sup>1</sup> , Strong <sup>3,4</sup><br>Strong <sup>3,4</sup>  |
| <b>Protein</b>                       | Goal 1.5-2.0 g protein/kg/day<br>Goal 1.3 g/kg/day<br>Protein goal on admission day<br>Time points for meeting goal: 80% of protein goal within 48-72 h<br>Supplement Glutamine<br>Do not supplement Glutamine (72) | D <sup>1</sup> , GPS <sup>2</sup><br>0 <sup>3,4</sup><br>GPS <sup>2</sup><br>GPS <sup>2</sup><br>C <sup>1</sup> , B <sup>3,4</sup>                | Strong <sup>1</sup><br>Strong <sup>3,4</sup><br><br><br>Weak <sup>1</sup> , Strong <sup>3,4</sup><br>Moderate <sup>2</sup>  |
| <b>Lipids</b>                        | Fat < 35% of total energy intake  | C <sup>1</sup>  | Weak <sup>1</sup>   |
| <b>Enteral nutrition</b>             | Prioritised feeding route EN<br><br>EN within 12 h from admission<br>EN within 4-6 h<br>EN within 48 h<br>Enteral feeding protocols<br>Non-intubated: ONS before EN<br>Dysphagia: texture-adapted food and/or EN    | C <sup>1</sup> , B <sup>3,4</sup><br><br>B <sup>1</sup> ,<br>GPS <sup>2</sup><br>A <sup>3,4</sup><br><br>GPP <sup>3,4</sup><br>GPP <sup>3,4</sup> | Strong <sup>1</sup> , Low-<br>very <sup>2</sup> , Strong <sup>3,4</sup><br>Strong <sup>1</sup><br>Moderate-high <sup>2</sup><br>Strong <sup>3,4</sup><br>Moderate-high <sup>2</sup><br>Strong <sup>3,4</sup><br>Strong <sup>3,4</sup> |
| <b>Improve tolerance</b>             | Metoclopramide<br>Erythromycin<br>Continuous infusion EN<br>Post-pyloric feeding  | 0 <sup>3,4</sup><br>B <sup>3,4</sup><br>B <sup>3,4</sup><br>B <sup>3,4</sup>  | Low <sup>2</sup> , Strong <sup>3,4</sup><br>Low <sup>2</sup> , Strong <sup>3,4</sup><br>GPS <sup>2</sup> , Strong <sup>3,4</sup><br>Strong <sup>3,4</sup>   |
| <b>Micronutrients</b>                | Vitamin B1/C/D/E<br><br>Selenium, Zinc, Copper  | C <sup>1</sup> , B <sup>3,4</sup><br><br>C <sup>1</sup> , B <sup>3,4</sup>  | Strong <sup>1</sup> , Low <sup>2</sup> ,<br>Strong <sup>3,4</sup><br>Strong <sup>1</sup> , Low <sup>2</sup> ,<br>Strong <sup>3,4</sup>  |
| <b>Electrolytes</b>                  | Week 1: measure potassium, magnesium, phosphate 1/day   | GPP <sup>3,4</sup>  | Strong <sup>3,4</sup>   |
| <b>Glycaemic Control<sup>5</sup></b> | Glucose level 4.5-8.0 mmol/L<br>Glucose level 7.8/8.3-10,0 mmol/L<br>Glucose level < 10.0 mmol/L  | D <sup>1</sup><br><br>A <sup>3,4</sup>  | Strong <sup>1</sup><br>Moderate <sup>2</sup><br>Strong <sup>3,4</sup>   |
| <b>Metabolic modulation</b>          | Early excision surgery<br>Propranolol<br>Oxandrolone <sup>6</sup>   | B <sup>1</sup><br>B <sup>1</sup><br>B <sup>1</sup>  | Strong <sup>1</sup><br>Strong <sup>1</sup><br>Strong <sup>1</sup>   |

**Abbreviations:** Intensive Care Unit (ICU), Enteral Nutrition (EN), hours (h), Oral Nutritional Supplement (ONS).

- <sup>1</sup>. ESPEN 2013(25) uses the GRADE methodology, (grade, recommendation, assessment, development and evaluation), grade A to D and an agreement (strong, moderate or weak).
- <sup>2</sup>. SCCM/ASPEN 2016 (52) uses a system adapted from GRADE Working Group, grading quality and strength of recommendations. Confidence in the estimated effect is graded for randomised clinical trials (high, moderate, low, very low), for observational studies (low, very low) and Good Practice Statement (GPS) are ungraded.
- <sup>3</sup>. ESPEN 2019 (46) and <sup>4</sup>. ESPEN 2023 (36) uses standard operating procedures for the ESPEN guidelines and consensus papers. Grade of recommendation A, B, 0 or Good Practice Point (GPP) with a classification of the strength of consensus on a four-grade scale from no consensus to strong consensus. For strong consensus > 90% of the participants agree.
- <sup>5</sup>. Glucose level measured in plasma.
- <sup>6</sup>. Oxandrolone is not recommended for use since 2023 due to safety and effectiveness concerns e.g., risks of severe liver toxicity and cardiovascular complication (73).

To decrease the hypermetabolic response, non-nutritional strategies for metabolic modulation (for example, early excision, non-selective beta-blockers, anabolic and androgenic steroids) are advocated (25). Significant clinical benefits (better graft take, fewer infectious complications and decreased mortality) have been associated with keeping plasma glucose (P-glucose) 4.5-8.0 mmol/L (25,71,74,75). Some contradictions to these results have been reported why future research should determine optimal, yet safe, treatment (76). Administration of insulin is advised if P-glucose > 10 mmol/L and P-glucose should be measured after admission to an intensive care unit and after the start of EN and/or PN (36). Patients recovering from burn injuries have been reported to be sensitive to total lipid load, causing increased length of stay and infectious risks (77,78) why ESPEN guidelines (25) states the importance of monitoring total lipid intake (including fat from sedatives as e.g., propofol) and keeping fat intake < 35% of total energy intake.

To optimise nutritional therapy, at least 80% of energy and protein goals should be reached within 48-72 hours (67). However, according to the latest ESPEN practical guideline (36), energy delivery should not exceed 70% of measured energy expenditure during the first *Acute phase* (day 1-3). During the *Post-acute phase*, energy delivery should then be increased to 80%-100% of measured energy expenditure as measured by indirect calorimetry (36,79). In the same effort, an enteral feeding protocol is suggested, such as a volume-based feeding protocol, where the volume of EN every 24 hours is targeted instead of hourly rates, which can increase the overall energy provided (67,80,81). Where clinically feasible, prokinetic medications (e.g., metoclopramide, erythromycin) and continuous administration of EN could be used to reduce the risk of aspiration and improve tolerance to gastric feeding

(36,67). In patients with gastric feeding intolerance despite prokinetic medication post pyloric, mainly jejunal, feeding should be evaluated (36). The wound healing process causes a loss and an increased demand of micronutrients and substitution of losses regarding Zinc, Copper, Selenium, Vitamin B1, Vitamin C, Vitamin D and Vitamin E are recommended by ESPEN (25,67). A reduction of wound healing time and infection rate have been associated with supplementation of micronutrients (82).

### 2.2.3 Nutritional therapy in clinical practice

More research concerning clinical practise in relation to guidelines are needed regarding post-burn nutritional therapy. Chourdakis et al. (42) reported a gap between recommendations (25,52) and nutritional therapy in practise post-major-burn injuries in 14 burn centres in the USA, Canada, Australia and South Africa. The reported average nutritional adequacy was suboptimal regarding the achievement of nutritional goals, with 65% ( $\pm$  40) for energy and 66% ( $\pm$  42) for protein (42). Energy and protein deficiency have also been reported in mechanically ventilated burn patients, with increased mortality with the greater deficit (83). A review (84) examining nutritional treatment practises compared to recommendations in burn units in the USA and Australia concluded that neither the macronutrient content of the EN formula used, nor the indication and use of PN were in accordance with guidelines.

Approximately 40% of patients receiving intensive care treatment have been reported to be able to eat orally during the first days of treatment (85). Patients in need of intensive care treatment for two weeks or more rely more on EN and only approximately 10% are reported to be able to eat orally (85). Patients eating orally seem to have low adequacy of energy (30-50%) and protein (40%) intakes compared to their goals during critical illness (86–88). Patients on standard ward-based care have also been reported to have insufficient intake, with more than half consuming half a portion or less (89,90). Patients with a TBSA  $\geq$ 10% receiving enteral nutrition have also shown inadequate intake, consistently consuming fewer calories than prescribed during the first 14 days following injury (91). In the post-intensive-care period oral nutrition provided alone is reported to be the most common mode of nutritional therapy (92) Also during this period energy and protein intake have been reported to be inadequate (92,93). Therefore, Van Zanten et al. (34) recommend the use of protein-enriched ONS for three months up to two years post discharge from an intensive care unit. Further studies are needed on what happens post discharge regarding nutritional adequacy in relation to outcomes.

## 2.2.4 Barriers to nutritional therapy

Since an adequate intake of macro- and micronutrients are important to optimise wound healing, optimising nutritional intake is essential in burn treatment (25,39,49). A wide variety of symptoms can negatively affect food intake. These symptoms can be assessed and quantified through nutrition impact symptoms (NIS) (94).

Reporting at least one NIS in the period from intensive care admission (admitted for medical, surgical or trauma reasons) to inpatient rehabilitation is very common (88%) (95). During the intensive care period altered conscious state, fasting, loss of appetite, nausea/vomiting and dysphagia have been reported as challenges to oral intake (95). In the post-intensive-care period fasting is more seldom reported instead e.g., dislike of hospital food can be present (95). Dysphagia have been reported more often among burn patients > 75 years old with a prevalence of 47% (96), compared to their county community dwelling counterparts, 23% (97). For these patients (TBSA 1-31%), several factors e.g., burn extent, mechanical ventilation, hospital length of stay, malnutrition, pre-existing cognitive impairment and complications during hospitalisation (e.g., delirium, pneumonia) was significantly associated with dysphagia (96).

Several barriers to nutritional therapy have been reported post burn (83,91). In mechanically ventilated patients e.g., delayed start of EN and interruptions in enteral delivery related to fasting before surgery or bedside procedures are common (83,91). Lack of support from a dietitian have been reported as a barrier for adequate EN therapy in the intensive care unit (98). Having an initial review of the patient within 24 hours of admission by a dietitian have been associated with better nutritional goal achievement (99).

A narrative review (100) identified four areas of barriers; *Process-related barriers* (e.g., under prescribing and insufficient screening for nutrition risk), *Intensive care treatment interruptions* (e.g., frequent EN interruptions for procedures and routine care), *Real/perceived intolerance* (concerns about gastrointestinal intolerance leading to delayed or reduced feeding) and *Provider attitudes/behaviour* (suboptimal practices and lack of adherence to feeding protocols). To improve nutritional therapy suggested solutions to these barriers in the intensive care unit are to e.g., implement screening tool for malnutrition, empower dietitians to manage EN orders, reduce fasting and use jejunal feeding when appropriate, use volume-based EN protocols, consider use of prokinetic agents and provide education through multiprofessional collaboration (80,81,100,101). Fasting (e.g., for surgery, dressing changes, bed-side procedures), feed intolerance, lower infusion rate of EN than prescribed and

unexplained delays in initiation of EN have been observed in patients with TBSA  $\geq$  10% during the first two weeks of hospitalisation after injury (91).

### 2.2.5 Questionnaires to measure nutrition impact symptoms

There are a few self-assessment questionnaires to assess appetite and NIS. One is the Appetite, Hunger and Sensory Perception (AHSP) questionnaire which correlates to the risk assessment tool to predict risk of malnutrition the Mini Nutritional Assessment, (MNA) (102,103). The AHSP has also been correlated with body weight (103). Other questionnaires assessing appetite also reported to be able to predict weight loss are the Council on Nutrition Appetite Questionnaire (CNAQ) and the Simplified Nutritional Appetite Questionnaire (SNAQ) (104). The AHSP, CNAQ and SNAQ were used together with a clinical rating scale for gastrointestinal symptoms (105) when two questionnaires designed to assess NIS were developed in Swedish, the Disease Related Appetite Questionnaire (DRAQ) and the Eating Symptom Questionnaire (ESQ) (106), (personal communication). The DRAQ and the ESQ were developed from focus group interviews with eight dietitians, cognitive interviews with 15 patients and questionnaires regarding content and clarity of the questions (n=16 patients) (106). The DRAQ consists of 11 questions about appetite, hunger and other symptoms that can affect dietary intake. The ESQ comprises 13 questions related to dietary intake and appetite. These questionnaires have been evaluated on patients with diagnoses within oncology and pulmonary diseases mostly (106) but they have also been applied to patients with liver disease (107).

## 2.3 Medical record documentation

All relevant data for monitoring and evaluation of patient care should be clearly documented in patients' medical records according to Swedish law (108). Swedish health care systems have documented in electronic health records for 20-30 years (108). Healthcare professionals should document all aspects of nutritional therapy including the nutritional assessment, problem, diagnosis, treatment, monitoring and evaluation to maximise the quality of patient care and effectiveness and efficiency of the health care teams (109). The design and structure of the medical records can vary between health care facilities, but it usually is a mix of free text and scrollbars. Although documentation in medical records is designed for clinical care the use of medical records for research is common in clinical research (110,111). Observational studies are well suited to explore e.g., what is achieved in clinical practise

(110). Different practical guidelines and checklists have been proposed to be used during the retrospective medical record review process to minimise bias during data collection and analysis (112–115). The data documented in the medical records can be biased by e.g., what the patient recalls/reports and/or what the healthcare professional chooses to document (115). The patients' actual received nutritional therapy may therefore not always correspond to what is documented in the medical record. For instance, previous studies have shown that food records are often incomplete and can differ up to 20% from the actual intake (116–118). Amon et al. (95) found that only 33% of patients eating orally in the intensive care unit had complete food record charts. In the study by Crossfield et al. (99), about half of the participants lacked documented reasons for delayed EN or for not achieving nutritional requirements.

### 2.3.1 Nutrition Care Process Terminology (NCPT)

The electronic Nutrition Care Process Terminology (eNCPT) is a standardised terminology used to communicate the Nutrition Care Process (NCP), both developed by the Academy of Nutrition and Dietetics (119). The global organisation, International Confederation of Dietetic Associations, (ICDA), representing over 50 dietetic associations, including the Swedish association of registered dietitians recommends the use of the NCP and the eNCPT (120,121). The eNCPT contains defined terms for each of its four steps: *Nutritional assessment and reassessment*, *Nutritional diagnosis*, *Nutritional intervention* and *Nutritional monitoring and evaluation* (119,122). The Nutritional assessment is a systematic way to collect and categorise relevant information to identify nutritional problems and their aetiology. It also includes to reassess the information in relation to patient status and situation during follow-ups. The *Nutritional assessment and reassessment* can include information regarding several areas for example food- and nutrition-related history (e.g., EN intake), anthropometric measurements (e.g., weight) and physical exam findings (e.g., dysphagia). The *Nutritional diagnosis* is the practitioner's identification and labelling of the nutritional problem that the practitioner is responsible for treating (e.g., inadequate EN infusion). The eNCPT provides reference sheets including definitions, possible aetiology and common symptoms identified in the nutrition assessment step related to the nutritional diagnoses. The *Nutritional intervention* is the action planned to resolve or improve the nutritional diagnosis or nutritional problem (e.g., management of rate/volume/schedule of EN). During the final step, *Nutritional monitoring and evaluation*, the goal of the intervention provides the basis for measuring outcome and to monitor progress (e.g., measured volume EN in 24 hours) (119).

## 2.4 The rationale for the present studies

Nutritional therapy is a cornerstone in burn care since suboptimal nutritional therapy can result in delayed wound healing, increased muscle wasting, decreased immune function and increase the risk of infection after burns (25,39,40). Guidelines for nutritional therapy post-major burns exists (25,52,67) but there are no specific guidelines concerning nutritional therapy for patients with minor-burn injuries. A lack of adherence to nutritional therapy guidelines post burn in the intensive care setting has been observed in burn centres in the USA, Canada, South Africa and Australia (42). The adherence to guidelines in a European setting during the *Acute phase* and *Post-acute phase* post burn needed further investigation. Given that the risk of energy and protein deficits appears to increase sixfold with each 1% increment in TBSA (43) and considering the reported malnutrition prevalence of 29%–78% among patients with TBSA  $\leq$ 30% (44,60,61) further investigation into the overall nutritional therapy for patients following minor burns was needed. Nutrition impact symptoms have been associated with low intake and malnutrition but its presence in the *Rehabilitation phase* post burn is poorly investigated. Therefore, describing nutritional therapy (Study I), the adequacy of energy and protein intake (Study I), documented nutritional interventions and barriers to these interventions (Study II) during the *Acute phase* and *Post-acute phase*, as well as examining NIS in the *Rehabilitation phase* post discharge at six to 12 months post burn (Studies III–IV) in relation to burn extent, could provide further insight into factors that is needed to improve nutritional therapy following burns.

## 3 Aims

The overall aim of this thesis was to examine nutritional therapy post burns in relation to the extent of the burn.

The specific aims of paper I-IV were:

- I. To evaluate documented nutritional therapy in relation to nutritional guidelines and to compare the adherence to nutritional guidelines between minor and major burns.  
The secondary aim was to evaluate documented energy and protein intake compared to individual nutritional goals post-minor and major burns.
- II. To describe the documented nutritional interventions and to identify the barriers to these interventions in medical records during the first twelve days of hospitalisation post burn. The secondary aim was to compare the documentation of nutrition for patients with minor versus major burns.
- III. To modify the Disease Related Appetite Questionnaire (DRAQ) and the Eating Symptom Questionnaire (ESQ) for assessments of nutrition impact symptoms after burns.
- IV. To investigate the differences in the prevalence of nutrition impact symptoms with respect to total body surface area burned at six and 12 months post burn.  
The secondary aim was to compare the differences in nutrition impact symptoms between six and 12 months post burn.

## 4 Methods and data collection

### 4.1 Overview

An overview of the study designs, methods and analyses included in the thesis is described in Table 3.

The FINER criteria (evaluating if a study is feasible, interesting, novel, ethical and relevant) were applied in the formulation of the research questions (123). These were evaluated as feasible in terms of time, resources and expertise; interesting due to their clinical relevance; novel in their focus on nutritional therapy in accordance with guidelines from a European perspective and for highlighting patients post-minor burns; ethical and deemed relevant within the healthcare community.

**Table 3.** An overview of the studies included in the thesis.

| Study               | I  | II  | III  | IV   |
|---------------------|--|---|--|--|
| <b>Study design</b> | Retrospective Cohort   | Retrospective Cohort  | Methodological Validation  | Prospective Longitudinal Cohort  |
| <b>Data source</b>  | Medical records  | Medical records   | Expert review<br>Cognitive interview<br>Expert consultation  | Questionnaires<br>Medical records  |
| <b>Study period</b> | 2017-2019  | 2017-2019   | 2020-2021  | 2021-2024  |
| <b>Study focus</b>  | Evaluate documented nutritional therapy in relation to guidelines during first 12 days post burn | Explore differences in documentation of nutritional interventions and barriers between patients post-minor and major burns during the first 12 days post burn | Adapt and validate questionnaires to measure nutrition impact symptoms in the rehabilitation phase post burn | Investigate the difference in prevalence of nutrition impact symptoms 6-12 months post-minor and major burns |
| <b>Participants</b> | n=134<br><br>Inclusion criteria:<br>Burn <sup>1</sup><br>≥ 18 years<br>Hospital care > 72 hours  | n=134<br><br>Inclusion criteria:<br>Burn <sup>1</sup><br>≥ 18 years<br>Hospital care > 72 hours   | Expert group, n=6<br><br>Cognitive interviews, n=10<br>Expert consultation on terminology, n=5               | n=60<br><br>Inclusion criteria:<br>Burn <sup>1</sup><br>≥ 18 years<br>Proficient Swedish/English             |
| <b>Analyses</b>     | Chi-square<br>Mann-Whitney   | Content analysis<br>Chi-square or Fisher test<br>Mann-Whitney   | Content validity index<br>Clarity analysis<br>Scale-content validity index                                   | Chi-square or Fisher test<br>Mann-Whitney  |

<sup>1</sup>. Admitted for a burn to the Burn Centre at Uppsala University Hospital, Sweden.

## 4.2 Retrospective cohort study (Studies I-II)

A consecutive sample was used in Study I-II including all eligible patients fulfilling inclusion criteria during the time frame 2017-2019. Originally, also patients fulfilling inclusion criteria hospitalised 2015-2016 were considered for participation in the studies but due to organisational changes in the archives of the medical records these were not accessible to the authors at the study start and therefore not included.

### 4.2.1 Participants and data collection

In both Study I (124) and in Study II (125) data were retrospectively collected from patients' medical records spanning the period from admission to either discharge or death, or for a maximum duration of 12 days. Information pertaining to patient characteristics, burns, comorbidities and prescribed medications, weight progression and nutritional therapy and barriers thereto was collected. Patients identified as fulfilling the inclusion criterions; having a burn,  $\geq 18$  years and admitted for  $\geq 72$  hours were included in the study. At the Uppsala University hospital two medical record systems were used during the time periods of the conducted studies in this thesis Cosmic (126) and Metavision Suite (127).

The guide on how to conduct medical record review by Patanwala et al. (112) and the twelve criteria for quality control in retrospective record reviews, stated by Worster et al. (113) were employed in the study design and data collection processes. Personnel responsible for data extraction and analysis were familiar with the relevant medical record systems, Cosmic (126) and Metavision Suite (127). An abstraction manual was utilised (Study I) to ensure consistency. To decrease subjectivity during the data analysis phase, twenty-four (Study I) and ten (Study II) medical records were randomly selected and reviewed by three independent observers. Each record was assessed for 24 items related to nutritional therapy in accordance with established guidelines (Study I) and for documentation related to nutritional intervention and barriers to implementing nutritional intervention (Study II). Any discrepancies identified were resolved through discussion until a consensus was reached.

Information regarding nutritional treatment guidelines (25,46,52) extracted from the medical records (items  $n=24$ ) post burn in Study I was: energy goal on admission day; requirements per indirect calorimetry; meeting 80% of energy goal within 48-72 hours; protein goal on admission day; goal 1.5-2.0 gram protein/kg body weight/day; meeting 80% of protein goal within 48-72 hours; fat intake < 35% of total energy intake; EN as a prioritised feeding route; EN within 12 hours of admission, use of enteral feeding protocol;

nutrition risk screening; supplementation with Vitamin B1/C/D/E, Selenium, Zinc and Copper; metabolic modulation through early excision surgery; propranolol (beta-blocker) or oxandrolone (anabolic and androgenic steroid); use of metoclopramide (dopamine receptor antagonist) or erythromycin (macrolide antibiotic and pro-kinetic agent) and keeping P-glucose level 4.5-8.0 mmol/L. The adherence to nutritional therapy in relation to nutritional guidelines (25,46,52) post burn was analysed for each individual recommendation in the guidelines (n=24). The documented nutritional therapy's degree of adherence with nutritional guidelines was defined as high  $\geq 80\%$ , moderate 60-79.9%, or low  $< 59.9\%$  (128–130). Missing data were examined and variables with 20% or more missing entries in the medical records were classified as having a high degree of missingness.

#### 4.2.2 Content analysis

In Study II, using a content analysis (131), the medical records were read through several times to get an overall understanding of the content. Starting with a deductive approach, text related to nutritional intervention and barriers to nutritional interventions was divided into meaning units and extracted. A categorisation matrix was constructed to organise the extracted text alongside a chronological timeline for the first twelve days of hospitalisation. All identified text sharing common features were grouped and coded using the eNCPT (119). Nutritional interventions were defined according to the eNCPT as “purposefully planned action(s) designed with the intent of changing a nutrition-related behaviour, risk factor, environmental condition or aspect of health status” (119). Barriers to nutritional intervention were defined as “any documented subjective or objective sign or symptom that may prevent/limit the possibility of a nutritional intervention and/or nutritional intake” (119,125). When data did not correspond to any existing NCPT codes, an inductive approach was used and new codes were developed to accommodate the novel information. The codes were then quantified in two ways: first, they were counted once per patient during the entire hospital stay and secondly, they were counted once per hospital day per patient.

### 4.3 Methodological study (Study III)

To accommodate the questionnaires DRAQ and ESQ a content validation of the questions was done through an expert review. They rated the questions on a 4-point Likert scale (1 = not relevant, 2 = partially relevant, 3 = relevant, 4 = highly relevant) if symptoms were representative for the burn population in

the *Rehabilitation phase* post-burn. An item-content validity index (I-CVI) was calculated for each question using dichotomised Likert points (1–2 Likert points = 0, 3–4 Likert points = 1) (132). An I-CVI  $\geq 0.78$  was considered to represent approved content validity and those questions were kept in the questionnaires, while questions with I-CVI  $< 0.78$  were removed from the questionnaires (132,133). The expert group was also asked if any symptoms were missing that should be added to the questionnaires. All newly added questions were clarity validated through translation and backtranslation, cognitive interviews with participants who experienced a burn 6-12 months earlier (n=10) and expert consultation on terminology (physiotherapists n=2, dietitians n=2 and occupational therapist n=1). The modified questionnaires were named DRAQ-burn and ESQ-burn (134).

## 4.4 Prospective longitudinal cohort study (Study IV)

### 4.4.1 Participants and data collection

Patients  $\geq 18$  years, admitted to the Burn Centre at Uppsala University hospital between 1 April 2021 and 30 November 2023, proficient in Swedish and/or English were asked to participate in the study.

Patients completed the DRAQ-burn and the ESQ-burn (134) at their routine follow-up visit to the Burn Centre at six and 12 months post burn. Also, data with information about the burn and treatment, patients' demographics and medical history were collected.

## 4.5 Statistical analyses

In Studies I-II and IV, the data were divided according to TBSA,  $\geq 20\%$  or  $< 20\%$  and analysed through descriptive statistics. Continuous variables were reported as means with standard deviations (SD) or for skewed data as medians with interquartile ranges (IQR) and categorical variables as number and percentages. The Mann-Whitney U-test (for continuous variables), Pearson's Chi-square test and Fisher's exact test (for categorical variables) were used to analyse if a statistically significant difference existed between the groups of patients in Study I-II and IV and for comparing symptoms over time (at six compared to 12 months post-burn) in Study IV. A probability value of  $P < 0.05$  was considered statistically significant. IBM SPSS Statistics for Windows, Version 28.0 (IBM Corp., Armonk, NY, USA) was used to analyse the data.

Calculating necessary sample size (Study I), thirty-two participants were needed in each group (patients post-minor and post-major burn) to compare differences in goal adherence and/or differences between documented intake and documented individual goals, assuming a power of 80% and a two-sided alpha of 0.05 (using results from Chourdakis et al. study (42) in the calculation). Energy/protein adequacy (Study I) was calculated taking the amount of energy/protein received as a percentage of the individual energy/protein goal prescribed for all patients' evaluable nutrition days. In the total amount of energy and protein received, all calories and proteins from PN, EN and per oral intake as well as calories from propofol infusion and intravenous glucose infusion, were included.

When comparing frequencies of documented nutritional interventions and barriers thereto between groups (Study II), an intervention or barrier were only counted once per patient during hospitalisation. Looking at the distribution of each documented nutritional intervention and barrier from day one to day 12 of the hospital stay in Study II, each intervention or barrier were counted once per patient per hospital day.

In Study III, a scale-content validity index average (S-CVI/Ave), was calculated for the DRAQ-burn and ESQ-burn (135). The S-CVI/Ave is the sum of items rated relevant or highly relevant divided with the total number of ratings. A S-CVI/Ave  $\geq 0.8$  was considered as the average congruity for revised questionnaires (136).

In Study IV, each item was calculated on extracted answers from the DRAQ-burn and the ESQ-burn excluding missing values. Missing data were presented separately and the original analysis was compared with a complete case analysis as a sensitivity analysis. Responses to the DRAQ-burn and ESQ-burn were analysed both categorised into two groups (e.g., absence versus presence of symptoms in the ESQ-burn) and based on the number of symptoms reported. Prevalence of each symptom was also calculated. Finally, to further evaluate symptom severity in the ESQ-burn, prevalence was calculated according to whether symptoms were reported as mild or moderate to severe.

## 5 Ethical considerations

These studies were performed with the ethical principles of medical research involving human subjects that have their origin in the updated Declaration of Helsinki (137). It was developed by the World Medical Association in 1964 to ensure that medical research was conducted with respect to human rights, dignity and safety (137). Ethical approval was obtained from the Swedish Ethical Review Authority, for Study I-II (reference no: 2020-03192 and

complementary approval 2021-02103 adding patients TBSA  $\geq$  20%) and for Study III-IV (reference no: 2018/436 and 2020-02088).

The ethical principles of medical research have been taken into consideration in this thesis, beneficence (to do good), non-maleficence (to do no harm), to have respect for autonomy and to be just (138). The purpose of this thesis was to do good by gaining more knowledge and enhancing clinical understanding through examining nutritional therapy post burn in relation to the extent of the burn. The intent was to improve patient care and for the newly gained knowledge to be beneficial to future patients post burn.

The retrospective cohort study (Study I-II), the methodological validation of questionnaires (Study III) and the prospective cohort study (Study IV) were not experimental in their nature and therefore of minimal risk of doing physical harm to the participants. Completing questionnaires may pose a risk of psychological discomfort, as some questions can evoke negative emotions or introduce new concerns. To minimise harm, participants were informed about the purpose of the study and the nature of the questions. Participation was voluntary, and withdrawal was possible at any time without consequences. Contact information for support was provided in the event of emotional or psychological discomfort.

Participants' autonomy was considered, all participants were pseudonymised and given a code number, coded case report forms were used in the discussions among the researchers. In all analyses data were on group level, minimising identification of an individual. All case report forms and questionnaires were stored in a locked cabinet at the hospital. The need for informed consent was waived (Study I-II) since this was a retrospective observational study without interventions. In the ethical application careful considerations was made due to that informed consent would have been difficult to obtain since part of the study population was deceased and that others were without decision-making competence due to psychiatric disorders, decreased health and/or heavy social load. These conditions could be potential risk factors for nutritional difficulties highlighting the importance of not excluding these individuals (139–142). The research offers potential benefits for future individuals who suffer burn injuries and poses minimal risk of harm or discomfort to the participants. Altogether the benefits were considered to outweigh the risks and the Swedish Ethical Review Authority approved the research with waived consent since the research was considered to have important value for future patients post burn and the research poses no more than minimal risk for the participants. Study III was a methodological study to modify questionnaires and no sensitive personal data were collected from experts or participants who experienced a burn. The participants were informed of the study and

volunteered to answer questions about the questionnaires. Oral and written informed consent were collected (Study IV) from all included study participants. During the inclusion period (Study IV) I worked part-time as a clinical dietitian at the Burn Centre where the recruitment was performed. To minimise the risk of impacting the patients decisions I was not the participants' dietitian during the study period, which took place at six to 12 months post trauma. Participants were informed that the participation was voluntary, that they could withdraw it without explanation or consequences and that all data would be pseudonymised.

Children < 18 years old were not included in the studies in this thesis since the study sample was considered too small and too heterogenous to enable statistical analyses. Patients non-proficient in Swedish and/or English were excluded (Study IV) since the need for an interpreter to translate information could potentially decrease the possibility to independently make a decision about participation. Some potential participants were never invited to participate (Study IV) due to organisational reasons. According to the justice principle all persons should be treated equally, this principle could have been influenced since not all potential participants were invited to participate for the above reasons.

## 6 Results

### 6.1 Study participants (Studies I-IV)

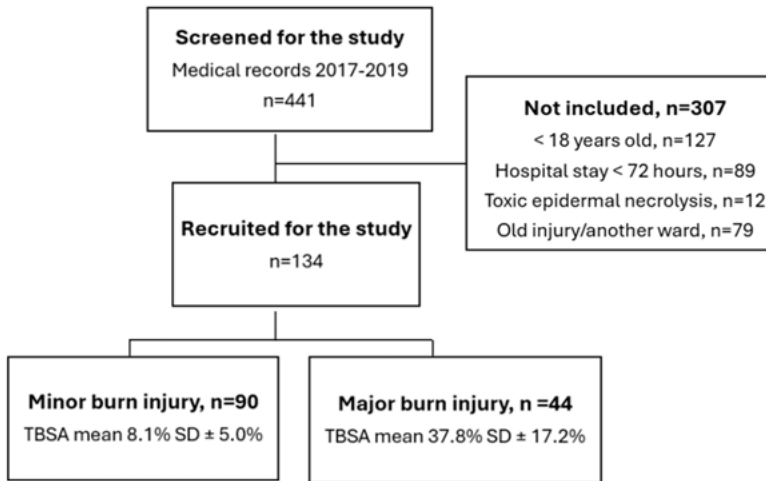
A selection of patients' characteristics in Studies I-II and IV are shown in Table 4. Of the 134 included patients (Studies I-II), 90 were minor burns (TBSA median 7.3%, IQR 9.1%) and 44 were major burns (TBSA median 40.3%, IQR 13.4%). There were statistically significant more patients in need of mechanical ventilation (91% vs 28%,  $P=0.001$ ) and documented inhalation injuries (41% vs 11%,  $P=0.001$ ) among the major burns than the minor burns in Study I-II. Of the 60 included patients (Study IV), 49 were minor burns (TBSA median 4.5%, IQR 6.5%) and 11 were major burns (TBSA median 24.0%, IQR 6.0%). There were statistically significant more patients with facial (14% vs 73%,  $P>0.01$ ) and arm burns (33% vs 73%,  $P=0.020$ ) and more dietitian contact (53% vs 91%,  $P=0.005$ ) during hospitalisation among the major burn patients.

**Table 4.** Overview of clinical characteristics in Study I, II and IV.

| Study                            | I-II        | I-II        | IV          | IV          |
|----------------------------------|-------------|-------------|-------------|-------------|
|                                  | Minor burn  | Major burn  | Minor burn  | Major burn  |
| <b>Number of participants, n</b> | 90          | 44          | 49          | 11          |
| <b>Age, year</b>                 |             |             |             |             |
| n (%)                            | 54.2 (19.6) | 48.3 (17.5) | 56.8 (18.2) | 45.6 (17.6) |
| <b>Gender, male</b>              |             |             |             |             |
| n (%)                            | 63 (70)     | 30 (68)     | 28 (57)     | 6 (55)      |
| <b>BMI, kg/m<sup>2</sup></b>     |             |             |             |             |
| Mean, (SD)                       | 25.4 (5.4)  | 27.8 (5.0)  | 27.8 (6.6)  | 27.7 (6.3)  |
| Missing data, n                  | 9           | 1           | 10          | 0           |
| <b>TBSA, %</b>                   |             |             |             |             |
| Median, (IQR)                    | 7.3 (9.1)   | 40.3 (13.4) | 4.5 (6.5)   | 24.0 (6.0)  |
| <b>Inhalation, yes</b>           |             |             |             |             |
| n (%)                            | 10 (11)     | 18 (41)     | 2 (4.1)     | 1 (9.1)     |

**Abbreviations:** Body mass index (BMI), Standard deviation (SD), Total body surface area (TBSA), interquartile range (IQR). Major burn: TBSA  $\geq$  20%, minor burn: TBSA  $<$  20%.

Of 441 screened medical records of patients hospitalised for a burn between the years 2017 to 2019 at the Uppsala University hospital in Sweden, 134 patients were identified as fulfilling the inclusion criterion for Studies I-II, Figure 3 (124,125). The 307 non-included patients were: <18 years (n = 127), hospital stay <72 hours (n = 89), being diagnosed with toxic epidermal necrolysis and not a burn (n = 12) or readmitted for an old injury/admitted to another ward at the hospital (n=79). Patients hospitalised 2015-2016 were not included due to organisational factors with the archive system.



**Figure 3.** Flow-chart of included and not included patients in Studies I-II.

**Abbreviations:** Total body surface area (TBSA), Standard deviation (SD).

In Study III, the expert group consisted of six dietitians who answered the content validity questions. They had worked as dietitians for minimum five years, maximum > 30 years with a mean of seven years in burn care. They all had experience of treating patients with both minor and major burns. The non-expert group consisted of ten participants who had experienced a burn 6-12 months earlier and answered how they interpreted the questions. The experts consulted on terminology (n=5) were two physiotherapists, one occupational therapist and two dietitians.

In Study IV a total of 158 patients was screened for the study. The 60 who fulfilled inclusion criterion were recruited to participate in the study. Of these 49 patients had been treated for minor burns and eleven for major burns. Among the patients who were not included (n = 98), most were due to cancellation of follow-up (n = 69) or organisational reasons (n = 23). A few declined participation (n = 5), and one did not participate because of language barriers

(n = 1). The 12 months' questionnaires had 14 (23%) non-responders. Non-responders did not differ statistically significant from the responders regarding e.g., age, BMI, gender and TBSA except that more responders had facial injuries ( $P < 0.001$ ). There were some item-non-responses in both DRAQ-burn (six months n=6 and 12 months n=25) and ESQ-burn (six months n=0 and 12 months n=4). The sensitivity analysis revealed no differences in the prevalence of symptoms for either the DRAQ-burn or ESQ-burn for those participants with missing/without missing data at neither time point.

## 6.2 Documented nutritional therapy (Studies I-II)

Oral intake alone was the most common route of nutrition administration for minor-burn patients (69%). The remaining minor-burn patients had oral intake combined with enteral and/or PN (22%) or only EN and/or PN (9%). Nearly half of the major-burn patients received EN alone (20%) or combined with PN (27%). The other half had oral intake alone (11%) or oral intake combined with EN and/or PN (42%).

### 6.2.1 Study I

There was an overall low adherence to nutritional therapy guidelines. Of the 24 recommendations evaluated 75% (minor burns) and 67% (major burns) showed documented low adherence to guidelines. Two of the recommendations (8%) in each group were documented as having high adherence. Minor burns had high documented adherence with EN as prioritised feeding route and fat intake  $< 35\%$  of total energy intake. For patients post-major burn it was Vitamin C and Zinc supplementation that had high documented adherence. Four (17%) and six (25%) recommendations post-minor and major burns, respectively, were documented as having moderate adherence.

Almost half (11/24, 46%) of the adherence to the recommendations were statistically significant different between the groups with minor and major burns. Three recommendations had higher documented adherence in the post-minor burn group (fat  $< 35\%$  of total energy intake, EN as prioritised feeding route and EN within 12 hours). The remaining eight recommendations had higher documented adherence in the post-major burn group (measurement with indirect calorimetry, protein goal 1.5-2.0 g/kg/day, supplementation with Vitamin B1, Vitamin C and Zinc, early excision, use of propranolol and metoclopramide).

The adequacy of energy intake compared to energy goals (78% versus 89%) and protein intake compared to protein goals (66% versus 78%) were

lower post-minor burns compared to patients post-major burns respectively. Patients with minor burns had statistically significant lower mean documented energy goals (30 kcal/kg/day versus 32 kcal/kg/day), energy intake (21 kcal/kg/day versus 25 kcal/kg/day), protein goal (1.5 g/kg/day versus 1.6 g/kg/day) and protein intake (0.8 g/kg/day versus 1.2 g/kg/day) compared to major-burn patients the first twelve days after admission to hospital.

The variable with highest frequency of missing values was weight for both groups. For patients with a documented follow-up visits at six months post burn (n=101, 75%) only 23% had a recorded weight measurement. For patients post-minor burns, a high frequency of missing data ( $\geq 20\%$ ) was identified for the recommendations 80% of protein goal within 48-72 hours, fat < 35% of total energy intake, P-glucose 4.5-8.0 mmol/L, protein goal and adequacy of protein intake compared to protein goals. For patients post-major burns only weight of all extracted items had a high number of missing data.

## 6.2.2 Study II

From the deductive part of the content analysis 34 pre-existing NCPT codes for nutritional intervention (n=21) and barriers to nutritional intervention (n=13) were identified. However, inductively nine codes each for intervention/barrier had to be created. Thus, in total there were 30 different codes for nutritional intervention and 22 different codes for barriers to nutritional intervention.

The most documented nutritional interventions were nutrition supplement therapy (documented in 93% of medical records e.g., vitamin and mineral supplement therapy, protein powder, ONS) and nutrition prescription (91%, e.g., adjustment energy and protein goal). For patients post-major burns also EN and PN management (e.g., management of rate/schedule/composition/ volume of EN) were a common nutritional intervention (91%). All other nutritional interventions were documented less frequently, meals and snacks (43% e.g., modified schedule to limit fasting, protein modified diet), feeding assistant management (40%, e.g., meal support, meal selection assistance), manage feeding environment (1%, meal location management) and nutrition education content (14%, e.g., education on nutrition's influence on health). Half of the nutritional intervention codes (15/30) differed statistically significant between the minor- and major-burn groups. Patients with minor burns had feeding assistance management (e.g., other encouragement) documented more often in their medical records. While major-burn patients' had EN and PN, vitamin and mineral supplement therapy and nutrition prescription (e.g., adjustment energy and protein goal and goal EN specified) more frequently documented in their medical records.

Of the documented barriers to nutritional intervention, fasting (93%) and gastrointestinal symptoms (49%) were the most prevalent. There was a statistically significant difference for half of the documented barriers to nutritional intervention between patients post-minor and major burns. These were decrease in appetite (23%) and risk of low intake related to preferences of food (10%) which were more frequently documented among minor burn patients. While patients post-major burn had a higher frequency of documented EN pause (48%), EN low infusion rate (45%), no enteral access (36%), secretion/mucus (30%), diarrhoea (25%), fewer (23%) and EN delay (9%).

For patients post-minor burns it was more common (59%) than for the patients in the major-burns group (25%) to not have any free-text annotations on nutritional intervention in their medical records for each day during hospitalisation ( $P=0.001$ ).

## 6.3 Nutrition impact symptoms (Studies III-IV)

### 6.3.1 Study III

The expert group consisted of six dietitians working in burn care in Europe (mean 14.5 years working as a dietitian and mean seven years in burn care). The content validation by the expert group resulted in the removal of two questions (concerning perception of food and if patients felt downhearted) from the questionnaire DRAQ and eight questions from the ESQ (concerning vomiting; stomach ache; diarrhoea; constipation; pain in the mouth; dry mouth; taste and smell) that were not considered relevant for patients in the *Rehabilitation phase* post burn ( $I-CVI < 0.78$ ). Five more burn oriented constructed items were incorporated into the DRAQ-burn and two into the ESQ-burn. The new items in DRAQ-burn addressed depending on others for meal preparation; dressings/scars/itching affecting appetite/preventing from eating; reduced functional ability preventing from eating and the use of ONS. In ESQ-burn the new items addressed fatigue affecting/preventing from eating. As a result, the revised instruments, DRAQ-burn and ESQ-burn, comprised 14 and eight items, respectively, in their final versions (134). A high level of expert agreement regarding item relevance was achieved, with scale-content validity index averages ( $S-CVI/Ave$ ) of 0.86 for DRAQ-burn and 0.83 for ESQ-burn.

### 6.3.2 Study IV

The prevalence of NIS over time was similar for both groups post-minor and major burns in the DRAQ-burn (both groups median 2.0 symptoms at six months and median 1.0 and 1.5 symptoms post-minor and post-major burns,

respectively at 12 months). In the ESQ-burn both groups reported median 1.0 symptom at six and 12 months.

There was no statistically significant difference between the groups post-minor and major burns for any of the symptoms in the DRAQ-burn or in the ESQ-burn at six months post burn ( $P > 0.05$ ). At 12 months post injury only “difficulty chewing” was statistically significant more prevalent among major burn patients ( $P=0.043$ ) compared to minor burns. There was also no difference in the change of number of symptoms in the DRAQ-burn ( $P= 0.97$ ) or in the ESQ-burn ( $P=0.45$ ) over time between six and 12 months post injury.

The most frequently reported symptoms in the DRAQ-burn at both six and 12 months were “eating and/or appetite varying from day to day”, “never/rarely feeling hungry” and “eating 0-2 meals per day”. At six months post-injury also “sometimes to always depending on someone for preparing meals” and at 12 months “food tasting worse/a lot worse compared to before injury” were reported. For the ESQ-burn the most frequently reported symptoms were “tiredness affecting appetite and/or preventing from eating” and “nausea”. In the DRAQ-burn 10%-18% reported no symptom while that number was 35%-47% in the ESQ-burn at six and 12 months post-minor and major burns. Reporting one symptom (DRAQ-burn 20%-35%, ESQ-burn 0-18%) or two symptoms (DRAQ-burn 16%-27%, ESQ-burn 9%-18%) were more common than reporting three symptoms (DRAQ-burn 4%-18%, ESQ-burn 6%-18%) or four symptoms or more ( $\leq 10\%$  for both questionnaires).

# 7 Discussion

## 7.1 Results discussion

### 7.1.1 Documented adherence to nutritional therapy guidelines

The overall documented adherence to guidelines was low (Study I) with adherence to most therapy recommendations < 60%. This is the first study to our knowledge reporting adherence to nutritional therapy guidelines in a burn centre in Europe also including patients not mechanically ventilated during hospitalisation and minor-burn patients. The range of adherence to the reviewed nutritional therapy recommendation varied greatly (0-93%). These results are aligned with earlier reported gaps in clinical practice compared to guidelines, reported in a review by Chourdakis et al. (42) including patients on intensive care treatment  $\geq 72$  hours (42). The adherence to guidelines and the adequacy of nutritional therapy has been associated with positive outcomes post burn (e.g., increased wound healing, decreased mortality and infection frequency and the preservation of lean body mass) (25,39,40,71,143). Therefore, the adherence to nutritional guidelines post burn is crucial for the patient's journey.

The low adherence to nutritional guidelines (Study I) may partly be explained by that specific guideline for nutritional therapy post burn were most recently updated more than a decade ago (25). Therefore, more updated nutritional guidelines for the general critically ill adult are also incorporated into practice post burn (144). Unfortunately, there are few recommendations with high level of evidence (32,145). Many of the nutritional therapy recommendations have been questioned (e.g., optimal protein targets, micronutrient supplementations and glycaemic control) (70,76,145), emphasising that more research is needed on the best nutritional therapy practice post burn. Disagreement with guidelines content have earlier been identified as a key barrier to the adherence to guidelines (143,146). Limited awareness and insufficient familiarity are other reported barriers to the adherence to guidelines (143,146). External constraints e.g., educational resources, time and staffing may also play a significant role. In certain circumstances, deviation from guidelines may be appropriate to accommodate unique clinical situations, since guidelines cannot anticipate every scenario, and complete concordance is neither expected nor realistic (143).

Reaching nutritional goals seem hard during hospitalisation post burn. The adequacy of energy and protein intake compared to individual goals have been reported to be approximately 65% (42). Results in Study I showed slightly higher adequacy for energy and proteins (66%-89%). Noteworthy, the participants in the post-minor burns group had documented lower adequacy for both energy and proteins compared to their post-major burns counterparts. A low intake increases the risk of malnutrition especially in combination with the inflammation and hypermetabolism seen post burn (36,57). Being malnourished can further worsen the outcomes (44,57). Low adherence to guidelines could potentially result in low adequacy of energy and protein intake (42,124) increasing the risk of malnutrition and poor outcome (39,40,44). The low intake could, by the presence of NIS/barriers to nutritional therapy, increase the risk of malnutrition or worsening the malnourished state of the patients (95,96). To ensure an overall adequate intake and adherence to guidelines post burn, continuous nutritional assessment throughout the burn care trajectory is proposed (36). Recurrent nutritional assessment could potentially facilitate to prevent, identify and/or treat barriers/NIS and to initiate adequate nutritional interventions at the right time-point.

Documented nutritional therapy is reported to not be a mirror of actual nutritional therapy (115,147,148). If the low documented adherence to nutritional guidelines and the overall low documented nutritional intake in our Study I mirrors the patients' actual nutritional therapy and intake there is a potential risk of undernutrition. Considering the predicted more severe hypermetabolic response after major burns, energy goals should be set using measurements instead of calculations (25,36,44,79,149). Following major burns, 77% of patients underwent indirect calorimetry (Study I). Although this is a relatively high proportion, the objective should be to assess all patients after major burns to enable the establishment of individualised energy goals based on measured requirements (36,69,79). We think that patients with minor burns who require mechanical ventilation or present with malnutrition on admission should also be considered for indirect calorimetry during hospitalisation (36,44,69). The low prevalence of measurements in patients with minor burns in Study I (23%) indicates scope for improvement. More individualised energy prescriptions could potentially enhance the adequacy of intake compared to calculated goals (69). Adequacy of nutritional intake compared to individual goals seems to increase over the first four days after admission (Study I). A possible explanation is the practice noted in some medical records where instead of documenting the actual daily energy and protein goals, practitioners noted the goals to be achieved within a few days. This practice poses a potential risk of under- or overnutrition, since when daily goals are not recorded in

the patient's medical records, the information must be communicated orally among healthcare professionals, creating a risk that it may not be communicated at all (150–153).

All patients referred to a burn centre could be regarded as having a severe burn according to referral criteria for minimal level of burn care (20). All participants in the studies in this thesis have experienced a trauma in the form of a burn regardless of burn extent, causing a mild to severe inflammation and a stress-response depending on the extent and depth of the burn and complications thereof. Patients with wounds characterised as minor burns are the largest patient group in burn care and they can also experience a severe inflammation and stress-response after injury with the need of intensive care treatment and mechanical ventilation (20). Altogether this highlights the importance of also including patients with minor burns in studies concerning nutritional therapy. Considering that there are no guidelines for patients with minor burns stipulated, the use of guidelines for nutritional therapy post-major burns (25) and for the critically ill patients (46,52) was considered reasonable to use for the comparison of adherence to guidelines (Study I). One must bear in mind that some patients in both the post-minor and major-burn groups may have a milder inflammation and less severe stress response, for example due to a smaller percentage of full-thickness burn. This can lead to a milder hypermetabolic response, thereby reducing the need for additional energy, protein, and micronutrients compared to patients with a more severe hypermetabolic response. Altogether, developing and dividing nutritional guidelines post burn according to intensity and length of stress-response as well as nutritional status instead of extent of burn in the future should be further explored.

### 7.1.2 Documented nutritional assessment

ESPEN recommends a thorough initial assessment of nutritional status, including an evaluation of malnutrition, in post-trauma patients (36,47). The low adherence (31%) to screening patients on admission for the risk of malnutrition is concerning (Study I). Nutritional therapy is important and appears to be associated with nutritional status prior to trauma, as observed in other critically ill patients (36,46). Patients with a poor nutritional status before trauma require special consideration when escalating nutrition, particularly regarding the risks of refeeding and overfeeding (e.g., when to initiate PN if EN is contraindicated) (35,36). The low screening frequency is not surprising, considering there has been no gold standard for screening patients post burn for the risk of malnutrition and the guidelines have been vague on practical implications in the past. In the latest revised ESPEN guideline (36) practical

implications and flow-charts are included to help the clinicians in their practice. The GLIM-criteria for the diagnosis of malnutrition (57,58) is also suggested for use in the intensive care setting (36). In practice the GLIM-criteria can be challenging to apply in the post-burn care setting, as obtaining an accurate history of weight prior to injury can be difficult. Calculation of BMI may also be unreliable due to uncertainty about the pre-injury weight and weight during the *Acute phase* post burn can be affected by water retention and fluid resuscitation. The water retention and fluid shift also compromise the results from muscle mass assessment by BIA, excess extracellular water lowers resistance, making the device interpret the body as having more lean mass than it does and thereby overestimating the fat-free mass including the muscle mass (154–156). Multifrequency BIA can assess the extracellular water excess to prevent lean body mass overestimation (157,158). Having non-burned skin to fix the electrodes to can also be a challenge (154). Using physical examination in the assessment of muscle mass can be complex to evaluate due to the water retention making it more difficult to distinguish muscle from fluid accumulation. The frequencies of measurements that could be used for the assessment of muscle mass (DXA, CT and Magnetic Resonance Imaging, MRI) are dependent on clinical status. In a complex burn setting the shifts in clinical status could pose a difficulty in having the measurements available in the diagnosis of malnutrition and for monitoring muscle mass over time (159). Measurement bedside by ultrasonography of muscle mass (160) has been reported to be feasible post burn although the inter- and intra-rater reliability are highly variable and more research is needed (160). Reports on early and rapid loss of muscle thickness, approximately 24%, during the first week of hospitalisation post burn regardless of burn extent (161) emphasises the increased risk of malnutrition for patients with both minor and major burns. The need for monitoring of nutritional status including assessment of muscle mass, weigh development and the diagnosis of malnutrition in the future of burn care seem evident.

The missing data on weight at six and 12 months post burn (Study I and IV) is concerning. Since weight loss is a risk factor for malnutrition (44,57,62), it seems important to include weight measurements also during follow-up post burn to enable nutrition risk assessments (162). There are currently no established guidelines for nutritional therapy following discharge after a burn injury. However, expert recommendations suggest increased requirements for both energy and protein for up to one year post trauma (34). Meeting these elevated goals can be challenging and low intake has been reported after discharge after critical illness, with approximately 80% of energy intake compared to goals (163). This overall increases the risk of malnutrition

during the long-term *Rehabilitation phase* following a burn, emphasising the need for ongoing nutritional assessment and regular weight monitoring throughout this period.

### 7.1.3 Documented nutritional intervention

Many patients post burn, especially post-major burns, depend on enteral and/or parenteral nutrition (e.g., all critically ill and mechanically ventilated) as part of their treatment since they are not able to achieve an adequate nutrition on their own (25). Also seen in our Study I-II with nearly half of patients receiving an enteral feeding tube. The documented use of EN and/or PN alone or together with oral intake was evident post-major burn (89% of patients) and existent although less common post-minor burns (31%). There was also a high documented use of ONS and/or protein powder (70%-80% of patients). The frequently documented use of medical nutritional therapy highlights the elevated need for nutritional therapy post burn. Intervention to EN management was frequently documented (Study II) but having an enteral feeding protocol was less common (Study I). To enhance clinical practice, implementation of an enteral feeding protocol has been proposed with reported benefits, e.g., improving achievement of energy targets (80,81).

Many patients will need nutritional interventions, due to e.g., NIS affecting appetite and/or intake, to ensure adequate nutrition (44). Considering that 78% of the patients in Study II had an oral intake at some timepoint during the study period, the low frequency of documented interventions targeting meals, snacks, feeding assistance and feeding environment is surprising. A lack of documented nutritional intervention has also been observed in general, for hospitalised patients with different diagnoses, where less than half of patients characterised as malnourished had a documented nutritional intervention (164). If interventions are not performed, but needed, the risk of inadequate nutritional intake and malnutrition is increased (17,44,45,57,62) and thereby the risk of worse outcome post burn (20). If interventions are performed but not documented the risk of miscommunication among health-care professionals regarding the evaluation and monitoring of nutritional therapy is increased and thereby also the risk of inadequate nutritional therapy (109,165,166). Deficient documentation on nutritional therapy during hospitalisation have been reported earlier (167,168). Documentation practices have been reported to be shaped by several factors, such as departmental policies, systemic constraints and personal factors e.g., clinical reasoning and professional experience (169). The documentation on food intake seems difficult considering reports on incomplete data entries and with potential errors of up to 20% when comparing results from food intake charts to actual intake (116,117). Interventions

targeting meals, snacks and feeding assistance are important components for the overall nutritional care, however, they may be considered routine and less clinically urgent than interventions involving EN, PN or nutritional supplementation. This area remains sparsely investigated and represents an important topic for future research.

At the study site (Study II), eating enhancement strategies to improve oral nutritional intake e.g., to receive assistance with feeding, feeding position management and meal selection assistance is often performed by assistant nurses. Assistant nurses did not routinely document nutritional interventions or barriers thereto in patients' medical records during the study period (Study II), which could have influenced the results. However, they recorded diet in the diet charts and measurements e.g., weight measurements in the records. Assistant nurses hold a protected professional title since 2023 in Sweden and are obligated to document e.g., measurements and observations in the medical records (108) however, the physician retains the overarching medical responsibility. The responsibility for the patients' nursing care plans is on the registered nurse. The dietitian holds responsibility for the nutrition care process including nutritional assessment, diagnose, intervention, monitoring and evaluation of nutritional therapy (59,170). Inadequate documentation of nutritional information has previously been reported in hospitalised patients (168). One way proposed to increase documentation on nutritional information in medical records is the use of a specific document that is prepared in advance, including e.g., diet to show what round notes are expected to look like (171).

#### 7.1.4 Barriers to nutritional therapy and food intake

Several barriers to nutritional interventions were documented in the medical records, with fasting being the most prevalent barrier for patients both post-minor (90%) and major (100%) burns during the first weeks of hospitalisation (Study II). Fasting has been observed in earlier studies as a barrier for nutritional intervention resulting in decreased adequacy of nutritional intake (101,172–174). In our Study II fasting six hours pre-operatively were practiced during the study period for most participants. The pre-operative fasting from midnight or six hours pre-operatively for all patients have been challenged (174–176). For critically ill patients on mechanical ventilation the administration of EN per-operatively has proven to be safe and effective (174,177,178). Considering the high prevalence of fasting (Study II) it seems important not to be fasting pre-operatively for longer than recommended or post-operatively for longer than medically indicated to optimise nutritional intake post burn (177).

Gastrointestinal symptoms were documented as a common barrier (Study II) which has also been reported in earlier studies (100,158,179,180). These symptoms can cause frequent and time-consuming interruptions in the nutritional delivery (180). Barriers to EN e.g., interruptions/delays to EN administration and problem with enteral feeding access is frequently reported in the *Acute phase* and *Post-acute phase* during critical illness (83,91) and was also frequently documented in Study II, especially for patients with major burns. Consequently, causing a risk of inadequate intake (81,91).

Several other symptoms (e.g., fatigue, decrease in appetite) that also can negatively affect food intake and thereby also have the possibility to affect the development of malnutrition were observed in both Study II and IV. Symptoms that also have been observed in earlier studies (179). During the first 12 days post trauma (Study II), decrease in appetite (17%) and early satiety (17%) were reported. At follow-up six months post burn approximately 1/3 of patients self-reported that the injury had affected their appetite but no difference between patients post-minor and major burns could be detected (Study IV). All these symptoms have earlier been reported as common barriers to eating during hospitalisation but also observed to be able to persist for several months after critical illness, highlighting the importance of extended follow-up post burn (93,179,181). Earlier studies have found burn extent and malnutrition to be independent predictors for dysphagia in older patients > 75 years old post burn (TBSA 1-31%) (96). In Study II only 5% of patients had dysphagia documented as a barrier in their medical records regardless of age. Of the 15 patients > 75 years old in Study II only two (13%) had dysphagia documented as a barrier in their medical record. This could be the result of not having a speech therapist at the study site on a regular basis or reflect that only one patient with documented dysphagia had a major burn. Clayton et al. (96) argues that being over 75 years old could be seen as a risk factor for swallowing impairment post burn since dysphagia have been observed in almost half of older patients with major burns (47%) (96). Treatment with changes in bolus volume and/or viscosity, have the potential to prevent nutritional and respiratory complications related to dysphagia (97). Texture-modified diets were documented in the medical records for half of the patients with dysphagia who had per oral intake (Study II). This is an area that warrants further investigation, as there appears to be scope for improvement.

## 7.2 Methodological considerations

### 7.2.1 Study design, validity and reliability

The observational, single-centre design of Study I-II and IV in this thesis, has its limitations why findings should be interpreted with caution regarding their generalisability. A strength with retrospective observational studies is their potential to portrait actual clinical practice (Study I-II). The prospective longitudinal design in Study IV allows for the observation of changes in NIS over time. Not measuring NIS before injury is a limitation to this study since symptoms reported post burn could have existed before the injury.

Enabling others to critically evaluate the strengths and limitations of study design, execution and analysis is important for the validity and reliability of research (110). Therefore, efforts were made to present the studies in this thesis with full transparency following the statement guidelines for reporting observational studies, Strengthening of the Reporting of Observational Studies in Epidemiology (STROBE) (110).

Using medical records as a data source in research comes with some limitations, as these are designed for clinical care and therefore rarely are standardised or complete and can be prone to subjectivity (110,111,115,182,183). The information can be biased due to patients' recall/reports or the health care professions' assessments or what they choose to document (115,169,184). Efforts were made to enhance data collection quality (Study I-II), by using Patanwala's (112) practical guide on conducting medical record review and Worcester's (113) criterion for quality control in medical records reviews. To increase internal validity and reproducibility an abstraction tool with defined variables and a standardised case report form was used. There is a risk of bias related to the lack of blinding of personnel and data analysts. Having a single trained data collector with experience in data extraction and clinical work in both medical record systems used can be considered a strength. Errors in transferring information from medical records to case report forms are more common in larger studies and when multiple collectors are involved (115). In efforts to decrease subjectivity in data analyses, three observers reviewed 24 randomly selected records for 24 items regarding nutritional therapy in relation to guidelines (Study I) and ten records for nutritional interventions and barriers thereto (Study II), any discrepancies were resolved via consensus.

Deficiency in accuracy has been reported regarding the poor agreement and missing data when comparing medical records to reports from health care practitioners (147). All outlier values were checked to ensure data accuracy. The amount of missing data in our Study I and II may have introduced bias and underscores the need for better documentation in medical records overall. However, a strength is that we reviewed all information in the records,

regardless of which healthcare professional that documented it. A limitation to Study IV was the considerable missingness of data during follow-up after 12 months, but a strength is the sensitivity analysis revealing no statistically significant differences in those participants with missing data compared to those with no missing data. A strength in Study II is the use of a structured terminology, eNCPT (119), with its limitation of not being well-recognised among other professionals other than the dietitians. Another strength is the use of a deductive and an inductive approach in the content analysis (131), enabling being open to the data and creating new codes when data did not align with the eNCPT.

Of the twelve dietitians invited to be part of the expert group (Study III), only six completed the content validation protocol, which may represent a limitation of the study. Nevertheless, between three and ten experts are generally considered sufficient for this type of validation (133). As the content validation was conducted in English and the clarity validation in Swedish, a clarity validation study should be undertaken with a native English-speaking group before these questionnaires are used in English. This approach was adopted because, at the time of the study, there were only two dietitians in Sweden with experience in burn care, making an expert group of Swedish-only dietitians unfeasible. To address this, a back-translation from English to Swedish was performed to minimise discrepancies. To increase validity and reliability, content validity by expert consensus and clarity validity by experts and participants who experienced a burn were done to ensure questions in the DRAQ-burn and ESQ-burn were clear and interpreted uniformly.

Only symptoms considered relevant or highly relevant by the expert group were calculated as 1 in the equation when calculating I-CVI in DRAQ-burn and ESQ-burn. Original symptoms rated as “partially relevant” were calculated as 0 and led to the removal of several symptoms in DRAQ and even more in ESQ. Potentially, these NIS could be missed for some individuals during follow-up after a burn. New questions considered relevant for patients after burns were added. Only 2/5 suggested new questions had  $I-CVI \geq 0.78$  when analysing DRAQ content validity. These were considered relevant according to our rating system. Although  $I-CVI < 0.78$  for the remaining three new questions, they were kept in DRAQ-burn, since they were created by the expert group and had an adjusted  $I-CVI \geq 0.78$  when also taking answers partially relevant into consideration. Good content validity was shown for DRAQ, ( $S-CVI/Ave = 0.86$ ), although three questions with  $I-CVI < 0.78$  were kept, as well as the  $S-CVI/Ave$  for ESQ-burn (0.83) (136).

Possible sample size decreased (Study I and II) due to lack of accessibility to archived medical records from 2015 and 2016. Since sample size necessary

to compare groups had been calculated, with alfa 0.05 and power 0.8, to 32, we concluded that it was feasible to start the study including only medical records from the years 2017-2019. A limitation in Study IV, is the imbalance between groups, 44 in the minor burn group and 11 in the major burn group could restrict the ability to draw firm conclusions regarding the observed differences. The risk of Type II error, falsely getting non-significant results, increases if the study is underpowered. Future studies with larger sample sizes are warranted to confirm the findings. Significance level was set to 0.05, accepting the observed effect can still be due to chance in 5% of the comparisons. The risk of Type I error, falsely rejecting the null hypothesis getting a significant result when no actual difference exists, increases with an increased number of independent comparisons. The number of comparisons in the studies is something to take into consideration when interpreting the results. To minimise selection bias, all patients fulfilling inclusion criteria (Study I and II) were chronologically enrolled and all eligible patients according to inclusion criteria with a follow-up appointment at the burn centre (Study IV) were invited to participate in the study. The inclusive approach is a strength in the studies, but the sampling method (Study IV) also presented potential limitations as 70% of excluded patients had cancelled their follow-up appointment for unclear reasons.

### 7.2.2 Generalisability

The observational single-centre design to the studies in this thesis is a limitation regarding generalisability. Findings may not be applicable to other populations due to factors e.g., differences in available resources, expertise, differences in health care systems, medical records, local protocols and patient population characteristics.

Implementing results from clinical research into clinical practice comes with the question of what if the results are generalisable only to your own clinical setting, patient population and practice. Generalisability can be seen as a continuum, results being more or less generalisable, rather than a dichotomy, results being generalisable or not (185). With this in mind the studies in this thesis are set within the context of a resource-abundant country, in a burn centre verified by the EBA. This centre treats patients requiring all levels of care, referred from across Sweden and occasionally from abroad. Nutritional therapy follows guidelines developed by ESPEN, with regular access to dietetic expertise. The centre operates within the Swedish health care system and uses two electronic medical records; Cosmic (126), primarily used in Sweden, and Metavision Suite (127), which is implemented internationally, including in Northern and Western Europe, the Middle East and Oceania. The

characteristics of the patients in the study samples presented in this thesis (e.g., age, gender, TBSA, full-thickness burn) must also be considered when evaluating the generalisability of the results to other settings. Therefore, the generalisability is limited and the findings in these studies are more representative to patients sharing similar characteristics in a similar context as described above.

The observational single-centre design, incorporating measures to strengthen internal validity represents an appropriate approach for initial studies exploring less-explored questions (nutritional therapy post-minor burn and NIS post burn). A logical progression would be to expand to larger studies involving more diverse populations and settings in future research, thereby enhancing the external validity of the findings.

## 8 Conclusions

In summary, this thesis demonstrates that current burn care practises often fail to meet established nutritional standards, as showed by the persistent gap between documented therapy and guideline recommendations. By identifying barriers to nutritional intervention, the findings illustrate challenges within the continuum of burn care. Furthermore, the sustained presence of barriers, including NIS, across both the *Acute/Post-acute phase* and in the *Rehabilitation phase*, accentuates the risk of inadequate nutritional therapy post burn. Overall, the studies emphasise the need for continuous nutritional assessment, individualised therapy, evaluation and monitoring throughout the burn care trajectory, irrespective of burn extent.

**Study I** revealed low adherence to nutritional guidelines post burn. A lower documented adequacy for both energy and proteins was found among patients post-minor burns compared to the major burns. Given the disparity between guidelines and documented nutritional therapy and the lack of specific guidelines for minor burns, there could be a considerable risk of inadequate nutritional therapy for patients post burn.

**Study II** highlights that vitamin and mineral supplement therapy and medical nutritional therapy are more frequently documented following burn injuries than are interventions targeting diet and meal support, despite most patients having oral intake. The lack of dietary interventions, whether unperformed or undocumented, warrants further investigation. Future studies should explore how documentation affects communication among healthcare providers regarding the prioritisation, monitoring and evaluation of nutritional therapy. The frequent documentation of barriers, with fasting impacting nearly all patients and gastrointestinal symptoms affecting approximately half, suggests a risk of inadequate energy and protein intake. Therefore, emphasising nutritional therapy and its documentation in burn care is crucial, regardless of burn extent.

In **Study III** questionnaires DRAQ and ESQ were modified and adapted for patients in the rehabilitation phase after burn. Eighteen per cent and 57% of

the questions in DRAQ and ESQ, respectively, were considered irrelevant and thus removed and more relevant questions were added. Within the expert group, a high consensus related to the final DRAQ-burn and ESQ-burn was reached. The results indicate that the modified questionnaires can be used for assessing nutrition impact symptoms after burn.

**Study IV** showed that, overall, the nutrition impact symptoms among patients post burn were characterised as mild rather than moderate to severe in nature. Symptoms appear to persist for at least up to 12 months post injury, with comparable prevalence observed after both minor and major burns (median 1-2 symptoms per patient). Although a subset of patients may experience a higher symptom burden, these findings underscore the importance of extended follow-up for nutrition impact symptoms, to mitigate the risk of malnutrition.

## 9 Clinical implications

This thesis highlights the risk of inadequate nutritional therapy post burn. Doing gap analyses between documented treatment and guidelines underscores important aspects for possible improvement of treatment in the clinical setting. Study I has illustrated several areas with low documented adherence to guidelines, e.g., setting energy/protein goals on admission day, reaching 80% of protein targets within 72 hours, screening for nutritional risk and the use of an enteral feeding protocol. Improving the adherence to the nutritional guidelines can be challenging (42). Continuously communicating clear routines in the burn care team regarding nutritional therapy (e.g., setting energy goal on admission day) seems like a good starting point, considering the different and continuously updated guidelines on nutritional therapy (4,5,25,36,46,52,67). At our burn centre, we updated our local guideline and developed a nutrition-calculation tool, which we integrated into the medical records to facilitate tasks such as setting nutritional goals and implementing an enteral feeding protocol.

Nutritional status pre-burn injury can sometimes be difficult to assess during the *Acute/Post-acute phase* of burn (e.g., the patient is sedated and background information is lacking). Considering its importance for nutritional therapy during the trajectory post-burn care efforts should be made to strive for doing the assessment as soon as possible.

Enteral feeding protocols were underused (Study I) despite their proven benefits (80,81). To enhance adequacy of intake compared to individual goals all patients receiving EN could benefit from having a goal volume of EN for each day documented in their medical record. EN is the prioritised feeding route (if not contraindicated) post burn, so the highly documented use of PN (Study I and II) is concerning. An increased utilisation of prokinetic agents, jejunal feeding tubes, and volume-based EN protocols could potentially reduce the use of PN. At our burn centre, we implemented the use of volume-based EN protocols, documented within the overall prescription template in the medical records. We had encountered difficulties in placing post-pyloric tubes at our burn centre, however, the introduction of new routines for tube placement, combined with a new triple-lumen enteral feeding tube, resulted in an increased number of successfully positioned jejunal tubes. In many medical

records, the rationale for initiating PN is not clearly documented (Study I and II). Also, documentation on e.g., meals, meal support, weight development seem inadequate post burn (Study I and II) complicating nutritional therapy evaluation and monitoring. Improving documentation of nutritional therapy seems necessary for better follow-up, monitoring, patient safety, and overall quality of care.

The occurrence of barriers to nutritional intervention post burn represents challenges to the implementation of effective nutritional therapy. Therefore, addressing these barriers seems crucial to improve nutritional therapy. Fasting was reported as a barrier for nutritional intervention for most patients (Study II). Hence, optimised and well-communicated/documented routines for fasting appear particularly important. Making sure patients are not fasting unnecessary either pre-, per- or post-operatively is a team task involving several aspects e.g., clear and well-communicated local guidelines on fasting procedures as well as on decisions on when operation/dressing changes starts. It is also important to ensure that personnel have sufficient time to assess when to stop the fasting and when to reintroduce nutrition without further delays.

Gastrointestinal symptoms were frequently observed (Study II). Thus, it seems important to review what may be causing the symptoms and how they can be treated (e.g., through medication). Nutritional interventions to reduce the impact of symptoms on intake should also be considered, adapting food and meals in relation to e.g., nausea/vomiting by using small frequent meals with soft/easy to chew foods served cool or at room-temperature. In cases of tube feeding, measures such as adjusting the infusion rate or changing to post-pyloric feeding may have positive effects on gastrointestinal symptoms and should therefore be considered.

The presence of nutrition impact symptoms also in the long-term, six and 12 months post burn, highlights the importance of continuous nutritional assessment, evaluation and monitoring of nutritional therapy also in the *Rehabilitation phase* post burn (Study IV). The use of the questionnaires DRAQ-burn and ESQ-burn to identify nutrition impact symptoms that can influence appetite and intake during follow-up in the *Rehabilitation phase* post burn are proposed (Study III).

In summary, healthcare professionals should make use of available facilitators to support adherence to guidelines, remain aware of barriers to nutritional therapy and actively work to overcome them, and ensure continuous nutritional assessment during and after hospitalisation to minimise the risk of malnutrition throughout the burn care trajectory, regardless of burn extent.

## 10 Future perspectives

During the work with this thesis the need for nutritional therapy guidelines also after minor burns and post discharge from hospital has become more evident. Future research should therefore challenge the cut-off TBSA > 20% used in the nutritional guideline by ESPEN (25). If practical guidelines that integrate the stress response to injury with pre-injury nutritional status were developed, they could potentially facilitate more adequate nutritional therapy, regardless of burn extent. However, this requires further investigation.

The frequency of malnutrition pre-trauma, during hospitalisation and post discharge regardless of burn extent needs further investigation. The adequacy of energy and protein intake compared to individual goals were < 80% (Study I). How this is associated with malnutrition, quality of life and function in the *Rehabilitation phase* post-burn needs to be explored in future research. How to assess the nutritional status post burn especially during intensive care treatment and in the early post-intensive care treatment period can be difficult, though. Combining a nutritional assessment including physical examination findings (186) with measurements bedside by ultrasonography of muscle mass (156,160) could have the potential of better understanding the degree of malnutrition and customise the nutritional therapy accordingly. Also, how being malnourished pre-/post burn is associated with quality of life and function in the *Rehabilitation phase* after a burn should be further explored.

There were several barriers identified to nutritional therapy in this thesis, future research should further investigate facilitators to the identified barriers to better understand how to prevent, or minimise, the effects of these barriers.

Very little has been documented on eating enhancement strategies in the medical records (Study II). Investigating those strategies effect on oral intake in the *Post-acute phase/Rehabilitation phase* could bring new insights to future clinical practice. This is particularly important considering the documented inadequate adequacy of energy and proteins in Study I and reports of low intake in the post-intensive-care period (187). Interestingly, reaching protein goals (Study I) seemed harder than reaching energy goals. Considering that the amount of protein intake for optimal wound healing is questioned (70), this is an interesting field of research in the future.

In summary, further research on nutritional therapy during the *Acute/Post-acute phase* and in the long-term *Rehabilitation phase* post burn, regardless of burn extent, is needed to enhance burn rehabilitation. Improving acute and long-term burn rehabilitation (including nutritional therapy) has also recently been identified as one of the top three research priorities in burn care, considered most important by survivors, carers and clinicians worldwide (188).

# 11 Sammanfattning på svenska

En brännskada är ett komplext trauma som påverkar kroppen en lång tid efter skadan (17). Efter en större brännskada (en skadeutbredning motsvarande 20% eller mer av kroppens yta) kan traumat utlösa ett flertal reaktioner i kroppen som bland annat kan ge en förhöjd ämnesomsättning (17,25,39,41). Den förhöjda ämnesomsättningen orsakar ett ökat behov av bland annat energi, proteiner, vitaminer och mineraler (25,32,36). Om en person får för lite energi- och näring efter sin skada kan det leda till bland annat sämre sårhäkning, en större förlust av fett- och muskelmassa samt ökade risker för komplikationer som till exempel infektioner (25,39). Oavsett skadeutbredningen har ett för lågt energi- och näringsintag jämfört med personens behov rapporterats, vilket ger en ökad risk för malnutrition och i och med det risk för ett sämre resultat av behandlingen (42–44). Nutritionsbehandling brukar därför räknas som en av hörnpelarna inom brännskadevården.

I denna avhandling utforskas nutritionsbehandling efter brännskador ur ett flertal aspekter; följer given nutritionsbehandling de internationella riktlinjerna (Studie I), uppnår patienterna efter en brännskada sitt individuellt uppsatta energi- och proteinmål (Studie I) och vilka nutritionsåtgärder och hinder för dessa åtgärder finns dokumenterade den första tiden efter skadan (Studie II). För att vidare undersöka hinder som kan påverka intag efter en brännskada har symptom som kan påverka aptit och ätande utforskats gällande dess förekomst vid 6 och 12 månader efter skadan (Studie IV). Två enkäter: DRAQ och ESQ, som är framtagna för att uppskatta förekomst och grad av symptom som kan påverka aptit och ätande modifierades (Studie III) för att kunna studera dessa symptom efter en brännskada (Studie IV).

Det övergripande syftet med avhandlingen var att undersöka nutritionsbehandlingen efter brännskador i relation till hur stor del av kroppen som blivit skadad. Därför har materialet delats in i två grupper som jämförts med varandra vid analyserna: patienter med mindre brännskador (skadeutbredning under 20% av kroppsytan) och patienter med större brännskador (skadeutbredning 20% eller mer av kroppsytan).

Studie I och II är retrospektiva journalgranskningsstudier av journaler från de första tolv dagarna av vård efter brännskada. Studierna omfattar 134 patienter behandlade för sin brännskada på Brännskadecentrum, Akademiska

sjukhuset i Uppsala, Sverige, 2017–2019. Personerna var 18 år eller äldre och i behov av inläggande sjukhusvård i minst 72 timmar relaterat till sin brännskada. Resultatet visade en låg följsamhet till nutritionsriktlinjer både efter mindre och större brännskador (Studie I). Jämfört med patienter med större brännskador så hade patienter med mindre brännskador en lägre dokumenterad måluppfyllelse av energi- och proteinintag i förhållande till sina individuella mål. Med tanke på skillnaden mellan dokumenterad nutritionsbehandling och riktlinjer samt avsaknaden av specifika nutritionsriktlinjer för patienter med mindre brännskador så visar det på en risk för otillräcklig nutritionsbehandling efter brännskadan.

I Studie II analyserades journaldokumentationen med hjälp av en innehållsanalys (131). Analysen inleddes med att all text i journalanteckningarna lästes igenom upprepade gånger för att skapa en helhetsförståelse av materialet. Därefter identifierades meningsbärande enheter som grupperades och kodades utifrån en terminologi för nutritionsbehandlingsprocessen (eNCPT) (119). För innehåll i texten som beskrev nutritionsåtgärder och/eller barriärer men inte passade in i den befintliga eNCPT-kodverket skapades ytterligare koder. Totalt identifierades därmed 30 olika koder för nutritionsåtgärder och 22 olika koder för hinder för åtgärder. Dessa koder kvantifierades, sammanställdes och analyserades slutligen statistiskt. Resultatet från denna analys visade att extra tillförsel av vitaminer och mineraler, användning av kosttillskott (näringsdrycker och proteinpulver), enteral nutrition (tillförsel av näringslösning via sond till mag-tarmkanalen) och parenteral nutrition (tillförsel av näringslösning direkt till blodbanan) var mer frekvent dokumenterat än åtgärder gällande vanlig mat och måltidsstöd. Detta trots att de flesta av patienterna kunde äta helt eller delvis via munnen under minst en av de observerade dagarna. Bristen på dokumenterade nutritionsåtgärder, vare sig de inte utförts eller inte dokumenterats behöver utforskas vidare i framtida studier. Hinder för nutritionsbehandling var frekvent dokumenterat. Fasta var det vanligaste hindret (dokumenterat i 93% av patienternas journaler) och för cirka hälften av patienterna följt av magtarmsymptom. Många dokumenterade hinder tyder på en risk för otillräckligt energi- och proteinintag. Oavsett brännskadans svårighetsgrad är det viktigt att uppmärksamma nutritionsbehandlingen i vården och att den dokumenteras.

I studie III tillfrågades en expertgrupp bestående av dietister verksamma vid brännskadecentra i Europa om hur relevanta (på en skala från 1–4, där 1 = inte alls relevant och 4 = mycket relevant) de ansåg att symptomen i frågeformulären DRAQ och ESQ var för personer under rehabilitering efter en brännskada, samt om de upplevde att några symptom saknades. För att säkerställa frågornas tydlighet gjordes också en genomgång av experter gällande

terminologin och även patienter fick berätta hur de uppfattade de olika frågorna. Två av elva frågor i DRAQ och åtta av fjorton frågor i ESQ bedömdes som ej relevanta för patienter efter brännskador och togs bort från frågeformulären. Expertgruppen lade till fem mer brännskader relevanta frågor i DRAQ och två i ESQ. En hög samstämmighet gällande relevans för de slutgiltiga frågorna i DRAQ-burn och ESQ-burn uppnåddes i expertgruppen. Således föreslås frågeformulären användas i rehabiliteringsförloppet efter en brännskada för att bedöma förekomsten av symptom som kan påverka aptit och ätande.

I Studie IV genomfördes en prospektiv longitudinell studie där 60 deltagare (patienter) inkluderades åren 2021–2023. Deltagarna var alla 18 år eller äldre och hade blivit behandlade för sin brännskada på Brännskadecentrum på Akademiska sjukhuset i Uppsala, Sverige. Varje deltagare besvarade frågeformulären DRAQ-burn och ESQ-burn vid sina ordinarie återbesök på Brännskadecentrumets mottagning 6 och 12 månader efter brännskadan. Resultatet visade att det var en låg förekomst av symptom som påverkade aptit och ätande 6 månader efter brännskadan oavsett initial skadeutbredning (median två symptom rapporterade i DRAQ-burn och ett i ESQ-burn). De vanligaste symptomen rapporterade i DRAQ-burn var att ätande/aptit varierade från dag till dag samt att patienterna aldrig/sällan kände sig hungriga. De vanligaste rapporterade symptomen i ESQ-burn var trötthet som påverkar aptit/hindrade personen från att äta. Symptomen verkade kvarstå vid 12 månaders återbesöket efter skadan oavsett den initiala skadeutbredningen vilket skulle kunna motivera en längre, än idag, uppföljningstid av symptom som kan påverka aptit och ätande.

Nutritionsbehandling efter brännskador, speciellt efter mindre brännskador, är ett relativt outforskat område. Denna avhandling tillför en liten, men viktig, pusselbit till brännskadevården gällande skillnaderna mellan aktuella nutritionsriktlinjer och given behandling i klinik liksom vilka hinder och symptom vi bör vara observanta på och följa upp i den kliniska vardagen efter en brännskada. Vilka åtgärder som skulle kunna ha bäst effekt på att öka följsamheten till nutritionsriktlinjerna, samt minska de identifierade hindren och symptomen, behöver utforskas vidare i framtida studier. Det behövs även mer kunskap om hur dessa svårigheter är relaterade till malnutrition och födointag efter brännskada och hur det potentiellt påverkar funktion och livskvalitet efter skadan. Ytterligare områden som behöver belysas inom framtida forskning är hur bedömningen av nutritionsstatus kan göras på bästa sätt, speciellt inom intensiv- och intermediärvård efter en brännskada för att kunna individualisera nutritionsbehandlingen utifrån denna. Även patienter med så kallade mindre brännskador kan få omfattande reaktioner i kroppen av sina skador och därmed vara i behov av intensiv-, eller intermediärvård samt drabbas av komplikationer som försvårar läkningsprocessen och vårdförloppet. Utifrån det

resonemanget saknas det nutritionsriktlinjer för patienter med mindre brännskador. Riktlinjer för nutritionsbehandling efter brännskador kanske bör utgå mer från kroppens reaktioner efter skadan än utifrån skadeutbredningen på kroppen. Även detta bör belysas i framtida forskning.

## 12 Acknowledgements

“There is no education like adversity.”

Benjamin Disraeli

For me this PhD-journey turned out to be an emotional roller coaster, with several setbacks and the Covid19 pandemic. In the end of this journey, I can summarise that I have learned a great deal about the joys and challenges of conducting clinical research, about methodology and also about myself. This thesis would not have been possible without the **patients and health care professionals** that participated and generously contributed with their experiences and time, thank you.

This journey would not have been possible without the support and encouragement from supervisors, colleagues, friends and family. I am grateful for having you in my life. I am hoping for and looking forward to future journeys along the research path with you. I would especially like to thank:

**Fredrik Huss** my main supervisor, like a magician there were never any obstacles only different solutions to my research problems. Your positive problem-solution focus inspires me. Thanks for years of believing in me and for your valuable feedback. I am grateful for you welcoming me into the world of burn care.

**Agneta Andersson**, my co-supervisor, thanks for your warm and never-ending support and encouragement over the years. Thanks for always taking the time helping me with all my questions and with the nutritional terminology in the papers. I have enjoyed our discussions and always left our meetings feeling more inspired.

**Catarina Lindqvist**, my co-supervisor, thanks for all your encouragement and all the discussions on research and scientific writing. I love your constructive feedback, which has helped me a lot over the years. Your understanding of the clinical implications of research is inspiring.

**Adriana Miculescu**, co-author in Paper I and III, thank you for your support and for taking your time for discussions on statistics and help with creating the figures. I always left our meetings with new insights.

**Lena Martin**, thanks for guiding me in clinical nutrition, from my first practice as a dietitian student to discussions on study design in the early phases of this thesis. Your clinical work and natural belonging in the teams at the wards worked as a role model for me during my first years as a clinical dietitian. Your competence and thoughtfulness have always inspired me. Thank you for all your support throughout the years.

**Kristina Carlsson** and **Ann-Lena Vetter**, thank you for teaching me calorimetry measurements in an intensive care setting and for our discussions on nutritional treatment and nutritional solutions. Especially thanks for all the laughs and for checking in on me and always making me feel welcome. It has meant more to me than you know.

**The Burn Care Team at Uppsala University Hospital**, thank you for your vast knowledge, dedication, collaboration, curiosity, support and for all the fruitful discussions throughout the years on best achievable nutritional therapy post burn. **Klara Holmberg Olausson**, thank you for a fun collaboration, your encouragement and your support when working together in the burn care outpatient clinic.

The present and former PhD-group “non physicians”, **Anna Stensson Zerpe**, **Åsa Okhiria**, **Marie Lindblad**, **Erika Olsson**, **Sara Enblom**, **Frida Carlsson**, **Olivia Sand**, **Åsa Alberius Munkhammar** and **Naima Hagström**, thank you for our discussions, feedback, encouragement, listening, cheering, laughing, for the social events and for being good friends. I can’t see what this journey would have been without you. I am forever grateful for your time and warmest support!

To “the big four”, this sloth lost its grip on the tree branch and splashed into the water. Confused, it barely managed to keep its head above the surface, but fortunately, it learned how to swim. You believed in me and told me throughout the journey that you knew that I was a great swimmer, for that I am grateful.

The **PhD group** and **senior staff** at the **Department of Food studies, Nutrition and Dietetics, Uppsala University**, especially **Evelina Liljeberg**, for support and strengthening questions. Thank you all for valuable and insightful discussions during the higher seminars.

The **network of dietitians working in burn care**, thank you for the discussions, shared knowledge, laughs and dances. I am convinced that our discussions throughout the years have improved several local guidelines on nutritional therapy among Burn Centres in Europe. Your support has meant a lot! A special thanks to **Gretha Wesseling Keuning** and **Yvonne Verweij Tilleman** you are my dietetic role models in burn care. Thank you for taking the time to answer all my questions. You made my first years working in burn care more interesting, rewarding and fun. I feel honoured to be part of the burn dietitian community.

**Marie Stenlund**, thank you for all the beneficial discussions on nutritional therapy post burn when we started working as dietitians in burn care together. Without your support I am not sure if I would have stayed in burn care. Thanks for the company on our learning and empowering journeys throughout the years to Linköping, Copenhagen and Groningen. I am grateful for the shared knowledge, all the laughs, the shared tears and for your friendship.

The **dietitian group at Uppsala University Hospital**, for your dedication to nutritional therapy and for always keeping the patient in the centre of the care. A special thanks to **Tobias Frid-Skhiri**, **Marie Stenlund**, **Lovisa Nonnen**, **Bita Banieghbal** and **Sofia Forsberg** for supporting me and facilitating my time off for research. Thanks to **Karin Blom Malmberg** for always checking in on me, being curious about my research and for your encouragement. Being seen is a truly warm feeling, thank you.

Former bosses and bosses, especially **Ellinore Svensson** and **Marie Stigsson**, thank you for the encouragement and for making it possible for me to combine my clinical work with doctoral studies.

**Jonas Selling** at Statistikakademin for statistical support. **Annie Smith** for language revision.

**Anneli Jonsson**, I love you for being there during frustrating months of colic when I to some degree lost a part of myself, I am forever grateful. Thank you for the walks, talks, laughs, shared meals and for our family vacations. With you it is easy to just be me.

**Anna Wänstrand**, thanks for the talks, the family adventures and the shared bubbles.

**Mikaela** and **Bodil**, thanks for all the uplifting talks, shared meals and walks. I value our friendship.

**Magdalena, Susanne, Maria** and **Sanna**, thanks for your friendship that have lasted over decades. Thanks for the shared laughter, excursions, for always listening and for all your support. I am so grateful to have you in my life.

My mom **Britt-Mari** and dad **Stefan**, my biggest supporters, thanks for all the cheering along the way. You may not have understood my research, but you truly understand me. I love you. A special thanks for your help with the dissertation party decorations. I'm convinced the tables will look lovely! My brothers **Martin** and **Anton**, thanks for support and all the family adventures throughout the years.

My beloved grandma, **Ulla-Britt**, that passed away. You wanted to be here when I got my doctoral degree and, in many ways, you still are, I miss you. Your stories about life and your curiosity for new flavours and recipes still inspires me.

My husband **Erik** and daughter **Alma**, thank you for always supporting me and making sure I do the things I love; like hiking, skiing, swimming, exploring new places, enjoying the sauna, reading books, doing puzzles, baking, and savouring a good meal. You bring me so much joy, laughter and love. My love for you is endless.

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