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Chapter 1

Introduction and Outline of the Thesis
1. HISTORY OF CENTRALIZED BURN CARE IN THE NETHERLANDS

Since ancient times, burn injuries have been documented as a category of wounds with a protracted course of illness, life-long sequelae and an often fatal outcome. Major improvements in treating burn patients were obtained with the introduction of topical treatment with Tannine by Davidson in 1925 [1], insights into shock therapy and the availability of antibiotics in the Second World War period and in the late sixties of the last century, when silver products as topical therapy were introduced by Fox [2]. Later, new operative techniques such as mesh grafting, introduced by Tanner and Vandeput, [3] and early excision by Janzekovic [4] became available [5,6].

During this period, doctors also became aware that specific knowledge and skills, a multidisciplinary approach and special architectural provisions for isolation and climate control were required to treat patients with burns, eventually leading to the awareness that these patients should be treated in specialized centres.

In the Netherlands at that time, concentrations of patients with burns were particularly influenced by special local situations.

In the sixties professor R. P. Hermans, a surgeon at the Red Cross Hospital in Beverwijk, during a period of minimal safety legislation in the industry, was frequently confronted with patients with burn injuries from the nearby steel factory. Because of the lacking knowledge and the nearly nonexistent interest from the regional universities, this group of patients who required intensive treatment, long hospital stays and extreme hygienic measures could not be referred. For this reason, Hermans focused on caring for burn patients in his own hospital and he became the pioneer of specialized burn care in the Netherlands [7].

In Rotterdam, the situation was nearly the same. In the former Zuiderziekenhuis, at the time the nearest hospital in a region with a large petrochemical industry, professor P.J. Kooreman frequently received patients with extensive burn injuries; this hospital also did not have the possibility of referring these patients to a tertiary care centre because the medical faculty in Rotterdam did not exist until 1966.

This is why Kooreman initiated special care and research for burn patients in the Department of Surgery of the Zuiderziekenhuis.

Lack of interest by the local university also played a role when plastic surgeon professor A. J. C. Huffstadt attempted to establish a burn care facility in Groningen, in the northern part of the country. He then concentrated burn patient care in the former Roman Catholic Hospital, which wanted to create a spearhead of care.

These local situations eventually led to the creation of 3 burn centres in non-university hospitals.
The burn centre of the Red Cross Hospital in Beverwijk, based on the model of the Shriners Burn Institute at Massachusetts General Hospital, which focused primarily on a multidisciplinary team approach and infection control, officially opened in 1974 (Hermans, Spijker).

In that same year, patients in the Rotterdam Zuiderziekenhuis were treated in 2 laminar-flow units in surgical intensive care (Figure 1) and in separate wings of the surgical and pediatric wards.

A new state-of-the-art, stand-alone, 20-bed burn centre in the Zuiderziekenhuis (later renamed Maasstad Hospital) was opened in 1986 (Boxma, Dokter) (Figures 2 and 3).

In Groningen, the Burn Centre of the Roman Catholic Hospital was officially opened in 1979 (Klasen, Sauer).

The ultimate goal of centralized burn care was to improve care quality by concentrating on this specific group of patients with specific emergency management challenges, diagnostics and treatment. As a direct consequence, this also included the need to improve care through research and education.

However, in the Netherlands, only university hospitals receive government funding for these purposes. Therefore, to enable grants for scientific research, Hermans and Huffstadt in 1971 founded the Dutch Burns Foundation for fundraising through donations, legacies and a national collection.

The foundation’s original objective was to support research concerning burn treatment, which was later extended to promoting fire and burn prevention through public information in order to promote quality of care and quality of life for patients with burns; it also expanded into operating a national skin bank, which was later the European Skin Bank (1995).

In 1988, the foundation installed a research department with 4 divisions: pathophysiology in Groningen, wound healing in Beverwijk, epidemiology in Rotterdam and psychological care, directed from Groningen actually implemented at all locations.

This construction led to a significant boost in clinical and experimental studies, leading to papers, publications and theses, following early Dutch theses on burns by A.J. Sneep [8], J. R. Borggreve [9], R. P. Hermans [10] and R. J. A. Goris [11].

To promote mutual contact, publications, and the organization of meetings and symposia, as well as maintaining contacts with related (inter-)national associations, burn care professionals in 1974 founded the Dutch Burns Club, changing its name in 1997 to the Dutch Society for Burn Care (Nederlandse Vereniging voor Brandwonden Zorg, NVBZ).

Reconsidering the framework for Dutch Burns Foundation research grants, Maljers in 2000 [12] concluded that there was a non-transparent and complex structure of consultation, no common vision on scientific research, split efforts and a vulnerable research department.

In a memo concerning adapting the structure of the Dutch Burns Foundation, van de Poll in 2002 [13] advised the foundation to return to its core business (fundraising, prevention, skin
bank) and to link the burn centres in one structure, including the research department and with appropriate funding. Furthermore, an appraisal of projects by an external independent scientific advisory board (Wetenschappelijke Advies Raad, WAR) was recommended to replace the Medical Advisory College (MAC) that had existed since 1974 and consisted of burn centre professionals.

In line with this development, the Dutch Council for Healthcare Research (Raad voor Gezondheids Onderzoek, RGO), which advises ministers of public health, education, science, and economic affairs about priorities and infrastructure in healthcare research, chaired by professor D. J. Gouma, published its advisory on research in trauma care [14].

It was concluded that the trauma research infrastructure in the Netherlands was not particularly well developed, with a relatively small number of researchers, isolated and mostly short-term projects, multidisciplinary research being performed only exceptionally and the lack of a nationwide uniform registration system.

The council recommended creating a Centre of Knowledge in Traumatology and set priorities for research themes. Because burn care is a special dimension in the care of trauma victims and because the majority of research in this field had been performed by the burn centres, the centres were explicitly instructed to contribute to the functioning of the Centre of Knowledge in Traumatology.

The council also recommended a nationwide registration and information system that confirmed to international standards and that would include background information about accidents (aiming at prevention), data on (pre-)clinical care, information concerning research and long-term sequels; in these ways, the system would enable monitoring and evaluating the nature, quality and efficiency of care.

As a result, the Association of Dutch Burn Centres (ADBC; Vereniging Samenwerkende Brandwondencentra Nederland, VSBN) was founded in 2003 to improve the treatment of burn victims in every aspect, expand the knowledge about burn care and patients, improve the quality of research on burns and implement results from preclinical research in the clinic (“from bench to bedside”).

The ADBC research program, directed by Professor E. Middelkoop, was divided into preclinical, clinical, and psychological research and epidemiology and registration.

2. RATIONALE OF REGISTRATION

The rationale for a burn-specific registration is determined by different causes of burns (scalds, flame, chemical, electrical), the fact that many factors influence trauma severity (total body surface area burned, age, depth, localization, co-morbidity) and burn-specific pathophysiology in time (shock, infection, hypermetabolism).
When the new Rotterdam Burn Centre was opened in 1986 and conformed to the advice of the Dutch Council for Healthcare Research, stressing the importance of registration as a quality control system and a standard for care outcomes, methods of registration in the Rotterdam Burn Centre were reconsidered.

At that time, there was no uniformity of registration in the three Dutch burn centres. In fact, the Rotterdam centre had to work with 6 separate registration systems: the local hospital administration registration, a burn centre based clinical dataset, a registration of the hospital Department of Bacteriology, datasets from the Dutch Burns Foundation and the National Hospital Discharge Register (Landelijke Medische Registratie, LMR), and a registry from the Consumer Safety Foundation (Stichting Consument en Veiligheid, SCV).

Many of the existing registration systems did not meet the burn centres’ requirements. The LMR was insufficient for describing the extent and severity of burn injuries, and scoring systems such as the Major Trauma Outcome Score (MTOS) included too few burn patients to validate changes in burn survival. The frequently used Baux score also provided only limited data for exactly predicting survival chances in a great variety of burn injuries.

Because of the lack of uniformity in registration, the author of this thesis together with H. Boxma started a comprehensive registration system for the Rotterdam Burn Centre in 1986 that showed an annual growth up to 6308 patients until January 2016 (Figure 4). Since its beginning, this dataset has been a source of many studies, presentations and publications on specific topics, for example burns in the elderly, inhalation injuries and the repatriation of burn victims.

The epidemiology and registration division of the ADBC in Rotterdam began efforts to develop a uniform nationwide burn-specific registration, the Dutch Burns Information System (DBIS; Nederlands Brandwonden Informatie System, NBIS). The DBIS was supposed to use relevant WHO classifications to collect patient data, information about etiology (International Classification of External Causes of Injury, ICECI), injury diagnoses (International Classification of Diseases, ICD-10), treatment (International Classification of Procedures in Medicine, ICPM), wound healing (with digital photography), complications and outcomes in terms of morbidity and survival.

The future perspective should entail registering separate dimensions of care such as bacteriological and psychosocial data and more treatment and outcome parameters (International Classification of Functioning, Disability and Health, ICF), eventually aiming at developing an international burn information system.

Using Internet facilities for data transport within the DBIS digital certificates and biometrical verification with fingerprint recognition, encryption and decryption via the keys of a digital notary as a trusted third party and firewalls were used to secure reliable input and output. Via biometric verification, data could be extracted for ad hoc analyses, standard reports such as morbidity and mortality figures, and multidisciplinary meetings. In the future, websites
could be filled with validated data for non-burn centre hospitals as a reference base for treatment and referral criteria to burn centres. Citizens would be able to obtain information about burn wounds, first aid and prevention. Developing this system, however, was extremely time consuming, and it posed a significant financial burden for the burn community. Combined with problems concerning privacy legislation and safety procedures, the project eventually had to be abandoned.

The most relevant development was merging the historical databases of the 3 burn centres in 2008 and the Dutch Burn Repository (DBR) R3 registration system, which became operational in 2009 and which contains information on all patients who were admitted to the 3 Dutch burn centres, including etiology, treatment and outcomes. This database is adapted and expanded in close consultation with its users and updated with developments in burn care, creating possibilities for comparison with international databases.

3. AIM AND CONTENTS OF THIS THESIS

This thesis aims to acquire knowledge on the epidemiology, treatment and outcomes of specialized burn care in the Netherlands and is based on data from the Rotterdam Burn centre since 1986, historical databases from the burn centres in Groningen and Beverwijk and the common Dutch Burn Repository R3 since 2009.

Part One includes 2 studies on epidemiology. Chapter 2 analyses the population of patients with burns in the Netherlands, with special reference to patients who were admitted to one of the 3 Dutch burn centres. It is based on the historical databases of the burn centres and the Dutch Burn Repository R3 dataset from 1995 through 2011 and it also includes data derived from the National Hospital Discharge Register.

The relatively high number of children who have sustained burn injuries in the Netherlands is the subject of the epidemiological study in Chapter 3, in which 2 age groups, 0-4 years and 5-17 years, are compared in the 2 time periods 1995-1999 and 2000-2007. The chapter describes referral patterns and admission rates in Dutch burn centres for younger patients with less severe burns.

Part Two addresses 2 different aspects of managing patients with burns. A relatively high percentage of burn centre admissions concerns younger children, who are most frequently injured by scalds. Treatment options are addressed in Chapter 4, comparing topical therapy versus modern wound dressings in children from 0-4 years with scald burns on up to 10% of total body surface area (TBSA) who were admitted to the Rotterdam Burn Centre between 1987 and 2010.
Facilitated by the defective skin barrier and the patient’s innate immune response, infections remain one of the major complications in the period following severe burns. **Chapter 5** discusses the rationale for taking bacteriological cultures on admission. The objective was to assess the frequency of colonization with potentially pathogenic microorganisms on admission and identify the bacteria involved and their potential roles in later septic complications in a large cohort of patients over a 24-year period. For this study, data from the Rotterdam Burn Centre were merged with data from the Department of Bacteriology of the Maasstad Hospital.

Prognosis and outcomes are evaluated in **Part Three**. Infectious complications and sepsis in later phases are closely related to mortality in patients with burns. Chances of survival in earlier stages can be determined by scoring systems such as the Baux score. **Chapter 6** is a validation study of the revised Baux score, which, combined with TBSA burned, age and inhalation injury, is recognized as an important contributor to mortality. Data were analyzed for all 4389 patients with acute burn injury who were admitted to the Rotterdam Burn Centre in the period 1987–2009. Mortality is an important outcome parameter of burn injuries. **Chapter 7** focuses on mortality and causes of death at the Rotterdam Burn Centre between 1996 and 2006 and compares these data with the National Burn Repository, a large American database of over 70 burn centres at the time of the study. **Chapter 8** studies early and late mortality in the Burn Centres of Rotterdam and Beverwijk during the period 2006-2011.

Summaries and conclusions in English and Dutch are presented in **Chapter 9**, followed by an addendum with acknowledgements in Dutch, a bibliography and the authors’ curriculum vitae.
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Figure 1: Surgical Intensive Care with 2 Laminar Flow Units of the Burn Centre Zuiderziekenhuis Rotterdam 1976

Figure 2: Burn Centre Zuiderziekenhuis Rotterdam 1986
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Figure 3: Intensive Care Burn Centre Zuiderziekenhuis Rotterdam

Figure 4: Growing number of admissions in the Rotterdam Burn Centre over the last decade