BURNS MANUAL

A manual for health workers

2nd edition
2008

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Malawi
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<td>Betadine® ointment</td>
<td></td>
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<tr>
<td></td>
<td>Eusol in paraffin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gentian violet paint</td>
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<td></td>
<td>Honey diluted or mixed with ghee</td>
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<td></td>
<td>Mercurochrome</td>
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<td></td>
<td>Papaya</td>
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<td>Silversulphadiazine (SSD)</td>
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<td></td>
<td>Silver nitrate (AgNO₃) 0.5%</td>
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<td>Silver nitrate stick (caustic pencil)</td>
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<td></td>
<td>Tannin solution</td>
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FOREWORD

to the second edition

The first edition of the Burns Manual was well received. It has been popular with staff and students not just at the Queen Elizabeth Central Hospital but also in hospitals throughout Malawi.

The Manual has been in great demand and if its effect on the care for patients with burn injuries is in any way related to the number of copies distributed it is likely to be having a significant impact indeed.

Economic parameters have not changed much in Malawi. Access to electricity is still very much the exception, the majority of households continue to cook on open fires exposing particularly children to manifold risks. Even the increase throughout the country of feeding programmes in schools has inadvertently led to an increase of hot porridge burns in school children.

We expect that the new, revised and improved second edition of the Burns Manual will continue the advocacy for optimal burn care at all levels in the Health Service.

Professor E S Borgstein, FRCS (Ed), FCS (ECSA)
Dean of Postgraduate Studies and Research
College of Medicine
Blantyre
Malawi
Every surgeon, travelling around the world sees how seriously patients and especially children can be affected by burns. Even in the rich countries the suffering is enormous.

The burn instruction manual as written by Evert van Hasselt contributes to expand knowledge how a certain standard and quality of care for burn victims can be provided, even under difficult circumstances.
I can really recommend this manual for everybody working in the difficult field of burn treatment in rural areas.

Professor dr Robert W Kreis, MD PhD
Surgeon, Burn Department
Red Cross Hospital
Beverwijk
The Netherlands

FOREWORD
to the first edition

‘Kufunsa ndi kudziwa njira’

To ask is to know the way – the way to manage burn injuries in Malawi, in the setting of resource constraint, is set out succinctly and appropriately in this manual.

A didactically pleasing approach has been used to guide clinicians at all levels in the practical aspects of the treatment of Burns. The author has drawn on his own vast clinical experience in the treatment of Burns as well as on his long association, from the early design and planning stages on, with the Burns Unit at the Queen Elizabeth Central Hospital to provide step by step guidelines for all aspects of burn care.
The Burns Unit at QECH was conceived and funded by Ms Ann Gloag of Stagecoach Holdings Plc. The design and implementation were guided by Dr E J van Hasselt MD FCS-ECSA together with Prof Jimmy James FRCSEd FRCS, FCS-ECSA and Mr J Howard Stevenson MD, FRCSEd. The opening of this Unit in 1993 transformed burn care at QECH and set new standards for the whole of Malawi.

The Burns Unit has now been in use for more than 10 years and it is timely to draw on the experience gained there to assist clinicians elsewhere in Malawi in dealing with this challenging and distressing condition.

The author has taught burn care to many students and trainees passing through the Department of Surgery of the College of Medicine. At a time when Continuing Medical Education is becoming a focus for the College while Postgraduate training is becoming a reality, this manual will provide a valuable resource indeed.

Professor E S Borgstein FRCS (Ed), FCS (ECSA)
Dean of Postgraduate Studies and Research
College of Medicine
Blantyre
Malawi
ACKNOWLEDGEMENTS

In this second edition of the Burns Manual new concepts and techniques have been introduced. More pictures have been included and a number of them have been redrawn. I like to thank all who have contributed to the revison and to the completely new layout of this manual. The ‘Nederlandse Brandwonden Stichting’ (Dutch Burns Foundation) has made this possible and I would like to thank them wholeheartedly for their very generous contribution and support. The ‘Nederlandse Brandwonden Stichting’ has become the publisher of this manual.
TO THE READER

Burns are a common problem in Malawi and other countries in the region and the management poses a difficult challenge. Because of various circumstances such as lifestyle, ignorance about safety, poverty, the lack of understanding of the seriousness of this condition and the treatment in far from ideal circumstances it is not easy to deliver the optimal care.

The first essential step in the management of a burns victim is
• to treat immediately life threatening problems such as compromised airway and shock (ABCDE)

The next step is
• to determine the severity of the injury

The three most important interventions to prevent death in major burns are
• fluid to treat shock (‘routine’ IV resuscitation of burn injuries less than 15% TBSA is unnecessary)
• food early use of the gut prevents bacterial translocation and reduces ischaemic damage to the mucosa of the bowel
• immediate surgery immediate excision of the dead skin down to the fascia and skin grafting result in minimal blood loss and probably give the best outcome

In our circumstances we should be able to deal with the first two interventions. Due to limited resources it will be difficult to carry out the third intervention.
The following objectives in the management of (severe) burns have to be met

- prevention
- stop the burning process
- provide life support measures such as oxygen, fluids, food and surgery
- give appropriate analgesia
- promote wound healing
- restoration of function by rehabilitation and reconstruction
- support and reassurance of patients, relatives and staff

These will be discussed in this manual, which follows the format of ‘what you should know’ (background reading) & ‘what to do’ (practical procedures). This concept was introduced by Peter Bewes in his book Surgery first published by AMREF in 1984.

We also make use of text boxes at the end of each chapter to highlight important practical steps (‘key points’).

In Part II procedures (‘how to do it’), charts, equipment, drugs, topical agents and feeding regimens will be presented and discussed.

This manual should be used with common sense; a number of treatment regimens and procedures for example cannot be used in health centres, but all of them should be used and carried out at district and mission hospital level.

Please don’t hesitate to give comments & suggestions and send these to the undersigned using the addresses given in chapter 20.

E J van Hasselt
### LIST OF ABBREVIATIONS

<table>
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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AMPLE</td>
<td>allergies, medication, past medical history, last meal, environment</td>
</tr>
<tr>
<td>ARDS</td>
<td>adult respiratory distress syndrome</td>
</tr>
<tr>
<td>ATS</td>
<td>anti tetanus serum</td>
</tr>
<tr>
<td>AVPU</td>
<td>alert, vocal, pain, unresponsive</td>
</tr>
<tr>
<td>CO</td>
<td>carbon monoxide</td>
</tr>
<tr>
<td>CPR</td>
<td>cardiopulmonary resuscitation</td>
</tr>
<tr>
<td>DD</td>
<td>deep dermal</td>
</tr>
<tr>
<td>dob</td>
<td>date of birth</td>
</tr>
<tr>
<td>DW</td>
<td>dextrose water</td>
</tr>
<tr>
<td>ED</td>
<td>epidermis</td>
</tr>
<tr>
<td>E.g.</td>
<td>exemplia gratia (for example)</td>
</tr>
<tr>
<td>EP</td>
<td>eusol in paraffin</td>
</tr>
<tr>
<td>et seq.</td>
<td>et sequentia = and the following (pages)</td>
</tr>
<tr>
<td>EUSOL</td>
<td>Edinburgh University solution of lime</td>
</tr>
<tr>
<td>FBC</td>
<td>full blood count</td>
</tr>
<tr>
<td>FT</td>
<td>full thickness</td>
</tr>
<tr>
<td>g</td>
<td>gram</td>
</tr>
</tbody>
</table>
GV  gentian violet
Hb  haemoglobin
hr(s)  hour(s)
Ht  haematocrit (= PCV)
ICU  intensive care unit
i.e.  id est (that is)
IP  interphalangeal
IM  intramuscular
IV  intravenous
KCl  potassium (kalium) chloride
L  litre
LOC  level of consciousness
MCP  metacarpophalangeal
MP  malaria parasites
MU  mega unit
NGT  nasogastric tube
NS*  normal saline
O₂  oxygen
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ORS</td>
<td>oral rehydration solution</td>
</tr>
<tr>
<td>PCV</td>
<td>packed cell volume</td>
</tr>
<tr>
<td>PRN</td>
<td>pro re nata (as required)</td>
</tr>
<tr>
<td>PO</td>
<td>per os (by mouth)</td>
</tr>
<tr>
<td>qid</td>
<td>quarter in die (4 x daily)</td>
</tr>
<tr>
<td>RL</td>
<td>Ringer’s Lactate</td>
</tr>
<tr>
<td>SC</td>
<td>subcutaneous</td>
</tr>
<tr>
<td>SD</td>
<td>superficial dermal</td>
</tr>
<tr>
<td>SIRS</td>
<td>systemic inflammatory response syndrome</td>
</tr>
<tr>
<td>SSD</td>
<td>silver sulphadiazine (flamazine®)</td>
</tr>
<tr>
<td>SSG</td>
<td>split skin graft</td>
</tr>
<tr>
<td>TBSA</td>
<td>total body surface area</td>
</tr>
<tr>
<td>tds</td>
<td>ter die sumendum (3 times a day)</td>
</tr>
<tr>
<td>tob</td>
<td>time of burn</td>
</tr>
<tr>
<td>TTV</td>
<td>tetanus toxoid vaccine</td>
</tr>
<tr>
<td>U</td>
<td>unit</td>
</tr>
<tr>
<td>Wt</td>
<td>weight</td>
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</table>

NS* although widely used, the term physiological saline is better, but best would be sodium chloride 0.9% (British National Formulary March 2004, page 452)
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  P Bewes
  AMREF 2003
1 INTRODUCTION

Some facts

- A burn may be life threatening especially in the very young and very old
- A burn is very painful ‘it hurts like hell’
- Regular sleep is very difficult
- A burn is unique, no other condition is so painful for so long and debilitating
- Burns are preventable, yet they keep occurring
- Estimated mortality rates of fire-related burns in 2002 worldwide were 322 000; 40 000 of them occurred in sub-Saharan Africa (WHO)
- More people suffer from disabilities and disfigurement caused by burns
- This results in personal and economical effects on both the victim and family ultimately culminating in social stigma and restriction in participation in society
Local & general response to the burn injury

What you should know

- local response
  experimental work by Jackson has shown that a burn wound consists of 3 zones

**Jackson’s Burn Wound Model**

- zone of coagulation: cell death and immediate coagulation of cellular proteins
- zone of stasis: damage in microcirculation resulting in compromised circulation, untreated it will lead to necrosis
- zone of hyperaemia: damage causing production of inflammatory mediators leading to dilatation of blood vessels
• general response
  - skin is the largest organ in the body and isolates chemically, thermally, biologically and mechanically the inside from the outside
  - a burn destroys these functions
  - a burn is three dimensional, it opens up a surface and leads to:
    1. loss of water, electrolytes, proteins and heat due to vascular permeability, which results in the formation of oedema
    2. in burns > 20% TBSA, effects on the whole body are:
      a. hypovolaemia (= shock phase = first 48 hours)
      b. immunosuppression leading to infection
      c. impairment of barrier function of the gut leading to translocation of bacteria (it is therefore important to start enteral feeding early)
      d. systemic inflammatory response post burn affects the lungs resulting in Adult Respiratory Distress Syndrome (ARDS), even in the absence of inhalation injury

What to do

• administration of first aid
• correction of hypovolaemia is life saving in the first hours post burn
• appropriate management of infection
• early enteral feeding

KEY POINTS FOR CLINICAL PRACTICE

- local effect of burn causes 3 zones of injury
- normal capillary exchange is disturbed leading to oedema and loss of albumin from the circulation
- general effects occur in circulation, metabolism, temperature control, immune competence and function of gut & lungs
Epidemiology and causes

What you should know

• some burns are genuine accidents, but most do occur due to carelessness, inattention, pre-existing medical conditions or alcohol abuse
• as long as cooking takes place at ground level and very young children are looked after by their slightly older siblings this will be the main contributing factor to the incidence of burns in children
• lack of safety precautions by adults e.g. topping up paraffin lamps while still burning and hot
• the most frequently encountered pre-existing medical condition is poorly controlled epilepsy, commonly leading to burns
• the majority of burns take place at home
• in more than 50% of the cases children younger than 10 years are affected
• main causes of burns are hot liquids and fire (> 80%), each of which counts for approximately 40%
• a number of burns especially in girls are caused by the combination of fire and nylon (acrylic) dresses

What to do

• at community level safety measures must be taught with the emphasis on a change
  - in cooking habits and
  - in the care for the very young by the somewhat older but not yet responsible sibling
• treat and monitor pre-existing medical conditions e.g. epilepsy carefully and instruct patients about the dangers of not taking the prescribed medication
Introduction

Key points for clinical practice

- Burns are frequently caused by carelessness and inattention.
- Pre-existing medical conditions such as poorly controlled epilepsy contribute to the burden of the burn injury and its sequelae.
- The majority of burns occur in or around the home.
- The most affected group are children below the age of 10 years.

The team concept of burn care

Burns Unit

Improvements in resuscitation, nutrition, the introduction of topical antimicrobials and the introduction of management protocols have shown that specially trained staff is able to operate more effectively within a burns unit.

Burn Team

This is a multidisciplinary group in which individual skills complement each other.

Members are

- Clinicians
- Nurses, who provide the day to day continuity of care and are the backbone of the team
- Physiotherapists & occupational therapists, who play an indispensable role in the rehabilitation process from the time of admission
- Dietitians; to counteract the extreme catabolic response, optimal nutrition is paramount in the care of burn patients
- Social workers for reintegration in the community
2 EMERGENCY EXAMINATION & MANAGEMENT

Prevention

What you should know

- 90% of burns in children can be prevented using common sense and basic household safety measures
- 60% of burns in children occur in the age group below 3 years
- most households still cook at ground level and the very young are looked after by the slightly older sibling
- inflammable clothing such as acrylic dresses can cause severe burns
- careful and continuous management and follow up of pre-existing medical conditions such as epilepsy can prevent burns
- alcohol abuse is indirectly responsible for burns
- be aware of the possibility of (child) abuse

What to do

- educate people about safety and achieve its implementation in and around the home as well as at work
- teach and try to achieve a change in lifestyle at home i.e. no cooking at ground level and don’t let young children be looked after by other young ones
First aid

What you should know

• the management of a burn starts at the scene of the accident
• quick action can reduce the area and the depth of the burn
• the principles of first aid are
  - to stop the burning process
  - to cool the burn wound
• cooling the surface of the burn is also an effective analgesic
• cooling the burn wound will only be effective if commenced within 3 hours of the injury
• in small children prolonged cooling may lead to hypothermia
• do not use ice or ice water, it will deepen the tissue injury and increases the risk of hypothermia

What to do

• first and foremost remove the patient from the cause of burn, if the patients clothes are burning wrap him/her in a blanket and douse with water or roll on the ground
• in a scald (hot water burn) remove clothing rapidly, because soaked clothing acts as a reservoir of heat
• leave adherent clothing in place and cut around it to remove the non adherent clothing
• use cold running (tap) water for 10-20 minutes to stop the burning process; the ideal temperature is 15-18° C (range from 8° till 25° C)
• spraying or sponging is also effective
• prevent hypothermia by checking the temperature, keeping the ambient temperature at 30° C or more and keeping the rest of a child well wrapped
• note the time of the injury
KEY POINTS FOR CLINICAL PRACTICE

- the treatment of a burn starts at the scene of the accident
- stop the burning process
- cool the burn wound
- prevent hypothermia especially in small children
- note time of injury

Primary Survey

What to do

A  Airway maintenance

- open and clear the airway; in case of a suspected injury to the cervical spine keep movement of the neck to a minimum and never hyperflex or hyperextend the head and neck. Stabilize the neck with a hard collar or in between 2 sandbags
- if smoke inhalation is suspected intubate before oedema makes this difficult or even impossible

B  Breathing & ventilation

- expose the chest and make sure that chest expansion is adequate
- always provide O₂ in severe burns or when inhalation injury is suspected give 4-8 L/minute
- beware of a respiratory rate of more than 20 per minute
- perform escharotomy (decompression) in full thickness circumferential burns of the chest (see Ch 14, page 97, 103)
C Circulation and haemorrhage control

- check pulse
  if the **radial** pulse is palpable the systolic BP is 100 or more
  if the radial pulse is not felt feel for the femoral pulse
  if the **femoral** pulse is felt the systolic BP is 80 or more
  if the femoral pulse is not felt, feel for the carotid pulse
  if the **carotid** pulse is felt the systolic BP is 60 or more
  if the carotid pulse is not felt **immediately** start CPR
- stop bleeding with direct pressure
- check capillary refill, if > 2 sec it means hypovolaemia or the need for escharotomy on that limb; check the other limb to compare
- pallor occurs with ≥ 30% loss of blood volume
- in severe burns (>20% TBSA) insert 2 large bore peripheral IV lines

D Disability - neurological status

- check the level of consciousness (LOC)
  - A = Alert
  - V = response to Vocal stimuli
  - P = response to Painful stimuli
  - U = Unresponsive
- examine the pupils for light reaction
- hypoxia can cause reduced LOC

E Exposure with environmental control

- keep patient warm
- keep environment warm
- check for any adherent clothing, cut around it, when removing clothing
Fluid resuscitation

- estimate TBSA, use the Lund & Browder chart or use the palmar surface of the patients own hand = 1%
  (see Ch 13, page 87, 88)
- weigh the patient, if not possible use the following formula:
  2 x (age in years + 4)= ... kg, use only in children < 12 years
- give IV fluids in burns >10% TBSA in children
  and >15% TBSA in adults
- use Ringer’s Lactate or sodium chloride 0.9% (NS)
- formula to be used is 4 cc x wt in kg x % TBSA burn
  (see Ch 3, page 40)
- give half of the calculated deficit in the first 8 hours starting from the time of burn and not from the time the IV drip has been commenced
- monitor adequacy of resuscitation by measuring the urine output, children 1 cc/kg/hr, adults (from 30-40 kg body wt)
  0.5 cc/kg/hr ~ 30-50 cc/hr, accurate measurement is only possible with an indwelling catheter
- insert a NGT in burns > 20% TBSA in children
  and > 30% TBSA in adults
- give adequate analgesia, preferably morphine (not in neonates) or pethidine (see Ch 3, page 43)
Secondary Survey

This is a comprehensive history and head to toe examination after life-threatening conditions have been diagnosed and treated.

- mechanism of injury
  - how
  - when
  - where

- AMPLE
  - Allergies
  - Medications
  - Past medical history
  - Last meal
  - Events/Environment related to injury
    (e.g. was she/he in a closed room)

- head to toe physical examination

Burn wound assessment

Estimation of the area burned

What you should know

The risk of dying from a burn injury is related to the age of the patient and the percentage of the total body surface area (TBSA) burned. In the very young and old you will find that the greater the area injured the higher the mortality rate is. That part of the body which is only superficially burned (there is only redness but no blisters, so called epidermal burns) should not be incorporated in the estimation of TBSA. Palpation of the burned area (use gloves) will reveal blisters and will help to exclude areas of only epidermal burns.
What to do

- the rule of nines divides the body in areas of 9% or multiples of 9%, this rule is relatively accurate in adults, but inaccurate in children. In children use as rule of the thumb the following: up to the age of 1 year the head is 18% and each leg 14%, for each following year
  - subtract from the head 1% and
  - add to each leg 0.5%  
    (see Ch 13, page 89)
- estimate the area burned in small burns by using the area of the palmar surface of the hand (from fingertips to wrist), which is approximately 1% of the TBSA (see Ch 13, page 88)
- the Lund and Browder chart is the most accurate and takes into account the age of the patient (see Ch 13, page 87)

Depth of the burn

Skin structure
Depth burn wound

What you should know

**Superficial burns**
These will heal spontaneously by epithelialisation and can be divided in

- **epidermal** burns, they affect only the epidermis, examples are minor flash injuries and sunburn.
  Hyperaemia occurs due to the production of inflammatory mediators, they are painful and heal within 7 days
- **superficial dermal** burns (=partial thickness superficial), they affect the epidermis and the superficial part of the dermis.
  Here
  - the **blister** is the most important feature
  - the exposed dermis is pink to white
  - the sensory nerves are exposed and the wound is therefore extremely painful
  - they heal within 14 days
Deep burns
These are more severe and will only heal after a prolonged period of time and with significant scarring

- **deep dermal** burns (=partial thickness deep), there may be some blistering but here
  - the appearance of blotchy red discoloration is characteristic
  - an important feature is the absence of capillary refill
  - the dermal nerve endings are destroyed resulting in loss of sensation to pinprick

- **full thickness** burns, both layers (epidermis and dermis) are destroyed and the burn may penetrate underlying structures. Here
  - the burn wound has a white, waxy or charred appearance
  - an important feature is the leathery appearance which is called an eschar
  - there is no pain sensation

*What to do*

**Diagnosis of burn depth**

<table>
<thead>
<tr>
<th>DEPTH</th>
<th>EPIDERMAL</th>
<th>SUPERFICIAL DERMAL</th>
<th>DEEP DERMAL</th>
<th>FULL THICKNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLOUR</td>
<td>Red</td>
<td>Pale Pink</td>
<td>Blotchy Red</td>
<td>White</td>
</tr>
<tr>
<td>BLISTERS</td>
<td>No</td>
<td>Present</td>
<td>+/-</td>
<td>No</td>
</tr>
<tr>
<td>CAPILLARY REFILL</td>
<td>Present</td>
<td>Present</td>
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<tr>
<td>SENSATION</td>
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<td>Painful</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>HEALING</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
In general a superficial dermal (=partial thickness superficial) burn
  • has a moist surface
  • has a positive capillary refill and
  • is painful

Assessment on day 3-5 post burn will help define the depth of the total area burned

**Emergency burn wound care**
  • before hospital admission cover with a clean sheet
  • in hospital either expose or dress with one of the available topical agents
  • avoid the use of tight dressings in limbs with compromised circulation

**Admission criteria**
  • **age**
    - neonates always (often deep burns)
    - babies (< 1 year) TBSA > 5%
    - children TBSA > 8%
    - adults TBSA > 15%
  • **site**
    - head & neck
    - hands & feet
    - groin & axilla
    - perineum
    - circumferential burns of chest and limbs
  • **depth**
    - full thickness burns TBSA > 5%
  • **special**
    - electrical, chemical, inhalation burns
  • **other**
    - social indication

When in doubt admit overnight and reassess the next day.
Laboratory
- take blood for FBC or PCV (=haematocrit)
- if available urea, creatinine & electrolytes
- in children regularly check blood glucose to detect hypoglycaemia
- in case of fever check blood for malaria parasites

**KEY POINTS FOR CLINICAL PRACTICE**
- check airway & breathing, give O₂ in child with >20% and adult with >30% TBSA burned, give 4-8 litre humidified O₂ / minute
- check pulse and capillary refill
- check neurological status, use AVPU
- weigh patient [or 2 x (age + 4) = kg], measure extent (TBSA), note time of burn
- burns >10% in children and >15% in adults start IV resuscitation
- give RL/NS 4 cc x wt x TBSA%
- give ½ in first 8 hours; calculate from time of burn
- monitor urine output, in children > 1 cc/kg/hr, in adults > 0.5 cc/kg/hr, if less increase drip rate
- perform escharotomy and / or fasciotomy (decompression) if limb circulation is compromised or chest expansion is diminished
- **Reasses 4 hourly**: breathing, circulation and neurological status
3 HOSPITAL TREATMENT

Fluid resuscitation

What you should know

Oral fluids

• in all burns < 10% TBSA give oral fluids, use oral rehydration solution (ORS)
• between 10 and 15% TBSA give ORS, but monitor the intake as in IV resuscitation
• in burns up to 20% in children and 30% in adults if no IV or intraosseous access can be achieved insert a nasogastric tube and rehydrate with ORS, use formula as in IV resuscitation

IV fluids

• in major burns (> 20-30% TBSA) there is increased vascular permeability due to release of inflammatory mediators (see Ch 1, page 23); this leads to the development of generalized oedema
• oedema formation stops after 18-30 hours
• from a practical point of view Ringer’s Lactate (Hartmann’s solution) is the internationally accepted choice of IV fluid for the initial resuscitation
• children have limited physiological reserve and greater surface area to mass ratio compared to adults
• the threshold to start IV fluids is lower (10%) in children and they need a higher volume per kg; in addition to the volume deficit they should be given maintenance fluids as well
What to do

Estimation/calculation of fluid deficit

- Adults
  4 cc RL x wt in kg x % TBSA burn =
  deficit for the 1st 24 hrs
  no maintenance

- Children
  4 cc RL x wt in kg x % TBSA burn =
  deficit for the 1st 24 hrs
  plus
  maintenance with DW 5% and NS *
  2 x … kg + 10 = … cc/hr
  or
  100 cc/kg <10kg + 50 cc/kg 11-20 kg +
  20 cc/kg >20 kg per 24 hrs

  e.g. a 35 kg child will need

  2 x 35 + 10 = 80 cc/hr
  or

  - 100 cc / kg for the first 10 kg = 1000 cc
  - 50 cc / kg for the next 10 kg = 500 cc
  - 20 cc / kg for the last 15 kg = 300 cc
  - this gives a total of 1000 + 500 + 300 cc = 1800 cc/24 hrs
  - which is the same as 75 cc/hr (1800 ÷ 24)

* beware of hyponatraemia and hypoglycaemia in children
How to give
- give half of the calculated deficit in the first 8 hours starting from the time of the burn (tob). At the same time in children start maintenance (from the time of insertion of the IV drip)
- give the other half of the deficit over the next 16 hours and in children continue to give maintenance fluids
- for the second 24 hour period after the burn both adults and children must be given maintenance fluids (adults 2500 - 3000 cc/24 hrs)

| ___8 hrs___ | ___8 hrs___ | ___8 hrs___ | _____24 hrs_____ |
| tob ½ deficit | ¼ deficit | ¼ deficit | maintenance |
| add maintenance in children | both children & adults |

Monitoring adequacy of fluid resuscitation
- the best and most reliable method is by monitoring the urine output
- adults 0.5 cc/kg/hr ~ 30-50 cc/hr
- children 1.0 cc/kg/hr
- if the urine output is below this level give extra fluids, either by giving IV boluses of 5-10 cc/kg or by increasing the fluid intake over the next hour to 150% of the planned volume
- when the urine output needs to be monitored closely an indwelling urinary catheter is necessary. Make sure the catheter is removed after 48 hours, it will cause infection if left in too long
- restlessness, confusion and anxiety are signs of hypovolaemia (shock) and the first response is to assess the adequacy of the fluid resuscitation
- in children it is important to look for hypoglycaemia, to prevent this early enteral feeding with carbohydrates is useful
- if possible check electrolytes, children are also prone to hyponatraemia
Problems with resuscitation

- oliguria (urine output < 20 cc/hr or < 0.5 cc/kg/hr) means insufficient fluid resuscitation, do not give diuretics to correct this, give extra fluid instead
- extra fluid resuscitation may be necessary in
  - children
  - inhalation injury
  - electrical injury
  - delayed resuscitation

KEY POINTS FOR CLINICAL PRACTICE

- fluid resuscitation is essential for survival
- IV resuscitation in
  - children > 10% TBSA burned
  - adults > 15% TBSA burned
- the deficit is calculated as follows:
  - child (<30 kg) 4 cc x wt in kg x % TBSA burn plus maintenance
  - adult 4 cc x wt in kg x % TBSA burn
  - ½ of deficit in the first 8 hours (from the time of the burn),
  - ½ over the next 16 hours
- children need carbohydrates early
- use Ringer’s Lactate in the 1st 24 hours
- for the 1st 48 hours insert a urinary catheter in burns > 20% TBSA
- measure PCV / Hb, blood glucose and electrolytes
- constant reassessment and appropriate readjustment of the fluid regimen are vital measures to be taken
Pain relief

What you should know

- a burn hurts like hell
- regular sleep is impossible

What to do

- at regular intervals (4-6 hourly) give opiates IV or IM
- use morphine (not in neonates), give 0.1 mg/kg/dose, do not use it more frequently than every 2 hours
- if morphine is not available use pethidine instead, 1-1.5 mg/kg/dose to be given 4-6 hourly
- for change of dressings use ketamine, 2 mg/kg/dose IM is recommended
- after 48 hours use Paracetamol, give 15 mg/kg/dose (maximum dose per 24 hours = 4 g in adults)

KEY POINTS FOR CLINICAL PRACTICE

- use opiates in the first 48 hours
- give at regular intervals and not PRN
- use ketamine (2 mg/kg/IM) for change of dressings
Nutrition

What you should know

- early feeding is important because the passage of food through the intestines
  - protects the small bowel mucosa from damage that occurs after starvation and trauma and so
  - prevents translocation of bacteria through the bowel wall, which may lead to gram-negative sepsis. This is often fatal in severe burns
- due to a rise in the metabolic rate in severe burns provision of approximately 2 to 3x the usual amount of energy is required
- the body temperature rises (up to 39°) and any skin cooling will cause a further rise in metabolic rate
- at the burn site, where the blood flow may increase tenfold, the O₂ concentration remains low and the wound tissues use anaerobic glycolytic pathways; in other words large amounts of glucose are consumed
- there is an increased breakdown of protein with 80 to 90% of the nitrogen lost in the urine as urea; there is a concomitant loss of lean body mass. A burn of 40% TBSA can cause weight loss of 30% within a few weeks
- in our environment patients are often undernourished. They are from the start when a burn is sustained, nutritionally at a disadvantage
- there is also loss of vitamins and minerals due to skin loss and muscle breakdown
What to do

- keep the ambient temperature high
- give extra feeds high in calories and proteins, such as Likuni phala, high energy milk, Plumpy’nut and commercial feeds like Pro Nutro (see Ch 19, page 129)
- supplement with Vitamins A and C, Iron and Zinc
- use aggressive nutritional treatment for burns > 20% TBSA
- in this group (> 20% TBSA) preferably start naso-enteric feeds 24 hours post burn
- use the following formulas
  - adults proteins 1 g/kg + 3 g/% burn
    calories 20 kcal/kg + 70 kcal/%burn
  - children proteins 3 g/kg + 1 g/% burn
    calories 60 kcal/kg + 35 kcal/% burn
- give extra feeds twice daily in burns up to 20%; increase the frequency when TBSA is > 20% (see Ch 19, page 129)
- preferably feed by mouth, if this is not possible feed by the smallest possible nasogastric tube
- weigh patients at least once a week

KEY POINTS FOR CLINICAL PRACTICE

- early feeding is important
- add Vitamin A & C, Iron and Zinc
- in patients with burns > 20% TBSA aggressive early feeding is essential
- give in burns up to 20% TBSA 2 x daily extra feeds
- in patients with burns > 20% TBSA give extra feeds according to table (see Ch 19, page 129)
- preferably feed by mouth
- weigh patients at least once a week
Burn wound care

What you should know

- a wound is a disruption of tissue architecture and cellular processes
- the thermal insult (heat or cold), electricity or chemical action cause denaturation of proteins and a disruption of cellular structures
- a burn wound interferes with
  - temperature regulation
  - sensory function
  - immune response
  - protection from bacterial invasion
  - protection from fluid loss
- a burn wound is heterogenous i.e. not all areas of the burn are equally deep
- aim of the treatment is to minimize the disruption of function locally as well as systemically
- therefore an as early as possible healed wound is vitally important
What to do

• **first aid** *(see Ch 2, page 28)*
  - clean the burn wound
    - by hand held showering to remove dirt, dressing etc.
    - clean further by using Hibicet® (Savlon®) or normal saline
    - open the blisters and remove loose tissue

• **early active debridement and SSG**, consider this treatment 5 days post burn in all patients with full thickness or deep dermal (= partial thickness deep) burns of the hands. This may not be possible due to
  - the general condition of the patient
  - superimposed illness or trauma
  - anaemia
  - inhalation injury

• **delayed conservative management**, there are basically two approaches

**Exposure** of the burn wound is only possible in a clean and dry environment; after 3-4 days a dry and adherent slough (=eschar/crust) develops, which acts as a barrier against infection. This is achieved by
  - cleaning the wound with normal saline or Hibicet® (Savlon®)
  - removing loose tissue and deroof blisters
  - allowing the burn wound to dry and to form a crust (3-4 days)
  - from then on the wound can be cleaned preferably **twice daily** with normal saline or Hibicet® (pat dry after cleaning) and the patient can be bathed; after 10-14 days the burn has healed or the slough will separate gradually leaving a granulating wound surface which can be grafted

Be aware, that in a **warm** and **moist** environment the eschar acts as a culture medium.
Nurse the patient under a bed cradle *(see figure)* and under mosquito netting.
**Closed** wound treatment in which dressings are used. The dressing is the barrier to infection, to be effective an antibacterial topical agent has to be added otherwise it will create a warm and moist environment which acts as a culture medium for bacteria.

Examples of topical agents are

- acetic acid 0.5%, acts against Pseudomonas, an alternative is diluted vinegar
- eusol in paraffin (EP) is used to remove slough and to induce granulation tissue formation. If no EP is available soak Vaseline gauze in Eusol, apply a layer of gauze soaked in Eusol over it and cover these with dry dressings and a bandage. If a watery solution of Eusol is used then the bandage dries very quickly
- honey mixed with ghee, vegetable oil, glycerine or water is active against Staphylococcus aureus
- papaya, also has antibacterial properties and reduces the formation of hypergranulation
- povidone - iodine (Betadine®) ointment, is active against Staphylococcus aureus
- silver sulphadiazine (Flamazine®), is active against Staphylococcus aureus and Pseudomonas aeruginosa
- silver nitrate solution (AgNO₃ 0.5%), as above
- tannins, made from tea or its byproducts, will lead to improved wound healing and reduced scar tissue formation (fewer hypertrophic scars)
- zinc oxide cream has an antibacterial action and possibly reduces the formation of hypergranulation

*(see Ch 17 how to prepare and to administer, page 121)*

**Differences between the two treatment options**

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<td><strong>INFECTION</strong></td>
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<td>Pseudomonas common</td>
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<td><strong>LABOUR INTENSIVE</strong></td>
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<td>High</td>
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<tr>
<td><strong>PAIN</strong></td>
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<td>Less painful</td>
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<tr>
<td><strong>EVAPORATION</strong></td>
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<td>Low</td>
</tr>
<tr>
<td><strong>HEAT LOSS</strong></td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

**THERE IS NO DIFFERENCE IN SURVIVAL RATE**
General remarks on dressing techniques

- preferably use a fresh dressing pack for each patient
- ideally dress the burn wound once daily. With the use of honey and zinc oxide, the dressing can be left undisturbed for 2-3 days
- remove dressings gently, otherwise newly formed tissue will be destroyed. Soak the dressings in a bath when they are adherent to the wound
- ask the patient to participate in the treatment, e.g. removal of dressings
- bathe or wash the patient after removal of the dressing
- preferably treat children in their room or ward as that is a safe environment for them
- be generous with ketamine especially in children (see Ch 16, page 118)
- be economic with gauzes and dressings, they are expensive
Physiotherapy

What you should know

- maintaining movement and appropriate position of all joints is essential because of the tendency of contracture formation in deep burns
- prevention of contractures has to start right from the beginning in the first few days after a burn injury
- burn patients tend to keep their joints in the ‘position of comfort’ and this will lead to contracture formation
- due to pain and discomfort burn patients don’t move and may develop pressure sores

What to do

- to prevent contractures keep
  - the neck in extension
  - the axilla in abduction
  - the elbows in extension
  - the wrists neutral or in extension
  - the metacarpophalangeal joints in flexion
  - the interphalangeal joints in extension
  - the knees in extension and
  - the ankles in 90° dorsiflexion
- take very good care of pressure sore areas such as occipital, sacral and calcaneal areas and turn patients every 2 hours 24 hours a day to prevent the development of pressure sores
- mobilize patients as early as possible
- involve physio- and occupational therapists at an early stage (see Ch 4, page 59)
Bacteria and infection

What you should know

• infection is mainly spread by the hands of the healthcare worker
• most burn wounds will be colonized with bacteria as early as 3 days after the burn
• where it is not possible to perform wound cultures look at the wound and the dressings, e.g. with Pseudomonas infections the dressings look blue green and with Streptococcus infection the wound is often bright red
• microorganisms most commonly seen in burns are
  - Staphylococcus aureus
  - Pseudomonas aeruginosa
  - β haemolytic streptococcus
  - Escheria coli
  - Proteus mirabilis
  - Klebsiella pneumoniae
  - Candida albicans
• in the early stages of a burn (first 5 days) the burn wound is colonized primarily with gram-positive bacteria such as Staphylococcus aureus, later followed by gram-negative bacteria such as Pseudomonas
• sepsis is a documented infection with systemic inflammatory response syndrome (SIRS), which is present when 2 or more of the following are found
  - temperature > 38 °C or < 36 °C
  - heart rate > 90 beats per minute
  - respiratory rate > 20 breaths per minute
  - WBC > 12 000 cells or < 4000 cells/mm³
- septic shock is as above together with a systolic BP < 90 mmHg or a drop in BP of > 30 mm Hg despite adequate fluid resuscitation
- be aware of other possible infections such as malaria, pneumonia, urinary tract infections etc.

**What to do**

- use alcoholic hand rub (AHR) in between patients and wash hands when they have been soiled *(see Ch 16, page 118)*
- take wound swabs when a wound infection is suspected
- be cautious with the use of urinary catheters and if they are necessary **remove** them as soon as possible
- in case of sepsis start with a combination of broad spectrum antibiotics e.g. chloramphenicol and gentamicine, take immediately a wound swab & blood for blood culture and when the results are out change to the most appropriate antibiotics
- use antibiotics in short courses (not more than 5 days), use the appropriate dose; it is best to use as high as possible a dose for the shortest possible time
- give the antibiotics intravenously until the fever is down, then administer orally
- use the appropriate topical agents e.g. silver nitrate or acetic acid for Pseudomonas

**What not to do**

- do not give antibiotics prophylactically
- do not treat an infected wound with systemic antibiotics unless there are signs of systemic infection
KEY POINTS FOR CLINICAL PRACTICE

- clean the burn wound with saline or Hibicet® (Savlon®), deroof blisters and remove loose tissue
- treat either by exposure or with dressings with antibacterial topical agents
- alternate different topical agents
- treat deep burns of the hand preferably with early debridement and skin graft (after 5 days)
- be generous with the use of ketamine as an analgesic especially in children
- prevent cross infection by using alcoholic hand rub in between patients
- when a patient is confused and/or irritable with a low body temperature think of sepsis
- with suspected sepsis use a combination of broad spectrum antibiotics, give short sharp IV courses
- do not use systemic antibiotics prophylactically or in infected wounds without signs of sepsis, treat the infected wound with topical agents instead

Closure of the burn wound

What you should know

- superficial dermal burns will heal within 10-14 days
- deep dermal burns will heal within 21-28 days
- any burn not healed after 21 to 28 days and larger than 3 cm in diameter may benefit from a skin graft
- a Hb of 12 g% (minimum of 8 g%) or a PCV of 40% (minimum of 24%) and a good nutritional state are essential for optimal wound closure
- full thickness burns always require surgical closure (SSG, full thickness graft, pinch graft or flaps)
- deep burns will need desloughing either by dressings with Eusol or by surgical debridement
- all burns requiring skin cover should be grafted as soon as possible, this reduces the chance of infection & anaemia and let the patient return to a positive nitrogen balance
before a split skin graft is applied the wound should be clean, has healthy flat granulations and preferably no bacteria (or a low count, $< 10^5$ or $\leq 2+$)

- there are three kinds of free skin graft
  - SSG (split skin graft), takes well, the thinner the graft the better the take, is cosmetically less satisfactory, shrinks in time up to 50%, is most commonly used and can cover large areas especially when meshed
  - **full thickness graft**, takes with more difficulty, is cosmetically better and will shrink up to 20%
  - **pinch graft**, is easy to do, the centre is full thickness, the sides partial thickness, resists pressure and infection well and is recommended for small difficult areas such as back of lower leg over the Achilles tendon

- graft failure is due to
  - infection (take a wound swab if possible)
  - bleeding (graft is lifted of its bed)
  - anaemia
  - movement (make sure the graft is fixed well)
  - unhealthy granulations, hypergranulations or no granulations at all

- best donor areas are
  - for a SSG, thighs, upper arms and flexor aspect of the forearm
  - for a full thickness graft, postauricular skin, supraclavicular skin and the groin
  - for a pinch graft, the thighs
What & how to do

• consider a skin graft
  - in defects larger than 3 cm in diameter
  - when the wound hasn’t healed after 21 days
• graft early in hand and facial burns
• how to take a SSG (see Ch 14, page 106)
• they are sutured directly or sometimes with a ‘tie-over’ suture (see Ch 14, page 110); when applied to an arm or a leg they can be fixed with a well applied bandage
• should overlap at the edges
• may be meshed (see Ch 15, the ‘Pizza cutter’, page 111)
• are placed over flexures which are maximally stretched (and splinted)
• are dressed with vaseline gauze preferably soaked in silver nitrate solution 0.5% or with SSD
• are inspected after 5 days unless the wound smells very badly earlier on, then inspect immediately
• when the graft has taken dress again with Vaseline gauze and bandage, after 10-14 days no dressing other than a protective bandage for another 2 weeks is necessary. Apply Vaseline or oily cream (e.g. coconut oil, there is some evidence that it reduces the chance of the development of a hypertrophic scar) to keep the grafted area supple
• apply on the donor area immediately after taking the skin graft gauzes soaked in ‘jungle juice’ (see Ch 16, page 117) during the operation and after finishing the operation apply Vaseline gauze soaked in silver nitrate or SSD and leave undisturbed for 10 days. If, when changing the dressing, the gauzes are still stuck to the donor area do not remove, but instead apply a fresh bandage on top of them
Do not apply a skin graft if
- the wound is colonized with
  - Streptococci (β haemolytic), seen on a Gram stain or when the burn wound looks bright red and bleeds easily
  - Pseudomonas aeruginosa (blue green pus)
- there is a heavy growth of bacteria > 10^5 or > 2+
- hypergranulation is present, treat with zinc oxide or papaya dressings or scrape away before applying the graft
- the wound bed is fibrous without granulations
- the patient is otherwise unwell

### Key Points for Clinical Practice
- consider a SSG when the wound has not healed after 21 days and is > 3cm in diameter
- graft only when a burn wound has healthy granulations, the Hb is ≥ 8g% or PCV ≥ 24% & the patient is well nourished
- fix graft securely
- inspect a graft 5 days postoperatively
- leave the donor area undisturbed until it has healed
- a graft remains fragile for 3 weeks
- keep supple with Vaseline or oily cream and bandage to protect
4 REHABILITATION & RECONSTRUCTION

What you should know

- maintaining movement of all joints with the help of physio- and occupational therapists is essential
- burns that take longer than 2 weeks to heal may develop hypertrophic scarring, physio- and occupational therapy might be required to deal with this using elastic bandages and pressure garments
- pressure garments are used in the treatment of hypertrophic scars
- management of keloids is more difficult
- contractures are preventable
- a burn patient may suffer psychologically as a result of post burn cosmetic disability (body image) and may need help from family, professionals and friends after he or she has been discharged from hospital

**KELOIDS & HYPERTROPHIC SCARS**

Both occur as a result of an exaggerated wound healing response, but the cause is unknown

- keloids are florid lesions, are grossly elevated, spread and involve the normal surrounding skin, are tender to touch and feel itchy & hot
- hypertrophic scars are raised, initially red, do not involve the surrounding normal skin and eventually regress

These descriptions are the extremes and as such easily recognized but in reality there are similarities and also gradation from one to the other. Because the treatment is often similar the name is therefore of less importance, but keloids are notoriously difficult to treat
What to do

- physical scarring is best prevented by maintaining clean non-infected wounds and providing early skin cover
- hypertrophic scars need to be treated vigorously by physio- and occupational therapists with custom fitted pressure garments for as long as 6-12 months or until redness and itchiness have disappeared and the scar has flattened
- keloids are more difficult to deal with, in small keloids (< 2 cm) intralesional injections with corticosteroids (e.g. 0.5-1 cc methylprednisolone / triamcinolone) every 4-6 weeks until flattening has occurred can be helpful, a larger keloid can be excised within its boundaries followed one week later by intralesional injections with steroids (weekly intervals x 3, then 6 week intervals x 3)
- for both hypertrophic scars and keloids the use of topical silicone gel sheets has been introduced with good results. It decreases the pain & itching and results in flattening of the scar. The mode of action is unclear. It is particularly useful in children. The sheets can be washed and reused
- contractures can be prevented or reduced by
  - movements of all joints several times a day
  - passive as well as active stretching of joints affected by a burn
  - activities and games to achieve this
  - splints and skin traction
  - pressure garments
  - early closure of the burn wound
- when this fails surgical release of the contracture may be carried out when it has softened, 6-12 months later on
- basic principles for contracture release are,
  - transverse releasing incisions, rather than Z-plasties
  - serial releases and SSG for severe contractures
  - occasional use of full thickness grafts
  - the use of flaps (random, axial, fascio-cutaneous)
    for the more difficult contractures
• give severely burned patients maximum support, they have to deal with a change in body image, loss of morale and subsequent deformities
• give them love and show compassion; they often need socio-economic support (extra food, special appliances, clothing)

**KEY POINTS FOR CLINICAL PRACTICE**

- frequent active and passive exercise of all joints is essential
- contractures are prevented by exercises, splinting and traction
- treat hypertrophic scars with pressure garments
- treatment of keloids is difficult
- a burn patient will need psychological support from professional staff as well as from relatives, friends and colleagues
5 BURNS IN CHILDREN

What you should know

Epidemiology

- in young children there are more hot water burns (scalds),
  while in older children flame burns are more common

An accurate history is important, particular attention should be given to the non-accidental burn (child abuse)

Body size & proportions

- a child differs from an adult in overall surface area to body weight ratio leading to
  - higher metabolic rate
  - greater evaporation (water loss through burned area)
  - greater heat loss
- also in a child the head and neck are comparatively larger than in an adult and the legs are comparatively smaller
- in a child up to 1 year old the head and neck are 18% of the TBSA, whereas each leg is 14%
- for every year of life > 1 year the head decreases by 1%, whereas each leg gains 0.5%
- by using this modification of the rule of nines it can be seen that the adult proportions are reached at the age of 10 years

Depth of the burn

- the skin in children is much thinner than in adults resulting in deeper burns, for example water of 60°C will cause a full thickness burn
  - in less than 1 second in an infant
  - in 5 seconds in an older child
  - after 20 seconds in an adult
- burn depth assessment is more difficult than in an adult, and can remain so up to 7-10 days post burn
Fluid management

- differences between children & adults
  - in a child a higher proportion of body water is extracellular, blood volume is 80 cc/kg (neonates and babies 90 cc/kg) compared to 60-70 cc/kg in adults
  - renal tubular concentrating capacity is less, this may lead to more rapid and greater fluid loss
  - fluid overload on the other hand may quickly lead to cerebral oedema, especially in combination with hyponatraemia. This risk can be reduced by the use of colloids after the first 12 hours post burn and by the head-up position in the first 24 hours

- assessment of fluid status
  - a child has good compensatory mechanisms, thus the circulation is seemingly well maintained in the face of a fluid deficit, also signs such as anxiety and agitation, which are useful signs of shock in adults are less helpful in children, because they may occur for other reasons
  - subtle signs of hypovolaemia are
    - general appearance of the child
    - skin colour & temperature
    - venous filling

- urine output
  - the most reliable way to assess fluid resuscitation is the measurement of the urine output (1 cc/kg/hr, range 0.5-2 cc/kg/hr), due to the use of fine tubes for catheterisation, mechanical obstruction of catheters does occur
  - when urine output is inadequate check therefore first the patency of the catheter, if this is fine, extra fluid boluses should be given

- intravenous access
  - can be difficult, cannulate larger veins (e.g. femoral vein) only if expertise is available, cannulation through burned skin is acceptable although more difficult, intraosseous access is relatively safe for a short period of time (8-12 hours)
• maintenance fluids
  - are necessary in children and should contain glucose, hypoglycaemia especially in association with hypothermia occurs very rapidly

Airway
• occult upper airway obstruction is common in children, enlargement of adenoids and tonsils may exist before the burn injury
• the lower airway is narrow, therefore swelling of the mucosa and accumulation of secretions interferes with oxygenation
• breathing by diaphragmatic movement is more important in children, this means that abdominal wall rigidity may interfere with oxygenation, consider in burns of the anterior chest and upper half of the abdomen escharotomies
  (see Ch 20, page 103)

Gut
• children are more prone to gastric dilatation and they tend to swallow air when crying, a nasogastric tube could therefore be helpful in burns > 20% TBSA for the first 48 hours
• because of their high metabolic rate and nutritional needs for growth, children should be given early feeds (after 24 hours) enterally; this also prevents loss of gut function
  (see Ch 3, page 45)

Non-accidental injury
• suspicion may be raised by
  - vague or inconsistent history
  - history not compatible with pattern of burn/injury
  - presence of other signs of trauma
  - certain patterns of injury such as cigarette burn marks or sharp demarcations as in ‘bilateral shoe & sock scalds’
• note that false accusation is very damaging to the relatives, unusual and bizarre patterns can be caused by accidental injury
Temperature

- children often run high temperatures in the first few days, unless it exceeds 39 °C, it will need no treatment. Be aware of malaria, check in case of fever always blood for malaria parasites (MP’s)

What to do

- estimate TBSA burned (see Ch 13, page 87)
- calculate and give the deficit plus maintenance (see Ch 13, page 90, 92)
  - after 12 hours replace crystalloids with if possible albumen 4.5% in aliquots
    - each aliquot is 0.5 x wt in kg x burn % TBSA
    - give each aliquot over 6, 6 and 12 hours
    - continue maintenance with crystalloids
- monitor the adequacy of the fluid resuscitation by measuring the urine output (see Ch 13, page 90)
- assess the fluid status by looking at the general condition (irritable, restless), skin colour & temperature and venous filling
- give adequate analgesia (see Ch 3, page 43)
- look at the respiratory rate, give oxygen
- consider a NGT in burns >20% TBSA
- keep the child warm and the ambient temperature high
- nurse in head-up position in the shock phase to prevent cerebral oedema
- prevent hypoglycaemia and hyponatraemia, check blood glucose with dextrostix and check electrolytes. If this is not possible use as maintenance fluid half DW 5-10% and half NS with 20 mmol KCL per litre
- start enteral feeding as early as possible (after 24 hours)
Example of the administration of albumen after 12 hours in a child of 10 kg with a burn of 30% TBSA

deficit for crystalloids is $4 \times 10 \times 30 = 1,200$ cc
600 cc given in 1st 8 hrs
150 cc given in next 4 hrs
then give aliquots of albumen calculated as follows:
$0.5 \times 10 \times 30 = 150$ cc
150 cc in next 6 hrs
150 cc in next 6 hrs and
150 cc in next 12 hrs
that means that after 36 hours this child will have received a total of
750 cc crystalloids plus 450 cc colloids = 1,200 cc IV infusion
give at the same time maintenance with crystalloids and continue this for another 12 hours (i.e. until 48 hours after the start of IV resuscitation)

KEY POINTS FOR CLINICAL PRACTICE

- greater metabolic rate, heat loss and evaporation
- smaller renal tubular concentrating capacity
- higher extracellular proportion of body water
- add to calculated deficit maintenance fluids
- with sodium and glucose
- urine output to assess the fluid resuscitation
- intraosseous access is safe for a short period of time (8-12 hours, max. 24 hours)
- early (after 24 hours) enteral feeding high in calories and protein (2-3 x higher than the normal) is essential

All 3 lead to a more rapid & greater fluid loss
6 INHALATION INJURY

What you should know

There are 3 types of inhalation injuries
- airway injury above the larynx, this is a burn due to inhalation of hot gases, most commonly occurring in an enclosed space. They produce the same changes as in a thermal injury of the skin resulting in oedema leading to airway obstruction. This often develops at the time of maximal wound oedema (12-36 hours post burn). This type of injury is relatively uncommon
- airway injury below the larynx, is produced by inhalation of the products of combustion
- systemic intoxication injury by carbon monoxide (CO) from exhaust fumes & heaters and by cyanide from burning plastics. CO has a much greater affinity to the Hb molecule than O₂, this leads to tissue anoxia. Cyanide is rapidly absorbed by the lungs and may cause loss of consciousness and convulsions

Diagnosis of inhalation injury

Inhalation injury is potentially fatal, therefore look in all cases of severe burns for
- increasing respiratory obstruction occurring over several hours (this is seen in injuries above the larynx)
- abnormalities in oxygenation as shown by restlessness and confusion (this is seen in injuries below the larynx and in systemic intoxication)

Clinical findings suggestive of inhalation injury are
- burns to mouth, nose ⇒ singed nasal hairs
- sputum with soot ⇒ productive cough
- change of voice ⇒ croup-like breathing
- inspiratory stridor ⇒ respiratory problems

What to do
Above the larynx
  • close observation, if stridor and respiratory distress occur
  proceed to endotracheal intubation

Below the larynx give respiratory support
  • humidified O₂, 8 litres per minute preferably by face mask
    (non-rebreathing type)
  • intubate if higher O₂ concentrations are required or if
    bronchial toilet is necessary to remove secretions

In systemic intoxication
  • give respiratory support with humidified O₂ (gradually CO
    and cyanide are removed from the body, although for cyanide
    it does not occur as effectively as for CO)
  • place the unconscious patient in left lateral coma position

**KEY POINTS FOR CLINICAL PRACTICE**

- Inhalation injuries are potentially fatal
- The diagnosis depends strongly on clinical suspicion
- Emergency treatment relies on administering respiratory
  support with oxygen and possible endotracheal intubation
- Mortality increases by 30-50%
7 BURNS OF THE HAND

What you should know

- the dorsum of the hand has a thin skin and the palm a thick skin
- the function of the hand and fingers is jeopardized in severe burns if no prompt and proper treatment is given
- the depth is difficult to assess
- early skin cover is essential (if after 5-7 days there is no sign of healing consider debridement & grafting)
- electrical burns are almost always full thickness burns
- be aware of the development of a compartment syndrome

What to do

In the acute stage (1-7 days)
- remove dirt and adherent material except tar
- wash copiously, tap water may be used
- leave blisters, which don’t interfere with movement or circulation, undisturbed
- apply SSD and either put the hand in a plastic bag or dress the fingers separately to avoid webbing
- elevate the hands on pillows or with a sling
- change dressings daily to assess the depth
- early movement of fingers and wrist joints are essential
- in severe burns give a volar splint with the hand in the position of rest (wrist in 20° extension, MCP joints flexed 70° and fingers [IP joints] straight)
- perform escharotomies and fasciotomies when deemed necessary (see Ch 14, page 97 et seq.)

In the intermediate stage (1-3 weeks)
- continue with mobilization (active and passive movements) & splinting
- apply skin grafts to bare areas
In the long term (after 3 weeks)
- treat hypertrophic scars with pressure garments for 6-12 months
- contractures can be multiple and severe, prevent them from occurring by good early treatment
- when contractures have developed they have to be released surgically

KEY POINTS FOR CLINICAL PRACTICE
- early and appropriate treatment will prevent complications
- debride and perform skin grafts relatively early
- be aware of compartment syndrome and treat accordingly
- treat hypertrophic scars with pressure garments
- established contractures need to be released surgically
8 FACIAL AND PERINEAL BURNS

What you should know

• are caused by hot water, fire or explosions (paraffin lamps)
• are often deep burns, but because of a good blood supply facial burns heal very well
• eyes may be injured by explosions or chemical substances
• severely burned eyelids may cause exposure of the cornea, ectropion and scarring
• the skin of the tip of the nose and ears is thin therefore cartilage often is also burned and / or exposed (especially the helical rim)
• mouth and lips are injured by inhalation or chemical ingestion
• in burns of the perineum and genitalia, retention of urine may occur due to the development of oedema

What to do

General
• clean thoroughly
• apply topical agents daily
• graft early and preferably do not use mesh grafts in facial burns, they will give poor cosmetic results
• in facial burns nurse in (semi)upright position and watch for signs of inhalation (see Ch 6, page 69)

Eyes
• first aid, wash copiously with water (in chemical burns at least for 1 hour) and cover with sterile pad
• in hospital, evert the lid and remove solid particles
• apply chloramphenicol 1% ointment tds for 15 days
• in severe oedema just clean and wait until the oedema has subsided
• if the cornea is exposed do a tarsorrhaphy
• consult the ophthalmologist early
Eyelids
- in deep burns of the upper eyelids early grafting (between 3 and 5 days) is important
- ectropion because of lid retraction will need a release followed by a full thickness graft

Ears
- exposed cartilage should be removed
- repeated cleaning should be carried out
- early grafting is best

Mouth and lips
- copious lavage in chemical burns
- early and selective debridement
- apply plain Vaseline to lips
- to prevent bleeding do not remove crusts

Perineum & genitalia
- insert a catheter and or observe urinary output carefully
- leave burns exposed preferably until healed, this area gets easily soiled when dressed, especially in small children
- if a dressing is required use Vaseline gauze, change frequently
- observe bowel movements

KEY POINTS FOR CLINICAL PRACTICE
- wash thoroughly
- clean thoroughly
- early debridement and skin coverage
- consult opthalmologist in an early stage
- be aware of retention of urine in perineal burns
9 ELECTRICAL BURNS

What you should know

• electrical burns are divided into
  - low voltage (< 1000 volts), household supply
  - high voltage (> 1000 volts), power supply (e.g. ESCOM)
  - lightning, extremely high voltage, short duration, peculiar injury pattern

• tissue damage is caused by the generation of heat and depends on the resistance of the tissues; skin and bone have a high and body fluids have a low resistance

• a high concentration of current and a high resistance cause intense heat

• low voltage current will cause local contact wounds but no deep tissue damage; it may cause cardiac arrest

• high voltage current causes injury in 2 ways:
  - flash burn, the current doesn’t pass through the victim, but the flash ignites for example the clothes
  - transmission of current results in skin and deep tissue damage, this is always full thickness; swelling within the limbs may produce signs of a crush injury and a fasciotomy may be necessary. Also renal failure due to haemolysis and myoglobin release from the muscle injury may develop

• lightning causes a high mortality when the victim is struck directly, in case of a side flash (when lightning strikes a tree and the current is then deflected through a victim on its way to the ground) it can cause a variety of burn wounds, partial and or full thickness
What to do

- remove the victim from the power source, be aware, that high voltage electricity will discharge through air; 40000 volts will jump 13 cm, if you can’t turn off the power use a piece of wood to separate the victim from the power source, preferably stand on a piece of rubber or wear rubber boots
- once clear start with primary survey as in any burn injury
- due to muscle injury (which can be concealed) the fluid requirements are greater than in a pure skin burn, aim for a urine output of 75-100 cc/hr or in children 1.5 cc/kg/hr especially when the colour of the urine is dark red
- in case of a cardiac arrest administer CPR
- assess the peripheral circulation hourly, look at/for
  - skin colour
  - oedema
  - capillary refill
  - peripheral pulses
  - sensory changes
- when the following signs and symptoms are present
  - a palpably tense limb
  - pain on stretching muscles
  - paraesthesia
  - a (not) palpable pulse
  - a brisk capillary refill
a compartment syndrome has developed, this requires an urgent fasciotomy (see Ch 14, page 99 et seq.)
KEY POINTS FOR CLINICAL PRACTICE

- avoid injury to those giving first aid
- treat cardiac and respiratory arrest promptly
- monitor the heart for at least 24 hours
- standard burns resuscitation formulae may be insufficient due to the muscle injury
- watch for myoglobinuria (dark red urine), in that case increase the drip rate and aim for an hourly urine output of 75-100 cc (in children 1.5 cc/kg/hr) until the urine is clear
- when a compartment syndrome is suspected perform an urgent fasciotomy
10 CHEMICAL BURNS

What you should know

• more than 25,000 products which can cause chemical burns are available for use in agriculture, household, industry and military forces
• hands and upper limbs are mostly affected due to handling of these substances
• commonly used chemicals capable of producing burns are:
  - household bleach, disinfectants, toilet bowl cleaners
  - industrial alkalis such as paint removers, caustic soda, lime, washing powders
  - acids such as hydrochloric acid
  - military phosphorus
• a chemical agent produces progressive damage until it is inactivated by a neutralizing agent or diluted with water
• estimation of depth may be difficult in the first few days
• some chemicals produce systemic toxicity (e.g. petrol)
• accidental ingestion (e.g. battery acid) is more common in children
• one third of all patients with intraoral burns eventually have oesophageal injuries, endoscopy is necessary to see the extent of the injury
• stricture formation of the oesophagus is common if burned by chemical substances
• chemical burns of the eye are often serious and may lead to loss of eyesight
What to do

- the first and foremost important action to be taken within 10 minutes of the injury is application of a constant flow of water
- in an acid burn irrigate with water and treat further as a thermal burn
- in an alkali burn there is less immediate damage than in an acid burn, irrigate at least for 1 hour
- phosphorus burns are extinguished by water, particles embedded in the skin continue to burn, therefore remove the visible particles
- in case of eye injuries treat with copious irrigation of water, apply topical antibiotics (e.g. chloramphenicol eye ointment) to prevent secondary infection (see The Surgical Hand Book Ed. E J van Hasselt, 2008, page 83, 84)

KEY POINTS FOR CLINICAL PRACTICE

- agents causing chemical burns are widely present in society
- all chemical burns need copious irrigation with water
- systemic toxicity may occur, especially with petrol
- chemical injuries to the eye will need copious irrigation with water for at least one hour and then referral to an ophthalmologist
11 OUTPATIENT MANAGEMENT

What you should know

- only patients with superficial dermal burns / deep dermal burns (partial thickness burns) < 10% TBSA should be treated as outpatients with exception of the very young & old and those with burns in special areas as discussed in the admission criteria (see Ch 2, page 36)
- scalds are less likely to be deep except in children
- in hand burns involve physiotherapists at an early stage
- every hand burn that takes longer than 2 weeks to heal may develop hypertrophic scarring
- itching may develop in a recently healed burn, moisturizing creams, massage and pressure all help

What to do

- estimate the extent of the burn with the palmar surface of the patients hand (from the fingertips to the wrist), it is approximately 1% of the TBSA (see Ch 13, page 88)
- look at the colour of the burn
- note the presence or absence of blisters
- apply digital pressure and observe the capillary refill
- give oral analgesics
- clean and dress the wound (see Ch 3, page 46 et seq.)
How to do it

- follow aseptic technique
- clean wound with Hibicet® (Savlon®) or normal saline
- puncture blisters and remove all dead and loose skin
- shave all visible hairs around the wound
- cover the wound with any of the available topical agents (see Ch 17, page 121)
- apply 1 layer of Vaseline gauze followed by dry sterile gauzes then bandage, if no Vaseline gauze available apply the topical agent on a dry sterile gauze and proceed as before
- change the dressings at least twice weekly or more frequently when soiled until the wound has healed
- advise patients to elevate bandaged limbs in the first week post burn
- when the wound hasn’t healed completely after 3 weeks refer to the next level (e.g. district hospital / burns unit)
- for minor burns of the hands or burns involving the joints physiotherapy may be necessary
- after the wound has healed it is often still vulnerable and itchy, creams (e.g. aloe vera, coconut oil) and ‘crepe’ bandages can be helpful

KEY POINTS FOR CLINICAL PRACTICE

• meticulous care of the burn wound is essential
• prescribe analgesics and give the correct dose
• when the burn wound has not healed completely after 3 weeks refer
• after the burn wound has healed apply oily cream for one week to keep the scar supple
• when hypertrophic scarring has occurred refer the patient
12 CRITERIA AND PROCEDURES FOR REFERRAL

From health centres to district hospital

- refer
  - children with burns > 5% TBSA and
  - adults with burns > 10% TBSA
  - all neonates irrespective the area burned
  - all full thickness burns
  - all circumferential burns immediately
  - all burns of face, hands, feet, genitalia, perineum and major joints
  - all inhalation burns
  - all electrical and chemical burns

- procedures before referral
  - keep the patient warm
  - wash wounds with Hibicot® (Savlon®) or normal saline and cover with a clean sheet
  - provide pain relief, paracetamol or morphine / pethidine if possible
  - give tetanus prophylaxis

- how soon should a patient be transferred
  - if the nearest hospital is within 30 minutes travel, refer the patient as soon as possible but start the treatment of shock
  - if the hospital is further away get first the shock under control as described on page 85
From district hospital to the next level
(e.g. central hospital / burns unit)

- refer
  - burns > 30% TBSA in adults
    > 20% TBSA in children
    > 10% TBSA full thickness
  - electrical and chemical burns
  - burns with associated inhalation injury
  - extreme age groups
  - circumferential burns of extremities and or chest
  - severe hand burns
  - all burns with associated major trauma

- do not refer when
  - TBSA > 50%, but instead
  - give adequate IV fluids and analgesics (opiates)
  - counsel the family and inform them that the patient is not likely to survive
  - if a patient is still alive after 48 hours and the urine output is more than 1 cc/kg per hour contact burns unit or surgeon on call in referral hospital for advice
When referring a patient take into account the following

- resuscitate adequately and start before referral
  - 4 cc/kg/% TBSA Ringer’s Lactate, give ½ of the deficit in first 8 hours post burn, adequacy is determined by urine output (see Ch 13, page 90), in children add maintenance, calculate as follows: $2 \times \ldots \text{kg} + 10 = \ldots \text{cc/hr}$
- monitor the urine output carefully
- give opiates (morphine 0.1 mg/kg/dose or pethidine 1 mg/kg/dose IV/IM)
- give 100% $\text{O}_2$ by face mask or nasal prongs, 4-8 litre / minute in adults, in children give at the highest flow rate available
- in children with burns > 20% and adults > 30% TBSA it is advisable to insert a nasogastric tube to keep the stomach empty and so minimize the risk of vomiting and aspiration
- in case of circumferential deep burns perform escharotomy (see Ch 14, page 97 et seq.) before referral. Incise the skin into the subcutaneous tissues
- wash the wound with Savlon® or normal saline and cover with a clean sheet
- keep patient warm
- check if tetanus prophylaxis has been given, if not administer when indicated

See for contact addresses and telephone numbers Ch 20, page 133
13 CHARTS AND FORMULAS

Lund & Browder admission chart

Name: .......................................................... M / F
Age/DOB: ...................................................................
Date of admission: .....................................................
Date & time of burn: ..................................................
Weight in kg: ................................................................
What happened: ......................................................

First aid: ....................................................................
Epileptic: yes / no       Inhalation injury: yes / no

---

\[= \text{Partial thickness (PT)}\]
\[\text{= Full thickness (FT)}\]

**IGNORE SIMPLE ERYTHEMA**

<table>
<thead>
<tr>
<th>REGION</th>
<th>PT %</th>
<th>FT %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ant. trunk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post. trunk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right arm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left arm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buttocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Genitalia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right leg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left leg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Burn</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Relative percentage of body surface area affected by growth

<table>
<thead>
<tr>
<th>AREA</th>
<th>AGE 0</th>
<th>AGE 1</th>
<th>AGE 5</th>
<th>AGE 10</th>
<th>AGE 15</th>
<th>ADULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: half of head</td>
<td>9.5</td>
<td>8.5</td>
<td>6.5</td>
<td>5.5</td>
<td>4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>B: half of one thigh</td>
<td>2.75</td>
<td>3.25</td>
<td>4</td>
<td>4.5</td>
<td>4.5</td>
<td>4.75</td>
</tr>
<tr>
<td>C: half of one leg</td>
<td>2.5</td>
<td>2.5</td>
<td>2.75</td>
<td>3</td>
<td>3.25</td>
<td>3.5</td>
</tr>
</tbody>
</table>
in small burns estimate the extent of the burn with the palmar surface of the patient's hand (from the fingertips to the wrist), it is approximately 1% of the TBSA
The picture on the right side shows a child of 1 year; for each year older than 1 year subtract 1% from the total percentage of the head and add 0.5% for each leg. Note that by the time a child has reached the age of 10 years it has the proportions of an adult.
Emergency Management of Severe Burns

A. Airway maintenance with cervical spine control
B. Breathing and ventilation
C. Circulation with haemorrhage control
D. Disability – neurological status
   Alert/Voice/Pain/Unresponsive = AVPU
E. Exposure and environmental control
F. Fluid resuscitation (IV) proportional to burn size
   adults: >15% TBSA  children: >10% TBSA
   give RL/NS 4 cc/kg/%TBSA / 24 hrs
   give half in first 8 hours post burn and the other half in the next 16 hours
   in children
   add maintenance NS with DW 5% or 10% per 24 hrs
   100 cc/kg <10kg + 50 cc/kg 11-20kg + 20 cc/kg > 20kg body weight or
   2 x …… kg + 10 = …… cc/hr
   Monitor urine output:
   adults 0.5 cc/kg/hr - 30-50 cc/hr
   children (< 30 kg) 1.0 cc/kg/hr (range 0.5-2.0 cc/kg/hr)
G. Get lab tests done  PCV, FBC, U&E’s
   Give drugs analgesics  Morphine 0.1 mg/kg/dose
   (not in neonates)
   Pethidine 1-1.5 mg/kg/dose or
   Paracetamol 10-15 mg/kg/dose
H. History
   A  Allergies
   M  Medications
   P  Past medical history
   L  Last meal
   E  Events related to injury

Head to toe examination
Wound management

- in full thickness circumferential burns consider escharotomy (decompression) immediately, when in extremities there is pain on stretching muscles, pulselessness, paraesthesia and paralysis and in chest burns when the patient has difficulties in breathing
- cover the burn wound with something clean
- elevate burned limbs
- in facial burns transport/nurse in half sitting position
- avoid tight dressings or bandages

**Burn resuscitation formula = deficit + maintenance**

**How to administer**

- give half of the volume deficit in the first 8 hours, starting from the time of the burn; at the same time in children start maintenance fluids
- give the other half of the deficit in the next 16 hours, continue in children with maintenance
- continue with maintenance for another 24 hours in both children & adults
- measure urine output for 48 hours
How to calculate

1st 24 hours

- Deficit children (< 30 kg)
  \[4 \text{ cc} \times \text{wt in kg} \times \text{TBSA \%} = \ldots \text{ cc}\]

Add maintenance
\[2 \times \ldots \text{kg} + 10 = \ldots \text{ cc/hr}\]

Or
\[100 \text{ cc/kg} < 10 \text{ kg} + 50 \text{ cc/kg} 11-20 \text{ kg} + 20 \text{ cc/kg} > 20 \text{ kg} = \ldots \text{ cc/24 hrs}\]

See Ch 3 page 40 for an example of the calculation of maintenance fluids

- Deficit adult (> 30 kg)
  \[4 \text{ cc} \times \text{wt in kg} \times \text{TBSA \%} = \ldots \text{ cc}\]

No maintenance

2nd 24 hours

In children continue with calculated maintenance and give adults 2500 - 3000 cc/24 hrs maintenance fluids as well. Discontinue the IV drip after 48 hours if well resuscitated as measured by the urine output

Urine output in > 30 kg 30 - 50 cc/hr (0.5 cc/kg/hr)
in < 30 kg 1 cc/kg/hr = \ldots \text{ cc/hr}
Table

Use the following table to write down the deficit and maintenance to be given

<table>
<thead>
<tr>
<th>Date</th>
<th>8 HOURS</th>
<th>16 HOURS</th>
<th>24 HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME OF BURN</td>
<td>…………</td>
<td>…………</td>
<td>…………</td>
</tr>
<tr>
<td>ACTUAL TIME</td>
<td>…………</td>
<td>…………</td>
<td>…………</td>
</tr>
<tr>
<td>FLUID VOLUME IN CC AS CALCULATED</td>
<td>…………</td>
<td>…………</td>
<td>…………</td>
</tr>
</tbody>
</table>

Weight

When there is no scale available calculate the weight in children < 12 years using this formula

\[ 2 \times (age \text{ in years} + 4) = \ldots \text{ kg} \]

Maintenance fluids in children

Use sodium chloride 0.9% and Dextrose water 5-10%

- Up to 10 kg: 4 cc/kg/hr or 100 cc/kg/24 hrs
- From 11-20 kg: 2 cc/kg/hr or 50 cc/kg/24 hrs
- From 21-30 kg: 1 cc/kg/hr or 20 cc/kg/24 hrs

Another formula used is

\[ 2 \times \text{ weight in kg} + 10 = \ldots \text{ cc/hr} \]
Normal paediatric vital signs

<table>
<thead>
<tr>
<th>AGE</th>
<th>Minimum heart rate (b/min)</th>
<th>Systolic BP (mm Hg)</th>
<th>Respirations Breaths/min</th>
<th>Minimum Hb (g/dl)</th>
<th>Minimum PCV/Ht (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 YRS</td>
<td>100-160</td>
<td>60</td>
<td>30-40</td>
<td>11.0</td>
<td>33.0</td>
</tr>
<tr>
<td>2-5 YRS</td>
<td>80-140</td>
<td>70</td>
<td>20-30</td>
<td>11.0</td>
<td>33.0</td>
</tr>
<tr>
<td>6-12 YRS</td>
<td>70-120</td>
<td>80</td>
<td>18-25</td>
<td>11.5</td>
<td>34.5</td>
</tr>
<tr>
<td>&gt; 12 YRS</td>
<td>60-110</td>
<td>90</td>
<td>16-20</td>
<td>12.0</td>
<td>36.0</td>
</tr>
</tbody>
</table>
14 PROCEDURES

Intraosseous puncture

Only in children < 2-3 years of age. Use intraosseous fluids preferably 8-12 hours but not longer than 24 hours

Anatomy

The arrows indicate the direction of the puncture, always start with the tibial intraosseous puncture 1-2 cm distal to the tuberosity, under an angle of approximately 45-60°
TECHNIQUE

- stabilize the leg with one hand,
- push the needle onto the tibia and rotate clockwise while pushing
- use a 14-16 G needle
- after perforation of the cortex aspirate marrow
- inject sodium chloride 0.9%, if this goes easily then start the drip
- splint the leg

COMPLICATIONS

- osteomyelitis
- perforation through the posterior cortex
- extravasation
- haematoma
- intra-articular placement of the needle
- injury to the epiphysis
Escharotomy

*(see also decompression page 102)*

**TECHNIQUE**

- preferred sites for incisions
- heavy lines emphasize the importance of incising the eschar over the joints
- incise the skin into the subcutaneous tissue
IMPORTANT POINTS

- keep the incision in the arm anterior of the medial condyle at the elbow to prevent injury to the ulnar nerve

- to treat the fingers place the incision preferably along the ulnar surfaces of the fingers, this will prevent future problems with scar sensitivity when grasping objects
Fasciotomy

(see also decompression page 102)

Lower leg

Skin incision lateral

Skin incision medial
**Decompression for the compartment syndrome**

**Technique**
- after incising the skin
- on the medial side incise the fascia of the posterior compartment
- on the lateral side first incise the fascia over the lateral compartment
- then rotate the skin forwards to incise the fascia of the peroneal muscles
- finally through the medial incision just behind the tibia thrust blunt tipped scissors to decompress the deep posterior compartment
Forearm

The forearm has 3 compartments
  • volar (flexor)
  • dorsal (extensor)
  • mobile wad (upper forearm muscles on the radial side)

They are all somewhat interconnected; opening the volar compartment may relieve the pressure in the other 2 compartments. If after incision the arm still feels tight an additional incision should be made to release the dorsal compartment

Markings for an incision to decompress the volar forearm
The incision begins in the hand for full decompression of the carpal tunnel

Markings for the incisions needed to decompress the dorsum of the hand and forearm
Technique

- make an incision as above and make sure you include the underlying fascia; in the palm you will release the carpal tunnel
- the dorsal compartment and mobile wad are released by a straight longitudinal incision on the dorsal surface of the arm; this incision does not have to cross the elbow or wrist

Decompression

- escharotomy is associated with the acute management of burns
- the principles and practice of this procedure are badly understood, taught and carried out
- escharotomy often is seen as a procedure with a beginning and an end
- it would be better to see it as a process
- this process is called decompression

Decompression has to be considered for all body compartments where an increase in compartmental pressure may compromise a vital function.

Compartments include
- intra- and extracranial head & neck
- chest
- abdomen
- limbs

Decompression of the cranium may be achieved by using hyperosmolar solutions such as Mannitol® to reduce swelling of the brain, by craniotomies or by fluid restriction and elevation of the upper body.

Decompression of the chest is often inadequately done, mainly because the classical incision (see also page 97) does not dissociate the ribs from the abdomen (see picture a).
Picture b shows a release below and parallel to the costal margin, which will effectively separate the chest and abdomen and so reduces resistance to ventilation.

Abdominal compartment syndrome, which recently has been appreciated can be diagnosed by measuring the intra-abdominal hypertension by direct measurement of the pressure in the urinary bladder. It may be resolved by conservative measures such as sedation and the administration of diuretics, possibly followed by surgical procedures such as escharotomy and finally laparotomy. To reduce the intra-abdominal pressure the abdomen is not closed but instead a ‘Bogota bag’ is sutured to the skin edges (see The Surgical Hand Book, Ed. E J van Hasselt, 2008, page 265).

In the limbs conventional thinking is focused on peripheral perfusion, but of greater concern should be a raised interstitial pressure in the closed osteofascial compartments, which may lead to microvascular compromise, ultimately resulting in inadequate tissue oxygenation.
The compartmental anatomy of the limbs is well described with
• 2 compartments in the upper arm
• 3 in the forearm
• 10 in the hand
• 3 in the thigh
• 4 in the lower leg
• 4 in the foot

The mechanism of the compartment syndrome in acute burn injury is
• rise of the interstitial pressure leading to
• cell death, which results in
• further oedema and
• further rise in pressure and cell death

Early findings of a compartment syndrome in the limbs are
• a palpably tense limb
• still palpable pulses
• pain on stretching muscles
• paraesthesia and
• a brisk capillary refill (this sign is frequently not mentioned)
Management

Non-surgical
- in a raised limb the mean arterial pressure and thereby the capillary flow may be reduced
- in a dependent limb swelling of the tissues may increase and so keeping the extremity at the level of the heart is probably the best compromise
- therefore the limb should rest on a pillow
- any constricting bandage should be removed
- the haemodynamic status should be monitored closely especially with regard to fluid overload; in this perspective the use of colloids in this perspective in resuscitation should be considered

Surgical
In acute compartment syndrome it is probably better to decompress ‘too often too early’ than ‘not often enough too late’. The following principles should be adhered to,
- avoid damage to cutaneous nerves
- preserve longitudinal veins
- avoid straight line incisions across joints
- decompress major nerves and / or vessels as indicated

Relevance of fasciotomy to escharotomy

The figures on the inside of the flap at the back show in red the classical incisions for an escharotomy and in black the dotted lines for a fasciotomy.
Looking at the cross section of the lower leg it is clear that, when the escharotomy incisions would be deepened to include the deep fascia, this will leave the anterior and deep posterior compartments unreleased.
Therefore it would be more logical to perform an escharotomy through the same skin incisions advocated for a fasciotomy (although in burns a release of the fascial compartments is not often necessary).
In summary

- decompression is a process which requires assessment, measurement and monitoring
- important measures are positioning of limbs and quantitative fluid resuscitation
- surgical intervention should be performed in a theatre with strict adherence to aseptic techniques
- depth, extent and placement of incisions should be based on anatomical considerations that allow for the safe and effective conversion of an escharotomy into a fasciotomy

KEY POINTS FOR CLINICAL PRACTICE

- remove rings, tight bandages and clothing
- position the limbs at the level of the heart
- consider colloids in resuscitation
- consider surgical decompression in circumferential full thickness and deep dermal (partial thickness) burns irrespective of symptoms & signs
- in full thickness burns also consider fasciotomy
- place the skin incisions for an escharotomy as for a fasciotomy
- assess again, again and again
- operate in theatre under strict aseptic conditions and with an aseptic technique
Skin coverage

• consider any skin defect larger than 3 cm in diameter and not yet healed after 3 weeks for grafting
• take preferably the skin of the thigh and/or the inner aspect of the upper arm as your donor area
• lubricate the skin and the knife with Vaseline
• to ensure the proper thickness adjust the opening of the blade so that you can snugly fit the beveled edge of a number 10 scalpel blade into the opening
• hold the Humby / Watson knife at an angle of about 45° with regard to the skin, press it down and make a to and fro motion over the tight skin, the knife will glide forward by its own weight
a thin graft is semi-transparent, a thick graft has the texture of an orange peel with curling edges

- mesh the graft with a Pizza cutter (see Ch 15, page 111) or place multiple cuts in the graft, this prevents blood and serum from accumulating under the graft

- remove from the recipient site any hypergranulation or unhealthy looking tissue

- decrease the amount of contamination by gently scraping the wound with the edge of a scalpel

- stop the bleeding by applying a wet gauze and pressure for a few minutes, haemostasis is important

- place the graft with the dermis side (the shinier side) down and either suture it in place in areas where no proper pressure bandage can be applied or fix the graft with ‘pull out’ tie-over sutures (see this Ch, page 110)

- after taking the graft apply immediately on the donor site gauzes soaked in ‘jungle juice’, after finishing the operation dress the donor site with Vaseline gauze soaked in silver nitrate solution or SSD and leave in place for 10-14 days, if soiled remove only the outer layer and reapply a new bandage

- dress the recipient area with Vaseline gauze soaked in silver nitrate solution or SSD if available

- inspect the graft on day 5 postoperatively, if it starts to smell earlier on, then inspect immediately, clean it gently and apply an antibacterial topical agent

- the graft will remain fragile for about 3 weeks, protect it with a bandage and keep supple with Vaseline or any oily cream

- in a SSG shrinkage can occur up to 50%
A **pinch graft** *(see picture)* can be used for small and difficult areas e.g. back of the lower leg near the heel

**TECHNIQUE**

- use local anaesthesia, infiltrate lignocaine 0.5 - 1% under the area to be used as donor skin
- pick up a ‘tent’ of skin with the point of a needle
- cut off the little piece of skin underneath; a knife blade no. 11 is very effective
- lay it on the granulating recipient area
- proceed as in a SSG
The ‘pull out’ tie-over dressing

The ‘tie-over’ dressing is a well known method to fixing skin grafts because it fulfills the following essential criteria required for a successful graft take:

- pressure
- absorption of exudate
- splinting / immobilisation

Recently the following modified technique has been developed.

**TECHNIQUE ‘PULL OUT’ TIE-OVER**

- first fix the graft with a circumferential peripheral 5/0 absorbable suture (see fig. 1)
- 3 or 4 monofilament 3/0 sutures are applied across the defect by passing them through the skin, the graft, across the graft and back through the graft and the skin (see fig. 1)
- paraffin gauze is then applied over the graft and a sterile foam or wool placed on top
- the monofilament sutures are tied individually over the foam (see fig. 2)
- a strip of paraffin gauze is wrapped around the edge of the foam followed by a dressing (see fig. 2)
- by cutting the monofilament sutures and sliding them out, the dressing can be removed easily

![figure 1](image1.png)

![figure 2](image2.png)
15  EQUIPMENT & MAINTENANCE

The Pizza cutter

By using a round pattern file, notches 5 mm deep are made in the sharpened edge of the pizza cutter at distances of 0.5 or 1 cm. On a board preferably of very hard wood (e.g. teak) or synthetic material (e.g. hard plastic or resin) the skin can be cut by rolling the wheel. Strips of 0.5 cm in width can be cut and will give an expansion of 1-1.5 times. The device can be sharpened by using fine grit abrasive film (sandpaper) or the equipment described below.

How to sharpen your Humby knife

- take a micro abrasive film preferably with a thick Mylar backing with which the microfilm is easier to handle
- the alternative is a microfilm with an adhesive backing, which is placed on top of a piece of X-ray film, which is not wider than the width of the knife of a Humby dermatome
- use a 15 micron film (to be obtained from good hardware stores), see picture
- after loosening of the guide bar the film is inserted with the abrasive against the blade, close the blade of the Humby knife down onto the bar, and pull the film through
- a downward angle of 30 degrees or so removes more metal especially if the blade is dull (see picture)
• the process is repeated 5 or 6 times which should be enough to improve even a very dull blade
• one sheet would do at least 10 sharpenings
• sharpening one side only is usually enough
• the 15 micron film is probably the most durable. As the particles fracture a finer edge is produced, so using a new film, followed by a used one is a good strategy
Sharpening your instruments

Scalpels, razors, skin graft blades

- rub the instrument against the rough side of a combination stone, always keep the same angle between the blade and the stone

- with a blunt knife rub in small circles to begin with, oil the surface of the stone, with a sharper knife rub in a straight direction, usually towards the sharp edge
- the blade is beginning to get sharp when there is no reflection of light from the very edge when you hold it up against the light
• sometimes a ‘burr’ develops, you can feel it by stroking with the finger. Rub it away by stroking the blade against the stone even more lightly, always at the same angle, and use oil as before

Feeling for the burr

Rubbing off the burr

• when the blade is really sharp, strop it. Hang the strop by its shoelace and stroke the blade firmly by pulling it away from its sharp edge

Smooth side

Rough side

A combination stone

A leather strop

Extra

A small grindstone
16 DRUGPROTOCOLS

Tetanus prophylaxis

- never immunized: ATS 1500 U SC/IM + 0.5 cc tetanus toxoid vaccine (TTV) SC/IM. Repeat TTV 0.5 cc week 4 and week 8.
- fully immunized: < 10 years ago, no need for TTV. > 10 years ago, give 1 dose of TTV.
- partially immunized: < 10 years give 1 dose of TTV. > 10 years give 3 doses of TTV with a monthly interval.

Tetanus treatment

Incubation period between 7-10 days, the shorter the interval between the injury and symptoms the more severe the disease.

Grading of severity

- grade 1 (mild): moderate trismus, no spasms, no respiratory problems, no or little dysphagia.
- grade 2 (moderate): moderate trismus, marked rigidity, short lasting spasms, tachypnea > 30/min, mild dysphagia.
- grade 3 (severe): severe trismus, generalized rigidity, prolonged spasms, respiratory failure, tachypnea > 40/min, severe dysphagia.
- grade 4 (very severe): same as in grade 3 plus autonomic disturbances, such as hypertension & tachycardia alternated with episodes of hypotension & bradycardia.
All patients should receive on admission
- antiserum preferably human tetanus immunoglobulin 3000-5000 U IV/IM, if not available equine antiserum 10 000 by slow IV injection. Beware of anaphylactic reaction / shock (see box below for treatment)
- sensitivity test is unreliable, it may be better to expect an anaphylactic reaction
- antibiotics, metronidazole 500 mg IV 6 hourly or 1 g IV 12 hourly for 7 days (benzylpenicillin is a poorer alternative 2 MU 8 hourly IV for 8 days)
- vaccination before discharge
- wound debridement

**Grade 1 & 2** can be treated in hospital without ICU facilities

- control spasms with
  - diazepam 0.05-0.2 mg/kg/hr IV or
  - phenobarbitone 1.0 mg/kg/hr IV/IM, followed 3 hours later with chlorpromazine 0.5 mg/kg/6 hourly IM
- reduce external stimuli
- keep airway patent
- change position 2 hourly but gently
- feed through nasogastric tube 2x the normal amount/calories

**Grade 3 & 4** will need mechanical ventilation and ICU admission
MANAGEMENT OF ANAPHYLAXIS

- stop administering antiserum
- secure airway and give \( O_2 \)
- give epinephrine (adrenaline) 0.5-1.0 mg = 0.5-1.0 cc of a 1:1000 solution IM, repeat every 10 minutes until BP & pulse increase
- give an antihistamine, like promethazine hydrochloride 25-50 mg IV slowly or chlorpheniramine 10-20 mg IV
- give hydrocortisone 100-300 mg IV
- deterioration requires IV fluids, aminophylline 250 - 500 mg IV, nebulized salbutamol and possible mechanical ventilation

‘Jungle juice’

- add to 1 litre of sodium chloride 0.9% 50 cc lignocaine 1% plus 1 cc of adrenaline (epinephrine) 1:1000, this will provide you with a local anaesthetic solution of 0.05% with 1:1000000 epinephrine
  In case you have a solution of lignocaine 2% use 25 cc per litre sodium chloride 0.9%
- it can be used to stop bleeding from for example the donor area after taking a skin graft or to infiltrate the area used for taking a skin graft (this is called tumescent technique, because it will raise the skin)
Alcoholic hand rub (AHR)

- should be used to clean your hands in between patients, is easy to prepare and by adding glycerine to methylated spirit your hands will not dry out. You only have to wash your hands with water and soap when they are soiled. Apply afterwards AHR.
- prepare as follows
  - add to 500 cc of methylated spirit
  - 2.5 cc of glycerine

Drugs commonly used in burn patients

<table>
<thead>
<tr>
<th>DRUGS</th>
<th>&lt; 50 KG</th>
<th>&gt; 50 KG</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANALGESICS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morphine</td>
<td>0.1 mg/kg/dose (not in neonates)</td>
<td>10 mg</td>
</tr>
<tr>
<td>Pethidine</td>
<td>1 - 1.5 mg/kg/dose</td>
<td>50 - 100 mg</td>
</tr>
<tr>
<td>Paracetamol</td>
<td>10 - 15 mg/kg/dose</td>
<td>750 - 1000 mg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(maximum dose is 4 g / 24 hrs)</td>
</tr>
<tr>
<td></td>
<td>frequency 4 - 6 hourly</td>
<td>frequency 4 - 6 hourly</td>
</tr>
<tr>
<td>ANAESTHETICS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ketamine (prior to change of dressing)</td>
<td>2 mg/kg IM</td>
<td>as in &lt; 50 kg</td>
</tr>
<tr>
<td>Ketamine (as an anaesthetic)</td>
<td>4 - 10 mg/kg IM</td>
<td>as in &lt; 50 kg</td>
</tr>
<tr>
<td></td>
<td>1 - 2 mg/kg IV</td>
<td>as in &lt; 50 kg</td>
</tr>
<tr>
<td>DRUGS</td>
<td>&lt; 50 KG</td>
<td>&gt; 50 KG</td>
</tr>
<tr>
<td>------------</td>
<td>---------------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>ANTI-BIOTICS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penicilline V</td>
<td>25 mg/kg/dose PO QID for 3 days</td>
<td>500 mg PO QID for 3 days</td>
</tr>
<tr>
<td>X-pen</td>
<td>25 mg/kg/dose 25 000 U/kg/dose IV/IM QID</td>
<td>1 - 2 g 1 - 2 MU IV/IM QID</td>
</tr>
<tr>
<td>Cloxacillin</td>
<td>25 mg/kg/dose IV/PO QID</td>
<td>500 mg IV/PO QID</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>12.5 - 50 mg/kg/dose IV/PO QID</td>
<td>500 mg IV/PO QID</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>5 - 7.5 mg/kg/24 hrs IV/IM once daily as a single dose</td>
<td>240 mg IV/IM once daily as a single dose</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>50 - 80 mg/kg/24 hrs IV as a single dose</td>
<td>1 - 2 g IV as a single dose</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>7.5 - 15 mg/kg/24 hrs PO divided in 2 doses</td>
<td>500 - 750 mg PO twice daily</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>7.5 mg/kg/dose PO/IV 6 or 8 hourly</td>
<td>500 mg PO/IV 6 or 8 hourly</td>
</tr>
<tr>
<td>ANTI-EPILEPTICS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phenobarbitone</td>
<td>5 - 8 mg/kg/24 hrs PO as single dose nocte</td>
<td>60 - 300 mg PO as single dose nocte</td>
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<tr>
<td>Phenytoin</td>
<td>4 - 8 mg/kg/24 hrs PO as single dose</td>
<td>150 - 300 mg PO as single dose</td>
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<tr>
<td>ANXYOLITICA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diazepam</td>
<td>0.2 - 0.5 mg/kg/24 hrs PO/IM/IV</td>
<td>5 - 20 mg PO/IM/IV</td>
</tr>
<tr>
<td>Midazolam</td>
<td>0.2 mg/kg/24 hrs Rectal/PO as single dose</td>
<td>5 mg IM as single dose</td>
</tr>
</tbody>
</table>
17 TOPICAL AGENTS

Acetic acid 0.5%

This is a watery solution, which your pharmacy should be able to make.
An alternative is ‘Vinegar’, this is a solution of 5% strength, by adding 1 part of vinegar to 9 parts of water you will have a solution of 0.5%. It is also active against Pseudomonas aeruginosa. The watery solution dries quickly and has to be applied several times a day. With Vaseline gauze soaked in this solution dressings only need to be changed once daily.

Betadine® ointment 10%

Is a povidone-iodine ointment and is especially active against Staphylococcus aureus bacteria.

Eusol (Edinburgh University solution of lime)

Mixed with liquid paraffin it acts as a desloughing agent, it also has an antibacterial action, but will not destroy Pseudomonas.
Keep preferably in the fridge.
Change dressings daily.

Gentian violet paint (GV paint) 0.5%

Has a disinfectant and antifungal action. It will dry the wound and is used in small almost healed burn wounds.
Hibicet® / Savlon®

Mix Chlorhexidine 1.5% and Cetrimide 15%
- 1 in 100 with water for skin disinfection and wound cleansing and
- dilute 1 in 30 in alcohol 70% for preoperative skin preparation

Honey & ghee

Has an antibacterial action against Staphylococcus aureus and also contains a proteolytic enzyme. This helps to break down the denaturated proteins and so digests necrotic tissue. The ghee component promotes granulation formation. Mix 2 parts of honey with 1 part of ghee, keep out of light or store in dark jars/bottles. If no ghee is available use instead glycerine, vegetable oil or water in the same way.

Mercurochrome

Has the same action and indication as GV paint. Keep also this solution in airtight dark bottles, too high a concentration is toxic.

Papaya

The pulp of the fruit contains the enzyme papain. It can be used to remove the slough from the wound, to remove thick crusts and to reduce hypergranulation. Mash the pulp and apply a thick layer. Change the dressing every second day. Patients sometimes complain of itching.
Silver sulphadiazine (SSD)

Also known as Flamazine®, is active against Pseudomonas aeruginosa. It can be applied on Vaseline gauze or direct onto the burn wound. It is used for facial burns and is directly applied on the wound, which is then left exposed.

In hand burns it is applied on the burn wound and then the hand is either put in a plastic bag, which is fixed to the wrist with adhesive tape or it is dressed (make sure that the fingers are dressed separately, this to avoid webbing).

Ideally it has to be applied daily.

It is also possible to make SSD in your own pharmacy, the prescription can be found in Primary Surgery, Editor M King, Volume Two, Trauma on page 81 or in Care of the Critically Ill Patient, D A K Watters e.a., page 236.

Silver nitrate 0.5% solution

Has the same action as SSD, the disadvantage is that it stains sheets and clothing black.

Prepare this solution as follows

• take 5 g silver nitrate crystals
• mix this with 15 cc distilled water
• dissolve this solution in 1 litre sterile water (= boil water for 10 minutes and cool)
• airtight closure of the bottles is essential to prevent oxidation, which results in a black silver oxide residue
Silver nitrate stick (caustic pencil)

Each stick contains 0.17 g of silver nitrate. It is mainly used to burn away small areas of hypergranulation. It is very painful so use it only in small areas. Before use moisten with water.

Tannin

Tannins are found in various plants, one of them is the tea plant. Ground tea stalks contain the same concentration of tannins as tea leaves.
It has an antibacterial action and also reduces the incidence of hypertrophic scars.

Prepare as follows
- over 10 g of ground tea stalks or tea dust (found in tea bags) or tea leaves
- pour 100 cc boiling water, leave this for 10 minutes and filter

Soak dressings in this solution and apply them onto the wound, you can also use Vaseline gauzes soaked in this solution, apply these on the wound and add an extra layer of ordinary gauzes also soaked in the solution on top.
To obtain 1 litre of this solution, pour 1 litre of boiling water over 100 g of tea or its byproducts.

Zinc oxide cream (5-15%)

Reduces hypergranulation and also has an antibacterial effect, apply on Vaseline gauze, redress after 4 days, remove previous layer with an oily solution
### DRUGS STOCK LIST FOR A BURNS UNIT

#### Anaesthetics

<table>
<thead>
<tr>
<th>Drug</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atropine</td>
<td>injection 1 mg in 1 cc vial</td>
<td></td>
</tr>
<tr>
<td>Epinephrine</td>
<td>1 cc vial 1:1000</td>
<td></td>
</tr>
<tr>
<td>(Adrenaline)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halothane</td>
<td>inhalation</td>
<td></td>
</tr>
<tr>
<td>Ketamine</td>
<td>injection 50 mg/cc in 10 cc vial</td>
<td></td>
</tr>
<tr>
<td>Lidocaine</td>
<td>injection 1%, 2% in vial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lidocaine + epinephrine 1:200 000 in vial</td>
<td></td>
</tr>
<tr>
<td>Midazolam</td>
<td>injection 2 mg/cc in vial</td>
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</tr>
<tr>
<td>Suxamethonium</td>
<td>injection 50 mg/cc in vial</td>
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</tr>
<tr>
<td>Thiopental</td>
<td>0.5 g powder for injection</td>
<td></td>
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</table>

#### Analgesics

<table>
<thead>
<tr>
<th>Drug</th>
<th>Form</th>
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<tbody>
<tr>
<td>Codeine</td>
<td>tablet</td>
<td>30 mg</td>
</tr>
<tr>
<td>Diclofenac</td>
<td>tablet</td>
<td>25, 50, 100 mg</td>
</tr>
<tr>
<td></td>
<td>suppository</td>
<td>50, 25, 12.5 mg</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>tablet</td>
<td>200, 400 mg</td>
</tr>
<tr>
<td>Morphine</td>
<td>injection</td>
<td>10 mg in 1 cc vial</td>
</tr>
<tr>
<td></td>
<td>tablet</td>
<td>10 mg</td>
</tr>
<tr>
<td></td>
<td>oral solution</td>
<td>10 mg /5 cc</td>
</tr>
<tr>
<td></td>
<td>suppository</td>
<td>10, 20 mg</td>
</tr>
<tr>
<td>Paracetamol</td>
<td>tablet</td>
<td>500 mg</td>
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<tr>
<td></td>
<td>suppository</td>
<td>100 mg</td>
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<tr>
<td></td>
<td>syrup</td>
<td>125 mg/cc</td>
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<tr>
<td>Pethidine</td>
<td>injection</td>
<td>50 mg/cc</td>
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#### Anaemia

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<th>Form</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferro + Folic acid</td>
<td>tablet</td>
<td>60 mg + 250 µg</td>
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### Antibiotics

<table>
<thead>
<tr>
<th>Drug</th>
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<th>Quantity</th>
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<tbody>
<tr>
<td>Cefotaxime</td>
<td>powder for injection 1 g</td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>powder for injection 1 g</td>
<td></td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>capsule 250 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>oral solution 150 mg/5 cc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>powder for injection 1 g in vial</td>
<td></td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>tablet 100, 500 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>suspension 250 mg/5 cc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>injection 2 mg/cc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50-100 cc bottle</td>
<td></td>
</tr>
<tr>
<td>Cloxacillin</td>
<td>capsule 500 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>oral solution 125 mg/5 cc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>powder for injection 500 mg in vial</td>
<td></td>
</tr>
<tr>
<td>Cotrimoxazol</td>
<td>tablet 400 mg + 80 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>oral solution 200 mg+40 mg/5 cc</td>
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</tr>
<tr>
<td>Gentamicin</td>
<td>injection 40-80 mg in 2 cc vial</td>
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</tr>
<tr>
<td>Metronidazole</td>
<td>tablet 200/400 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>suppository 500 mg</td>
<td></td>
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<tr>
<td></td>
<td>oral solution 200 mg/5 cc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>injection 500 mg/100 cc vial</td>
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<tr>
<td>Penicillin G (Xpen)</td>
<td>powder for injection 600 mg/vial</td>
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<tr>
<td>Penicilline V</td>
<td>tablet 250 mg</td>
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### Antiepileptics

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<thead>
<tr>
<th>Drug</th>
<th>Form</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>Carbamazepine</td>
<td>tablet</td>
<td>100 mg</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>tablet</td>
<td>30 mg</td>
</tr>
<tr>
<td>Phenytoin</td>
<td>tablet</td>
<td>100 mg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25 mg</td>
</tr>
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</table>
### IV fluids

<table>
<thead>
<tr>
<th>Drug</th>
<th>Quantity</th>
<th>no/quantity</th>
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</thead>
<tbody>
<tr>
<td>Albumin (isotonic)</td>
<td>250-500 cc</td>
<td></td>
</tr>
<tr>
<td>Dextrose 50%</td>
<td>ampoule</td>
<td></td>
</tr>
<tr>
<td>Dextrose Water</td>
<td>1 L</td>
<td></td>
</tr>
<tr>
<td>5% / 10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haemacel</td>
<td>500 cc</td>
<td></td>
</tr>
<tr>
<td>Ringer’s Lactate</td>
<td>1 L</td>
<td></td>
</tr>
<tr>
<td>Sodium Chloride 0.9% (NS)</td>
<td>1 L</td>
<td></td>
</tr>
</tbody>
</table>

### Sedatives

<table>
<thead>
<tr>
<th>Drug</th>
<th>Formulation</th>
<th>Quantity</th>
<th>no/quantity</th>
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</thead>
<tbody>
<tr>
<td>Chloralhydrate</td>
<td>mixture</td>
<td>1 g in 10 cc</td>
<td></td>
</tr>
<tr>
<td>Diazepam</td>
<td>tablet</td>
<td>5, 10 mg</td>
<td></td>
</tr>
<tr>
<td></td>
<td>injection</td>
<td>10, 20 mg</td>
<td></td>
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</table>

### Topical Agents

<table>
<thead>
<tr>
<th>Drug</th>
<th>Formulation</th>
<th>no/quantity</th>
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<tr>
<td>Acetic acid</td>
<td>solution 0.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(alternative is Vinegar)</td>
<td></td>
</tr>
<tr>
<td>Betadine® (povidone-iodine)</td>
<td>solution/ointment 10%</td>
<td></td>
</tr>
<tr>
<td>Eusol in Paraffin (EP)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gentian violet paint</td>
<td>0.5%</td>
<td></td>
</tr>
<tr>
<td>Hibicet® / Savlon® (in diluted form)</td>
<td>combination of Chlorhexidine 1.5% and Cetrimide 15%</td>
<td></td>
</tr>
<tr>
<td>Honey &amp; Ghee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercurochrome</td>
<td>1-2% solution</td>
<td></td>
</tr>
<tr>
<td>Silver nitrate</td>
<td>crystals</td>
<td></td>
</tr>
<tr>
<td>Silver sulphadiazine</td>
<td>cream 1%</td>
<td></td>
</tr>
<tr>
<td>Zinc oxide</td>
<td>cream 5-15%</td>
<td></td>
</tr>
</tbody>
</table>
Vaccines

Tetanus toxoid injection 5 cc vials _____________
ATS preferably Human Tetanus Immunoglobulin _____________
or equine antiserum
19 NUTRITION

- 3 simple feeding regimens are given plus the number of daily feeds in relation to the percentage of the TBSA burns
- these formulas are based on high energy & high protein feeds and should contain at least 250 kcal (= 1000 kilojoules) per 200 cc (divided in fat 8 g, protein 10.5 g and carbohydrates 42 g)
- they are in liquid or semisolid form

Examples are

- Likuni phala with ground nut flower
- high energy milk
- Plumpy’nut (Chiponde)

To all of them micronutrients like CMV (complex multivitamins) are added

Number of glasses or portions (200 cc) daily extra

<table>
<thead>
<tr>
<th>% TBSA BURN</th>
<th>11-15</th>
<th>16-20</th>
<th>21-25</th>
<th>26-30</th>
<th>31-35</th>
<th>36-40</th>
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</thead>
<tbody>
<tr>
<td>6.00 hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>•</td>
</tr>
<tr>
<td>9.30 hours</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>11.00 hours</td>
<td></td>
<td></td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>14.00 hours</td>
<td></td>
<td></td>
<td></td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>15.30 hours</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>19.30 hours</td>
<td></td>
<td></td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>20.30 hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>21.30 hours</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>22.30 hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>•</td>
</tr>
</tbody>
</table>
in liquid form they can be given orally by the glass or by NGT drip; a drip can continue throughout the night
- the daily normal high-protein high-calorie diet must continue with these supplements
- many patients are already malnourished before their burn
- it is very difficult to overfeed a severely burned patient, feed more not less

Recipes to make high protein-high energy feeds

- high energy Likuni phala (this is a 4:1 maize soya flour mix)

  Likuni phala 140 g  
sugar 35 g  
oil 7 cc  
add water to 200 cc

  this will give 706 kcal per feed and could be given 2-3 x per day along with high energy milk and Plumpy’nut

- high energy milk

  - with dried skimmed milk example of 300 cc portion  
    dried skimmed milk powder 110 g  
    oil 60 cc  
    sugar 50 g  
    add water to total volume 300 cc

  gives 440 kcals per feed

  - with fresh cow’s milk example of 300 cc portion  
    whole milk 300 cc  
    oil 10 cc  
    sugar 15 g

  gives 352 kcal per feed
Give 150 cc/kg per day in divided portions.

- **Plumpy’nut**

  peanut paste 1250 g  
oil 750 g  
full cream milk powder 1500 g  
inging sugar 1400 g  
complex multivitamins 10 scoops

  this will make approximately 5 kilograms and will deliver 545 kcals / 100 gram and needs to be given by spoon

These recipes are generally not suitable for children below six months of age.
20 CONTACT ADDRESSES

Malawi

- Queen Elizabeth Central Hospital, Blantyre
  + 265 (0)1 874333 Telephone operator
  877333
  874502
  877552
  extension: 3250 Burns Unit
  3243 Surgical Annex
  3096 Main Operating Theatre

- College of Medicine, Blantyre
  + 265 (0)1 874678 Secretary Department of Surgery

- E-mail addresses
  surgery@medcol.mw

- Postal address
  P/Bag 414
  Chichiri
  Blantyre 3
  Malawi

Elsewhere

- E J van Hasselt
  ehasselt@gmail.com

- Nederlandse Brandwonden Stichting (Dutch Burns Foundation)
  www.brandwonden.nl
  info@brandwonden.nl
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