# WO-04 Burns: cooling, dressings, fluids, grafts and the honest limits

HEALING after the FALL, research library, WO-04

Researched 10 October 2026 by Claude Opus agent for THRIVING after the FALL, Book Four. Library document, unverified.

## Findings by section

The related library documents (NU-02, WO-02, HY-11, NU-05, MA-07, SY-07) did not yet exist when this was written. Pain relief and antibiotic doses are left to MA-07, feeding detail to NU-02 and NU-05. The backbone of this report is the burns chapter of the ICRC manual War Surgery (Giannou and Baldan 2009), read in full, because it is written for surgeons without a burn unit. Figures that are my own arithmetic or inference carry [VERIFY].

### 1. Why burns kill, and in what order

A burn kills in a fixed sequence. In the first hours the danger is the airway, closed by swelling after hot gas or smoke, and carbon monoxide. From the first hour to the second day it is shock, because burned tissue leaks plasma. After the second day it is infection, which turns a burn that would have healed into a deep one and then into blood poisoning. Over weeks it is starvation, because a large burn can double the body's needs. Over months the scar shrinks and pulls joints into fixed bends (Giannou and Baldan 2009).

Leaky capillaries return to normal within 24 to 48 hours if resuscitation succeeds. Local swelling peaks at 6 to 12 hours, and above about 25 to 30 per cent of the body surface unburned tissue swells too, including the larynx. The burn has a dead centre, a middle zone of injured living tissue whose blood flow is failing, and an outer inflamed zone. First aid, fluids and clean dressings save the middle zone. Drying, infection and shock kill it (Giannou and Baldan 2009).

WHO estimates about 180,000 burn deaths a year, mostly in low and middle income countries, with child death rates over seven times higher there than in rich countries. Women die slightly more often than men, which WHO links to open-fire cooking and unsafe stoves (WHO 2023). Every household after the Fall will cook and light by flame.

### 2. First aid: cooling, and what not to put on

**Stop the burning.** Smother flames by rolling the person or wrapping them in a blanket, or pour water. Remove clothing and jewellery from the burned part. Wash chemical burns with large volumes of water (WHO 2023). Rings and watches come off before swelling makes them tourniquets, and anyone found unconscious at a fire is presumed to have carbon monoxide poisoning (Giannou and Baldan 2009).

**Twenty minutes of cool running water.** This is the best-supported act a household can perform. In a pig model of deep partial-thickness burns, Cuttle and colleagues compared 20 minutes of running water at 15 °C, running water at 2 °C, ice, and no cooling. Ice cooled the tissue fastest, yet only the running water improved re-epithelialisation and scar (Cuttle and others 2008, abstract). Twenty minutes beat 5, 10 and 30 minutes in pigs, and cooling delayed by up

to an hour still helped (BestBETs summary of Cuttle's group). Because ice cooled more but healed worse, running water seems to act by more than temperature (secondary summary).

The human evidence is observational but large. Of 2,495 children treated at the Queensland children's burn centre in 2013 to 2016, 90.6 per cent had some running water but only 71.3 per cent had 20 minutes within three hours. Adequate first aid was associated with lower odds of grafting (odds ratio 0.6, 95 per cent confidence interval 0.4 to 0.8) (Griffin and others 2020, abstract). In 2,897 adults in the Australian and New Zealand registry from 2009 to 2012, cooling before admission cut the probability of grafting from 0.537 by 0.070 (13 per cent), of intensive care from 0.175 by 0.084 (48 per cent), and stay by 2.27 of 12.9 days (18 per cent), with a dose-response for every outcome except death (Wood and others 2016). Neither study is randomised, and families who cool well may differ in other ways.

Guidelines differ on duration. ISBI, WHO, the British Burn Association and the Australian and New Zealand bodies say at least 20 minutes. The American Heart Association, the European Resuscitation Council and the American Burn Association say less, and ILCOR in 2015 said at least 10 (McLure and others 2021).

**Ice.** Cuttle found no benefit (Cuttle and others 2008). Venter's pig studies in Cape Town found iced water at 1 to 8 °C did more damage than no cooling, while tap water at 12 to 18 °C helped (Venter, secondary summary). Sawada found 10 minutes of ice after a scald harmful in rats (Sawada and others 1997, secondary summary). The other harm of cooling is hypothermia, worst in small children and large burns: WHO warns against cooling too long, and the ICRC says keep the patient warm once the burn is cooled (WHO 2023, Giannou and Baldan 2009).

**Butter, oil, toothpaste and pastes.** No trial shows they deepen a burn. What exists is a consensus of WHO, ISBI, ABA and ANZBA against any ointment at first aid (McLure and others 2021) and WHO's explicit list of things not to apply: paste, oil, turmeric, raw cotton (WHO 2023). The harm is mainly that grease replaces water, and that a non-sterile paste must later be scrubbed off an open wound.

FEASTING after the FALL already gives the household rule: cold running water for twenty minutes and nothing else on the burn that day, honey only on the later dressing, and any burn on a child bigger than the child's own palm to whoever has doctored (FEASTING after the FALL manuscript). That fits the evidence. The same book advises a weak vinegar rinse after lye on skin, whereas the ICRC advises only brushing off dry alkali and flooding with water (Giannou and Baldan 2009). No source read supports the vinegar step [VERIFY].

### 3. How big and how deep

Only partial and full-thickness burns are counted, never simple redness (Giannou and Baldan 2009). The rule of nines gives 9 per cent to the head and neck, 9 to each arm, 18 to the front of the trunk, 18 to the back, 18 to each leg and 1 to the perineum. It was devised by Pulaski and Tennison in 1947 and published by Wallace in 1951, while the Lund and Browder chart of 1944 adjusts for age (Paramedic Practice summary). In a baby under one, the head and neck are about 18 per cent and each leg about 14 (Giannou and Baldan 2009).

The ICRC gives the patient's whole hand as about 1 per cent (Giannou and Baldan 2009). Rossiter measured adults and found palm with fingers nearer 0.8 per cent in men and 0.7 in women, and the palm alone 0.4 to 0.5 (Rossiter and others 1996, secondary summary). The two sources therefore differ for adults, and the hand rule slightly overestimates adult burns. Clinicians overestimate size by up to 25 per cent, and the ICRC advises counting the unburned area as a check (Giannou and Baldan 2009).

Depth, in the ICRC's words reduced:

- Superficial: red, painful, no blisters, heals alone.
- Partial thickness: blistered, moist, pink or mottled. The less it blanches, the deeper it is. Painful, some pinprick feeling, hairs hard to pluck.
- Full thickness: charred, leathery or waxy, dry, numb, hairs pull out easily. Best grafted.

Scalds often look shallow at first, so experienced surgeons wait until day three to judge depth. Depth is underestimated, so re-examine at each dressing. The ICRC calls a burn minor below 15 per cent partial or 3 per cent full thickness, moderate at 15 to 25 per cent partial or under 10 per cent full, and major above that (Giannou and Baldan 2009).

**4. Fluids**

**Formulas.** Evans in 1952 first scaled fluid to burn size. Baxter and Shires at Parkland Hospital, Dallas, in 1968 proposed 3.5 to 4 ml per kg per per cent burn of crystalloid in 24 hours, half in the first 8. In 2000 Pruitt named "fluid creep", and Engrav found 58 per cent of patients received more than Parkland predicted, against 12 per cent in Baxter's own series (fluid history reviews, secondary). The ICRC therefore starts low: Ringer's lactate at 2 to 4 ml per kg per per cent in 24 hours counted from the time of the burn, half in the first 8 hours and a quarter in each later 8 hours, adults starting at 2 ml and children at 3, aiming at 0.5 ml of urine per kg per hour and slowing if output rises above that. Partial burns under 15 per cent are usually managed with oral fluids as outpatients (Giannou and Baldan 2009).

Example [VERIFY, my arithmetic]: a 70 kg adult with a 30 per cent burn needs 4,200 to 8,400 ml in 24 hours, half of it in 8 hours, so about 260 to 525 ml an hour. The urine target is 35 ml an hour.

**Fluids by mouth.** Kramer and colleagues (2010) gathered 12 studies with over 700 patients given salt solutions by mouth or tube:

- Fox, New York 1941 and 1944: 9 patients, 19 to 80 per cent, chilled isotonic sodium lactate, 100 to 150 ml per kg over 24 hours, given every 15 minutes.
- Moyer 1949: plain salt water caused acidosis. Buffered, weaker solutions caused less nausea.
- Markley, Lima 1956, for the US National Institutes of Health: 111 patients, isotonic bicarbonated saline at 110 ml per kg per 24 hours. Mortality at 48 hours equal or better than intravenous, but patients over 50 per cent were under-resuscitated.
- Jackson and Chen 1966: 162 patients, 10 to 35 per cent, three quarters by mouth alone. Vomiting in 30 per cent of children and 51 per cent of adults.
- Franke and Koch, Germany 1964: 22 children, 8 to 70 per cent. All 19 treated by mouth alone survived. Two of the three with 35 to 70 per cent burns, who also needed a drip, died.
- Sørensen, Denmark 1968: 26 patients up to 45 per cent drank anything they liked with salt tablets giving 5 g salt and 2.5 g baking soda per litre, 150 to 200 ml per kg on day one. Eighty per cent needed no drip.
- Ahnefeld 1975: only 4 of 58 arriving within an hour could not drink, against 16 of 23 arriving after two hours.
- El-Sonbaty 1991: children on WHO oral rehydration salts at the Parkland rate developed low blood sodium, as did the intravenous group.

Kramer's advice: start in the first hour, use chilled, buffered or slightly dilute salt solutions, about a cup every 15 minutes, use a tube if needed, never plain water. Contraindications are circulatory collapse, abdominal or gut injury and ileus (Kramer and others 2010).

The WHO-commissioned review by Hsiao and colleagues (2024) found three small human randomised trials (100 patients) of oral against intravenous fluid. Mortality did not differ (odds ratio 1.33, 0.33 to 5.36, very low certainty). In animals, oral fluid was worse than intravenous (odds ratio for death 36) but better than none (0.29, not significant). In a Nepalese pilot, 9 of 15 oral patients switched to a drip for vomiting. No included study exceeded 55 per cent burns, and many guidelines cap oral resuscitation at 40. The WHO emergency medical team guidance encourages oral fluid at the scene of a mass casualty (Hsiao and others 2024). The WHO burns working group's simplified formula is 100 ml per kg in 24 hours, by mouth or vein, for burns over 20 per cent. Leclerc found it matched standard formulas in adults with 25 to 50 per cent burns, underestimated above 60 per cent and only partly met children's maintenance needs, and it is untested clinically (Leclerc and others 2021, abstract via secondary).

Example [VERIFY, my arithmetic]: 100 ml per kg for 70 kg is 7 litres in 24 hours, about 440 ml an hour or 110 ml every 15 minutes for the first 8 hours. That falls inside both Kramer's advice and the Parkland range.

**What to drink.** WHO reduced-osmolarity salts contain per litre 2.6 g sodium chloride, 13.5 g anhydrous glucose, 1.5 g potassium chloride and 2.9 g trisodium citrate (WHO and UNICEF 2002). The Rehydration Project's home recipe is six level teaspoons of sugar and half a level teaspoon of salt in a litre of clean water (WHO and UNICEF 2002, Rehydration Project page). These differ: by teaspoon weight the home recipe carries less salt and more sugar [VERIFY]. The burn record used as much salt or more (Kramer and others 2010). All sources agree the drink must contain salt.

**Signs.** Urine volume is the best guide. A clear mind, warm hands and feet and a good pulse are good signs. Restlessness, confusion, nausea and cold extremities are warnings. Breathlessness and a tense abdomen mean too much fluid (Giannou and Baldan 2009). Without a catheter, collect each void in a marked jug, and in a child weigh nappies dry and wet, a gram being about a millilitre [VERIFY, my method]. Those who reach help after 72 hours without kidney failure have usually compensated by drinking, and infection is now their main danger (Giannou and Baldan 2009).

### 5. Airway and smoke

The warnings are fire in a closed space, deep burns of face, neck or front of chest, singed nasal hair and soot in nose, mouth or sputum. Swelling of the larynx can close the airway within hours and is worsened by fluids. The ICRC advises early tracheostomy with a breathing tube placed through it, oxygen at the highest concentration for six hours for carbon monoxide, and notes that inhalation raises fluid needs by about half. Its verdict is that serious smoke inhalation is rarely survived without mechanical ventilation (Giannou and Baldan 2009). Below the district rung, this is the clearest case where comfort replaces cure.

### 6. Escharotomy

A deep burn round a limb or the chest becomes a tourniquet as tissue swells under rigid dead skin. The ICRC cuts with a sharp knife through the burn into fat along the mid-lateral and mid-medial lines, up to but never into unburned skin, with a T-cut at each end. On the hand the cuts run onto the back and down the less-used side of each finger. On the chest they run down the front of the armpits and across the upper abdomen. The burn edges are painful, so ketamine is the anaesthetic of choice. Few who truly need a chest escharotomy survive without a ventilator (Giannou and Baldan 2009). The limb signs are pain, pallor, tingling, weakness, coldness and, late, loss of pulse (StatPearls).

### 7. Infection

Most deaths after the second day are from infection, which converts partial into full-thickness burns. Because the burn's blood supply is poor, systemic antibiotics may not reach it, so local care is the basis of treatment (Giannou and Baldan 2009). Local signs are new pain, spreading redness, colour change, unexpected deepening and early separation of dead skin. Systemic signs are abnormal temperature, rising pulse and breathing rate and intolerance of feeds, with three or more calling for a search for infection (Greenhalgh and others 2007, via Vanderbilt protocol, secondary). Green dressings as a sign of Pseudomonas is widely taught but unconfirmed here [VERIFY].

Prophylaxis is contested. The ICRC gives penicillin for five days against haemolytic streptococcus (Giannou and Baldan 2009). The Cochrane review found no reduction in wound infection (three trials, 119 patients) (Barajas-Nava and others 2013). Avni's meta-analysis found that prophylaxis for 4 to 14 days lowered all-cause mortality (risk ratio 0.54, 0.34 to 0.87, five trials) (Avni and others 2010, secondary). The reviews ask different questions and the conflict is unresolved. Doses belong to MA-07.

### 8. Dressings

**Methods.** The ICRC describes three. The closed dressing has an antimicrobial on fine-mesh or paraffin gauze, a thick absorbent layer and a bandage, with soaked outer layers changed at once and full changes every one or two days under analgesia. The plastic bag method covers creamed hands and feet with a loosely tied bag, the limb raised and the fingers moved. The open method, standard for face and perineum and the method of choice when dressings are short, leaves the burn exposed on clean sheets under a net in a warm room, at the cost of pain, smell, drying and cold. Wounds are washed with soap and comfortably warm running water. Small intact blisters stay. Large, bloody or pus-filled ones, and those over joints, are opened. Daily immersion in shared cold tubs is condemned (Giannou and Baldan 2009).

**Silver sulfadiazine.** The ICRC uses it because it penetrates eschar and suits infected full-thickness burns (Giannou and Baldan 2009). The Cochrane review of 30 trials found it consistently associated with slower healing than biosynthetic, silver and silicone dressings in superficial and partial burns (Wasiak and others 2022, secondary). Seven trials in 473 children found faster healing without it (Rashaan and others 2014, secondary). The label forbids it in newborns under two months, premature infants and women near term because of kernicterus, and warns of transient leukopenia and sulfonamide cross-allergy (Pfizer label). Salvaged stock should be kept for deep infected burns.

**Honey.** The Cochrane review by Jull and colleagues (2015) included 26 trials, 11 in burns. In partial-thickness burns honey healed 4.68 days faster than conventional dressings (minus 5.09 to minus 4.28, two trials, 992 patients, high quality). Against silver sulfadiazine it healed 5.12 days faster in four trials of 332 patients (very low quality), but the share healed at six weeks did not differ (risk ratio 1.00, six trials, 462 patients). It had fewer adverse events. Early excision and grafting beat it by 13.6 days (one trial of 50). Across burns overall, the review could not say whether honey was better or worse (Jull and others 2015).

The weakness is that one surgeon, Subrahmanyam in Maharashtra, ran most burn trials. Jull warned of this himself (Newswise 2015), and Wijesinghe found every trial scored 1 on the Jadad scale (Wijesinghe and others 2009, secondary). An independent trial in Indore of 78 patients reported healing in 18.2 against 32.7 days with silver sulfadiazine, all honey wounds sterile within 21 days, but its groups were unmatched (Baghel and others 2009, abstract). Subrahmanyam applied 15 to 30 ml of unprocessed honey under gauze, changed every two days (Cochrane table, secondary). The ICRC pours equal parts honey and ghee or oil over gauze, the fat stopping it sticking (Giannou and Baldan 2009).

Raw honey may carry clostridial spores. Gamma irradiation at 25 kGy sterilises it without loss of activity, while heating to 120 °C for 10 minutes kills spores but destroys glucose oxidase (Postmes and others 1995, Molan and Allen 1996, secondary). Most trials used raw honey and Subrahmanyam reports no adverse effects (Subrahmanyam 2010). After the Fall honey will be raw. The risk is unreported in burns but highest in a deep, dead wound.

**Banana leaf** (Musa species, leaf blade with midrib removed). Gore and Akolekar in Mumbai ran two split-body trials of 30 patients each in 2003. On graft donor sites banana leaf healed in 8.67 against 11.73 days with petroleum gauze, with pain on removal 0.97 against 9.47 out of 10. On partial-thickness burns it equalled boiled potato peel, most burns healing within 10 days, without statistics or a standard control. Gore costed it at under 2 US cents a dressing. Untreated leaves are heavily contaminated: boil 5 to 10 minutes, pressure-cook 15 minutes or autoclave at 121 °C for 15 minutes, and use within three to four days because fungus appears at 7 to 10 (Haesler, Watts and Solomons 2017a). The trials name no species. Strelitzia and Heliconia have similar leaves [VERIFY].

**Boiled potato peel** (Solanum tuberosum, peel of boiled tuber). Keswani introduced it in Bombay. In 17 patients, peel over silver sulfadiazine reduced inflammation but not bacteria (Keswani and others 1990, secondary). Against honey on 50 burns it healed slower (16.2 days) and cleared no colonised burn in seven days. It is a barrier only, for partial burns where nothing better exists (Haesler, Watts and Solomons 2017b). Do not use green peel [VERIFY].

**Aloe vera** (Aloe vera (L.) Burm.f., clear inner leaf gel). Four trials in 371 patients showed healing 8.79 days faster,

with heterogeneous products (Maenthaisong and others 2007, abstract). A 2024 meta-analysis estimated 3.76 days (1.84 to 5.69), and the Cochrane review found no gain over silver sulfadiazine (Huang and others 2024, Dat and others 2012, secondary). As first aid in pigs it did no better than nothing (BestBETs summary of Cuttle's group). The lookalike Agave americana has sap full of calcium oxalate needles, and a woman who used it as aloe developed severe facial dermatitis within twelve hours (Agave case report 2010). The yellow latex under the rind is an irritant purgative [VERIFY].

**Tannins and oiled gauze.** Davidson introduced tannic acid at Henry Ford Hospital in 1925. It swept the field, and by 1944 liver damage was commonest and worst in tannic acid patients (Nature 1944, secondary). After the Cocoanut Grove fire in Boston on 28 November 1942 (492 dead), Cope and Cannon at Massachusetts General Hospital used soft petrolatum dressings instead (Smithsonian 2017, MGH 2022). This is the warning for every bark or tea crust. The ICRC still lists tea, gentian violet, papaya, banana leaf, potato skin, fish sauce and frog skin as local methods (Giannou and Baldan 2009).

### 9. Feeding

The ICRC estimates energy as basal expenditure times 2.1 for a major burn times 1.2 in bed, about 4,000 kcal a day for a young 60 kg man, with protein 2 g per kg in adults and 3 g per kg in children. Its household tube feed per litre is 110 g skimmed milk powder, 80 ml oil, 50 g sugar, one banana and 3 g salt, made up with boiled water, about 1,415 kcal, with about 3 litres a day for a major adult burn. Raw eggs carry Salmonella, and the feed must be used within 24 hours. Feeding starts within 24 hours, and an unfed patient will not take a graft (Giannou and Baldan 2009). The common Curreri formula overestimates measured needs by 25 to 50 per cent, and the nutrition societies advise 1.5 to 2 g protein per kg (EAST, secondary), so the two sources agree on protein but differ on energy.

### 10. Contracture

The position of comfort is the position of contracture (Serghiou and others 2016). The Chinese Burn Association's guideline sets counter-positions: neck slightly extended, shoulder abducted, elbow alternately straight and bent, wrist extended about 20 degrees, knuckles flexed 50 to 70 degrees with finger joints straight, hip straight and spread, knee straight, ankle at 90 degrees. Positioning starts at once, joints move at least twice daily, splints are worn continuously, 10 hours on and 2 off, or at night. Pressure garments are worn over 23 hours a day from 2 to 3 weeks after healing for 1 to 2 years, replaced every 2 to 3 months (Chinese Burn Association 2015). The ICRC's hand position differs slightly: wrist back 30 degrees and knuckles as near 90 as possible. A grafted hand is never kept still more than ten days, splints are plaster slabs, stretching needs analgesia, and children need 6 to 12 months of management (Giannou and Baldan 2009). Serghiou's review found minimal evidence behind any of these angles (Serghiou and others 2016, abstract). This is where cloth, wood and patience change the outcome most.

### 11. Skin grafting

Reverdin told the Société Impériale de Chirurgie in Paris in 1869 that epidermal fragments 1 to 2 mm across would heal granulating wounds. Pollock in London grafted a burn this way in 1870, Ollier and Thiersch developed thin split grafts with a razor, and J. S. Davis of Johns Hopkins named the pinch graft in 1914 (graft history summaries).

A 1950 office method, reprinted in 2000, is within reach of a trained nurse: grafts about 0.5 cm across, thin enough that no fat shows, each raised over a wheal of local anaesthetic, laid 0.5 cm apart, held by tape, gauze and a firm bandage, splinted over joints, checked at 5 to 14 days. Kit: needle, syringe, forceps, half a razor blade and tape. The price is a cobbled scar at both sites (AAFP 2000). That nurses can do this safely is my inference [VERIFY].

For scarce resources the ICRC lets burns granulate under dressings for 2 to 6 weeks so that partial areas heal, then scrapes the granulation with the back of a scalpel handle. Dressings in supersaturated salt water for a couple of days give a clean bed. Thinner grafts take better, thicker work better. Mesh except face, hands and feet. Priority goes to

hands, feet, joints, eyelids, neck and chest, and the face waits two weeks. A healing burn shows white "leopard spots" of new skin. A red granulating surface without them needs a graft (Giannou and Baldan 2009). In Lilongwe, 27 per cent of 573 adults were grafted at a median 18 days, and access to surgery reduced mortality (Gallaher and others 2020, secondary).

### 12. Mortality by size and age without a burn unit

Baux in 1961 proposed age plus per cent burned as the percentage risk of death. Osler in 2010 added 17 points for inhalation injury [VERIFY, originals not read]. In 4,389 Rotterdam patients the revised score predicted well overall but worse at high scores (Dokter and others 2014, secondary).

Bull and Squire in Birmingham in 1949 began the statistics of burn death. The burn size that killed half (LA50) was about 51 per cent in children, 43 to 46 in young adults, 23 to 27 at 45 to 64 years and 9 to 10 over 65, in 1949 and 1954 (Bull and Fisher 1954, via Capek table). At Galveston, mortality fell about 2 per cent a year from 1989 to 2017 with better airway care, nutrition, resuscitation and early excision (Capek and others 2018, abstract).

Where there is no burn unit, Lilongwe reported 82 per cent survival and an LA50 of 39 per cent (Tyson and others 2013, abstract). A Kigali series found 13 per cent mortality, a Baux score killing half at about 90 and futility at 104 (Kigali series, secondary, authors unconfirmed). The ICRC states that 40 to 50 per cent burns rarely survive field conditions and should get fluid to thirst and generous analgesia (Giannou and Baldan 2009).

No study measures survival with no drip, no theatre and no blood. My inference [VERIFY] is that the village LA50 will lie below Malawi's 39 per cent, and that the village should treat as beyond cure any Baux score near 100, a burn over about 40 per cent in a young adult, a deep burn over about 20 per cent over 60, and serious smoke injury. These patients still get drink, warmth, pain relief and company. The household must not spend all its honey and nursing on a patient who dies on day four while a child with a 12 per cent burn goes undressed.

### 13. Prevention

WHO lists enclosing fires, limiting flame height, safer stoves and fuels, avoiding loose clothing, lower water temperatures and better epilepsy care (WHO 2023). In rural Bangladesh the open kerosene lamp predicted burns in children under 10 (odds ratio 3.16), and cooking in the open without a separate kitchen added risk (Mashreky and others 2010). Mills attributes 23 per cent of infant burns in Bangladesh and about 30 per cent of hospital burns in Nigeria to kerosene (Mills, secondary). FEASTING's rules fit this: the trough never at head height, hot pails never carried over anyone, a fat fire smothered with lid or sand and never water (FEASTING after the FALL manuscript). The evidence adds a raised enclosed hearth, a barrier between toddlers and the cooking place, pot handles turned in, glass-enclosed lamps that cannot tip, no loose sleeves at the fire, and no person with epilepsy alone by an open fire [VERIFY, compiled from WHO 2023 and Mashreky 2010, not tested as a package].

## Evidence grades

| Practice | Grade | Tradition | Record | Science |
|---|---|---|---|---|
| Cool running water 20 min within 3 h | B | Cold soothes | Registries of 5,392 patients: fewer grafts, ICU, days | Pigs: better healing, not only temperature |
| Ice, iced water | X | Colder is better | Rat and pig studies: equal or worse | Cold injury on heat injury |
| Butter, oil, toothpaste | X for replacing water, D for direct harm | Seals the burn | No trial, all guidelines against | Delays cooling, contaminates |

| Practice | Grade | Tradition | Record | Science |
|---|---|---|---|---|
| Rule of nines, palm rule | B | None | Standard since 1951, overestimates | Adult hand 0.7 to 0.8 per cent |
| Parkland-type IV fluids | B | None | Standard since 1968, fluid creep | Start low, follow urine |
| Salted oral fluids under 40 per cent | B | Give drink | Over 700 patients, 3 small RCTs | Vomiting limits it |
| Oral fluids over 40 per cent | D | Same | Under-resuscitation over 50 per cent | Animals worse than IV |
| Plain water in volume | X | Drink to thirst | Low sodium even with ORS | Dilution |
| Honey, partial thickness | A, single-centre caveat | Ancient remedy | 4 to 5 days faster | Osmotic, acidic, moist |
| Honey, full thickness | D | Same | Slower than grafting | Cannot regrow lost skin |
| Banana leaf, sterilised | B for pain and donor sites, C overall | Leaf wrapping in Asia | Small Indian split-body trials | Non-adherent, moist |
| Potato peel | C | Indian household use | Slower than honey | Barrier only |
| Aloe gel | B, modest | Worldwide | 3.8 to 8.8 days faster, weak trials | No first aid benefit |
| Silver sulfadiazine, clean partial burns | X for speed | None | Slower healing | Toxic to new skin |
| Silver sulfadiazine, infected deep burns | B | None | ICRC standard | Penetrates eschar |
| Tannin crusts | X | Protective crust | Liver damage, abandoned 1944 | Absorbed through raw skin |
| Escharotomy | B | None | Universal practice | Relieves pressure |
| Systemic prophylaxis | Contested | None | Reviews conflict | Streptococcus early |
| High-protein feeding | B | Feed the sick | Burn-unit standard | Hypermetabolism |
| Positioning and splinting | B principle, D angles | Bandaging | Expert consensus | Scar contracts to comfort |
| Grafting | B | None | Since 1869, lowers mortality in Malawi | Closes wound |
| Enclosed lamps and hearths | B | None | Case-control evidence | Removes hazard |

## Means ledger

| Practice | Hands | Hearth | Garden and still | Village dispensary | District infirmary | Hospital before the Fall |
|---|---|---|---|---|---|---|
| Cooling | Stream or pump 20 min | Poured water, wet cloths renewed [VERIFY] | Same | Same | Same | Same, then cling film |
| Assessment | Palm, nines | Charcoal outline on body | Scale for weight | Body chart, records | Lund and Browder chart | Depth imaging |
| Fluids | Salted drink | Home ORS, cup every 15 min, urine jug | Weighed salt and sugar | Salvaged ORS, stomach tube | IV Ringer's lactate, catheter | Titrated IV, blood, ICU |
| Dressings | Boiled cloth | Honey, ghee, soap, boiled banana leaf | Pressure-cooked leaf and gauze, aloe | Salvaged SSD for infected deep burns, bag method | Daily debridement, open method under nets | Biosynthetic and silver dressings |
| Airway | Sit up, fresh air | Same | Same | Recognise and refer | Oxygen if salvaged, tracheostomy if trained | Intubation, ventilation |
| Escharotomy | None | None | Sharp knife kept clean | Limbs in emergency [VERIFY] | Limb and hand with ketamine | Plus fasciotomy |
| Infection | Recognise | Clean water, soap | Strong salt soaks | Microscope, salvaged penicillin | Culture, antibiotics | Full microbiology |
| Feeding | Feed early | ICRC milk, oil, sugar mix | Weighed protein | Tube feeds | Measured feeds, transfusion | Dietitian, parenteral feeding |
| Contracture | Position, move joints | Rolled cloth, wooden splints | Carpentry, plaster | Stretching rounds | Plaster splints, release | Physiotherapy, garments |
| Grafting | None | None | Razor kept sterile | Pinch grafts by trained nurse [VERIFY] | Pinch and split grafts | Dermatome, early excision |
| Prevention | Rules taught | Raised hearth, lids, sand | Enclosed candles and lamps | Burn register | Cause analysis | Building codes |

What each rung changes: the hands rung saves the middle zone of the burn and most small burns. The hearth rung, with salted drink and honey, carries most burns under about 30 to 40 per cent if the patient does not vomit [VERIFY]. The dispensary's stomach tube overcomes vomiting. The district's drip, escharotomy and grafts rescue younger adults with 30 to 50 per cent burns and close wounds that will not heal. Only the hospital before the Fall saves the large burn with smoke injury.

## Harm test

**Cooling.** Ice, water below about 8 °C and wrapping a large burn in cold wet cloth cause cold injury and hypothermia, worst in infants, the old and large burns (Venter, WHO 2023). Signs: shivering, blue lips, drowsiness. Response: stop, dry, wrap, warm.

**Size estimation.** Overestimation of up to 25 per cent leads to overload or to abandoning a patient who could live. Underestimation leads to shock (Giannou and Baldan 2009). Check by counting unburned skin.

**Fluids.** Too little gives shock and kidney failure. Too much gives swollen lungs and larynx and a tense abdomen (Giannou and Baldan 2009). Plain water and even ORS at high volume lower blood sodium (Kramer and others 2010), with confusion and fits [VERIFY]. Vomiting risks aspiration. No oral fluid for the unconscious, the collapsed, the abdominally injured or those with a swelling airway (Hsiao and others 2024). Intravenous fluid made outside a sterile pharmacy can cause rigors and sepsis, and belongs to the district and to the library's fluids report.

**Honey.** Spores in deep dead wounds (theoretical), flies and ants, and false confidence that delays grafting a full-thickness burn (Jull and others 2015, Subrahmanyam 2010). Avoid in bee-product allergy [VERIFY]. Honey on infants' skin is not documented as causing botulism in any source read [VERIFY].

**Banana leaf and potato peel.** Unsterilised leaves carry fungi and bacteria. Stored leaves grow fungus. Dried leaf edges prick. Potato peel does not fight infection (Haesler, Watts and Solomons 2017a, 2017b). Banana is hard to mistake where it grows.

**Aloe.** Agave mistaken for aloe causes severe dermatitis (Agave case report 2010). Aloe as first aid displaces water. Wash off with plenty of water.

**Silver sulfadiazine.** Slower healing of clean burns, leukopenia, sulfonamide allergy, kernicterus in newborns and near term (Wasiak and others 2022, Pfizer label). Never in babies under two months or near term.

**Tannin crusts and pastes.** Liver damage (Nature 1944) and hidden infection under the crust. WHO lists turmeric, oil, paste and raw cotton as harmful (WHO 2023). Wash off gently.

**Escharotomy.** Bleeding, cutting tendons or nerves, cutting into living skin, pain without anaesthesia (Giannou and Baldan 2009). Not for burns that still stretch.

**Tracheostomy.** Bloody and complicated in a swollen neck (Giannou and Baldan 2009). Not below the district rung.

**Feeding.** Diarrhoea from excess fat or volume, Salmonella from raw eggs, water-borne disease from unboiled water (Giannou and Baldan 2009). Aspiration of tube feeds in the drowsy [VERIFY].

**Splints.** Pressure sores, stiff joints if left too long (Chinese Burn Association 2015, Giannou and Baldan 2009).

**Grafting.** Donor sites that fail in thin-skinned children, graft loss under blood or serum, failure in the unfed and anaemic (Giannou and Baldan 2009).

## Red flags

1. Hoarse voice, stridor, soot in mouth or sputum, singed nasal hair, burns of face and neck, fire in a closed room. The airway may close within hours. Sit upright, fluids with care, send for the district.
2. Unconscious after a fire, headache, confusion. Carbon monoxide. Fresh air, oxygen if any exists.
3. Burn over about 40 per cent in a young adult, about 20 per cent deep over 60, or age plus burn near 100. Beyond the village [VERIFY].
4. Little or no urine, dark or red urine, cold blue limbs, confusion. Failing resuscitation. Red urine after electrical injury means muscle breakdown (Giannou and Baldan 2009).
5. High-voltage electrical injury, however small the skin wound. Needs the district.

6. Circumferential deep burn with a cold, numb or pulseless limb, or a chest that cannot expand. Escharotomy within hours.
7. Vomiting so that nothing stays down. Tube, then drip.
8. After day three: fever or low temperature, rising pulse and breathing, confusion, refused feeds. Sepsis.
9. A partial burn turning black, grey or deeper, or dead skin lifting early with pus.
10. A deep burn still granulating at three weeks, especially over hand, joint, neck or eyelid. Needs a graft.
11. Eyelids that will not close. Keep the eye moist (Giannou and Baldan 2009).

Honest comfort: a person with an unsurvivable burn often stays clear-headed for hours or days. Full pain relief comes first and is not withheld for fear of shortening life. Warmth, water as wanted, family, and a truthful answer when asked. The ICRC treats this as care, not failure (Giannou and Baldan 2009).

## The case against

**The evidence base.** Trials are small, single-centre and from specialist units. Hsiao found three oral resuscitation trials with 100 patients (Hsiao and others 2024), Wasiak found dressing trials too poor to pool (Wasiak and others 2022), and Serghiou found minimal evidence for positioning (Serghiou and others 2016). The cooling evidence is observational. Nothing comes from a village with nothing.

**Honey.** Andrew Jull himself warned that one researcher did the burn trials (Newswise 2015). Wijesinghe scored every trial 1 on the Jadad scale (Wijesinghe and others 2009). The Cochrane verdict across burns overall is "unclear" (Jull and others 2015). Honey cannot close a full-thickness burn.

**Oral resuscitation.** Animals did worse on oral than intravenous fluid, 9 of 15 Nepalese patients switched to a drip, and the old series were uncontrolled (Hsiao and others 2024, Kramer and others 2010). Oral fluid is a bridge for moderate burns.

**The hospital.** Pruitt showed the hospital formula drowning patients (fluid history reviews). Silver sulfadiazine slows healing. Tannic acid was a hospital treatment that poisoned livers for fifteen years. Much of what saves the burns a village can save needs no hospital.

**The herbal remedies.** Aloe failed as first aid in pigs, potato peel does not fight infection, banana leaf is dirty until boiled, agave poses as aloe, and the tanning crust, among the oldest remedies, was abandoned for liver damage.

**The honest line.** The LA50 figures come from places with drips and staff. A line drawn too low abandons some who would live, one drawn too high spends dressings on the dying. The line here is an inference.

## 10-line summary

1. Twenty minutes of cool running water within three hours is the best household act, linked to about 13 per cent fewer grafts in adults.
2. Ice and pastes do not help, and ice is worse than water.
3. The patient's hand is about 1 per cent in a child and nearer 0.8 in an adult, and everyone overestimates.
4. Fluids are 2 to 4 ml per kg per per cent in 24 hours from the burn, half in 8 hours, aiming at 0.5 ml urine per kg per hour.
5. Salted drinks carried most burns under 30 to 40 per cent in old series of over 700 patients, but vomiting limits them, and plain water lowers sodium.
6. Honey heals partial-thickness burns 4 to 5 days faster, mostly in one surgeon's trials, and cannot close full-thickness burns.
7. Boiled banana leaf is a cheap, painless dressing, and silver sulfadiazine slows the healing of clean burns.
8. After day two infection is the main killer, and daily cleaning and trimming is the village's weapon.
9. Positioning against the scar from day one decides whether a survivor can use the hand and the neck.

10. Without a burn unit half die at sizes far below modern centres, and serious smoke injury rarely survives without a ventilator.

## Open questions

1. What is the survival of 20 to 40 per cent burns on oral fluids alone? Trials were under way in 2024 (Hsiao and others 2024).
2. Which oral fluid is best: WHO salts, saltier buffered drinks, or other?
3. Does honey's benefit hold in independent blinded trials?
4. How real is the botulism risk of raw honey on deep burns?
5. Do banana leaf and potato peel results replicate outside India?
6. Does prophylaxis save lives where wound care is poor?
7. What is the LA50 with no drip, no theatre and no blood?
8. Can a trained lay person pinch-graft safely, and with what take?
9. Does FEASTING's vinegar rinse after lye help or harm?
10. Are frequently renewed wet cloths an adequate substitute for running water?

## Sources to read in full

1. Giannou and Baldan 2009, ICRC War Surgery, Chapter 15.
2. Kramer and others 2010, the oral resuscitation record.
3. Hsiao and others 2024, oral resuscitation review.
4. Jull and others 2015, Cochrane on honey.
5. Wood and others 2016, water first aid.
6. Haesler, Watts and Solomons 2017, banana leaf and potato peel summaries.
7. Chinese Burn Association 2015, rehabilitation guideline.
8. Wasiak and others 2022, Cochrane on dressings (not read in full here).
9. The ISBI practice guidelines, Burns 2016 and 2018 (not read here, and not cited).

## At the bedside after the Fall

### The household

Needs to start: running water or a full vessel, salt, sugar and a level teaspoon, boiled cloth in a closed box, a sealed jar of honey, and every adult taught the palm rule and the twenty minutes. The household cools for 20 minutes, keeps the rest of the body warm, removes rings, covers with boiled cloth or clean plastic, measures with the patient's hand, and starts salted drinks. Any burn bigger than the child's palm, on face, hands, feet, groin or a joint, white or leathery, or from a closed-room fire, goes to the village healer. The first failure to expect: butter, oil or ice goes on the burn and nobody cools it.

### The village of 300

Needs to start: a trained lay healer, a clean warm room, a body chart, a scale, a measuring jug, salvaged stomach tubes, honey and ghee, a pressure cooker for leaves and gauze, splint wood or plaster, a record book. The healer charts size, depth and time, starts oral resuscitation for burns over about 10 per cent in children and 15 per cent in adults, measures urine, passes a tube for vomiting, washes and dresses daily with honey or boiled banana leaf, feeds from day one, splints from day one, and knows the red flags and when comfort is the treatment. The first failure to expect: a child vomits on day one, the drinking stops, and the child goes into shock overnight.

### The district of 3,000

Needs to start: a burns-trained nurse or doctor, a sterile room, sterile intravenous fluid, ketamine or local anaesthetic, scalpels, razors and forceps, a microscope, salvaged silver sulfadiazine, splint material, gauze production and about ten beds. The district gives intravenous resuscitation with a catheter, limb and hand escharotomy, daily debridement under analgesia, open care of faces under nets, delayed pinch and split grafting at 2 to 6 weeks after salt soaks and feeding, 6 to 12 months of splinting and stretching, and a register of every burn's cause. The first failure to expect: grafts fail because the patient is starving and anaemic or blood lifts the graft, and the team stops grafting.

## Protocols

### Protocol 1: First aid in the first hour

1. Make the scene safe. Smother flames or pour water. Separate from electricity with a dry stick.
2. Remove smouldering clothing, rings, bracelets and watches. Cut round cloth stuck to skin, do not pull it.
3. Cool the burn under cool running water for 20 minutes by the clock, within 3 hours. At least 10 minutes if that is all there is.
4. No ice, no iced water, nothing on the burn: no butter, oil, toothpaste, flour, mud or turmeric.
5. Cool the burn, not the person. Cover and warm the rest. Stop at once if a child shivers or the lips go blue.
6. Chemicals: brush off dry powder, then flood with water for at least 20 minutes. Eyes: pour water with the lids held open for 20 minutes.
7. Cover with boiled cloth, clean plastic or cling film, not on the face.
8. Measure with the patient's hand and note the time of the burn.
9. Over 10 hands in a child or 15 in an adult: start Protocol 3 and send for the healer.
10. After a closed-room fire: fresh air, sit up, watch the voice and breathing.

### Protocol 2: Size and depth

1. Undress fully in a warm room.
2. Count only blistered, white, brown or leathery skin.
3. Rule of nines for large areas: head and neck 9 (18 under one year), each arm 9, front 18, back 18, each leg 18 (14 under one year), perineum 1.
4. The patient's hand for small or scattered areas.
5. Count unburned skin too. The two must make about 100.
6. Moist, pink, painful, blanching is partial. Waxy, leathery, painless, hair pulls out is full thickness.
7. Mark any deep burn that goes round a limb or the chest.
8. Re-judge depth on day 3, especially scalds.
9. Chart size, depth, time of burn, weight, age, and age plus per cent.

### Protocol 3: Oral resuscitation without a drip

For a conscious patient who can swallow, without abdominal injury or a swelling airway.

1. Drink: WHO ORS made as the sachet says, or 6 level teaspoons sugar and half a level teaspoon salt in 1 litre of boiled cooled water. Never plain water as the main fluid.
2. 24-hour target from the time of the burn: adults 2 to 4 ml × kg × per cent, starting at 2. Children start at 3, plus usual drinks and breast milk. Over 20 per cent, 100 ml per kg is the WHO working group's simple target [VERIFY for the individual].
3. Half in the first 8 hours, a quarter in each next 8 hours.
4. Offer every 15 minutes, chilled if possible. At 70 kg and 100 ml per kg, about 110 ml every 15 minutes for 8 hours [VERIFY, arithmetic].

5. Urine target: adults 0.5 ml per kg per hour (35 ml at 70 kg). Children about 1 ml per kg per hour [VERIFY, secondary source only]. Marked jug, or weighed nappies.
6. Urine under target for 2 hours: raise the drink by a quarter. Well over target with a swelling face: reduce.
7. Vomiting: pause 10 minutes and restart with sips. Persisting over 2 hours: tube if trained, or send to the district.
8. Send for help at confusion, cold clammy skin, breathlessness or no urine.
9. Day 2: about a quarter of day 1 plus normal drinks and feeds.
10. Chart every drink and every void.

**Protocol 4: Daily dressing with honey or banana leaf**

1. Pain relief 30 to 60 minutes before (MA-07).
2. Wash hands. Boil scissors and forceps 10 minutes.
3. Wash the burn with soap and comfortably warm clean water.
4. Leave small blisters. Open large, bloody, pus-filled or joint blisters.
5. Trim loose dead skin, never into bleeding tissue.
6. Honey: 15 to 30 ml spread on a gauze pad, or equal parts honey and melted ghee or oil poured over boiled gauze.
7. Banana leaf: midrib out, washed, boiled 5 to 10 minutes or pressure-cooked 15 minutes, cooled, used within 3 days.
8. Thick absorbent boiled cloth over it, then a bandage, firm not tight.
9. Hands and feet: a clean plastic bag tied loosely at the wrist or ankle, limb raised, fingers moved hourly.
10. Change a soaked outer layer at once, the whole dressing every 1 to 2 days, daily if pus or smell.
11. Face: open, cleaned with warm boiled salt water, eyes kept moist.
12. At every change look for red flags 8 to 10 and record the open area.

**Protocol 5: Limb escharotomy (district, trained operator)**

1. Indication: deep burn round a limb with pain on stretch, pallor, coldness, numbness, weakness or lost pulse, within 48 hours.
2. Ketamine, or local anaesthetic at the burn edges.
3. Boiled sharp scalpel. Cut the mid-lateral, then the mid-medial line, through burn into yellow fat, no deeper.
4. Run the full length of the deep burn, up to but not into living skin, with a T at each end.
5. Hand: onto the back of the hand, then the thumb, index and ring fingers on the little-finger side, middle and little on the thumb side.
6. Recheck colour and pulse after 15 minutes. Control bleeding with pressure and elevation. Dress as a burn.
7. Still pulseless: the muscle compartment is tight and needs a surgeon.

**Protocol 6: Feeding**

1. Start within 24 hours.
2. Protein 2 g per kg a day in adults, 3 g in children.
3. Per litre: 110 g skimmed milk powder pasted with a little boiled water, 50 g sugar, 3 g salt, 80 ml oil, boiled water to 1,000 ml, one mashed banana, strained.
4. Major adult burn: about 3 litres a day in small feeds or by tube, plus cooked eggs.
5. Use within 24 hours, keep cold, never raw eggs.
6. Diarrhoea: less volume and oil, more often.
7. Weigh weekly. No graft until weight is steady.

**Protocol 7: Positioning and splinting**

1. From day one, position against the pull.
2. Front of neck: no pillow, a roll under the shoulders.
3. Armpit: arm out at about 90 degrees on a pillow or splint.
4. Elbow alternately straight and bent. Knee straight, splinted at night.
5. Hand: wrist back 20 to 30 degrees, knuckles bent 50 to 90 degrees, finger joints straight, thumb away from the palm.
6. Hip straight and spread, time face down. Ankle at a right angle.
7. Move every burned joint through full range at least twice a day after analgesia.
8. Check splints every 4 to 6 hours for pressure marks.
9. Never keep a grafted hand still more than 10 days.
10. After healing: night splints and tight elastic wraps over 23 hours a day for 1 to 2 years, renewed every 2 to 3 months.

**Protocol 8: Pinch grafting (district, trained operator)**

1. A clean, red, flat granulating wound in a fed, non-anaemic patient. Two days of dressings soaked in salt water saturated until no more dissolves.
2. Donor site of similar skin, usually thigh. Shave, wash with soap, water and alcohol.
3. A small wheal of local anaesthetic at each point.
4. Lift the skin on a needle, cut a disc about 0.5 cm across with half a razor blade, no fat showing.
5. Scrape loose granulation, lay grafts raw side down in rows 0.5 cm apart.
6. Tape, dry gauze, firm bandage, a splint over a joint.
7. Leave 5 to 7 days, then lift the outer gauze gently.
8. Donor site under dry gauze for 2 weeks.
9. Failed grafts: clean, salt-soak, feed, regraft.

## Numbers to carry

1. **20 minutes** of cool running water, within **3 hours**. Never ice.
2. **The hand is about 1 per cent** (nearer 0.8 in adults). Count blisters and deeper only.
3. Drink or drip from **10 per cent in children, 15 in adults**. By mouth to about **40 per cent**.
4. **2 to 4 ml per kg per per cent** in 24 hours, **half in 8 hours**. Or **100 ml per kg** over 20 per cent.
5. Urine **0.5 ml per kg per hour** in adults, 35 ml an hour at 70 kg.
6. **Age plus per cent near 100**: beyond the village. Over 65, half died at about **10 per cent** in 1949.
7. Honey **4 to 5 days** faster. Banana leaf boiled **5 to 10 minutes**.
8. Protein **2 g per kg** in adults, **3 g** in children.
9. Hand: wrist back, knuckles bent, fingers straight. A grafted hand still no more than **10 days**.
10. Still granulating at **3 weeks**: needs a graft.

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