WO-02 Cleaning the wound: irrigation, debridement, honey, sugar and the lessons of Ambroise Paré

HEALING after the FALL, research library, WO-02

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How to read this report

Bleeding is stopped (THRIVING library, WO-01). The next question decides whether the wounded person keeps the limb, and sometimes whether they live. What should the wound be washed with, how hard and how much? What must come out? Should it be closed or left open? What goes on it, and how often is it changed?

Each practice is split into *Tradition* (what people did and believed), *Record* (what surgeons observed) and *Science* (what controlled studies show). Grades are defined under "Evidence grades". [VERIFY] marks a figure taken from a secondary source I could not check against the primary, or my own inference. Pressures are kept in pounds per square inch (psi) as the trials used them. One psi is about 6.9 kilopascals.

Three warnings frame the evidence. 1. Most dressing trials were run on chronic wounds (leg ulcers, pressure sores, diabetic feet). Their results do not transfer to fresh wounds. 2. Most honey trials used gamma-sterilised medical honey, and most honey burn trials came from one investigator. 3. The plant evidence is thin, and much of it comes from interested sources.

Findings by section

1. Paré at Turin: the first lesson is to do less harm

Tradition. By the 1530s, surgeons following Giovanni da Vigo taught that gunpowder poisoned a wound. The remedy was to scald it with oil of elder, mixed with a little treacle, applied nearly boiling (Paré 1575, via James Lind Library).

Record. Ambroise Paré was a young army barber-surgeon of about 27 at the siege of Turin in 1536 or 1537, and sources differ on the year (Wikipedia, Ambroise Paré). After a day of heavy casualties, the oil ran out. He dressed the rest with a cold digestive of egg yolk, oil of roses and turpentine. He slept badly, expecting to find those men dead of poison, and went to them at first light. Those dressed with the digestive had little pain and no swelling or inflammation, and had rested through the night. Those scalded with oil were feverish, in great pain and swollen around the wound. He resolved never again to burn a gunshot wound so cruelly (Paré 1575, via James Lind Library). He told the story in several editions between 1545 and 1575, with minor differences in detail. I read only the James Lind Library summary and secondary accounts, not the French text.

Science. This was a chance comparison, not a trial. Allocation depended on when the oil ran out, so the scalded men may have been the earlier and worse-wounded. Even so, the direction of effect is what later evidence keeps confirming. Agents that destroy tissue make wounds worse.

Verdict. The lesson for the book is the one Paré drew. A wound is not made safe by hurting it. Boiling oil, cautery of fresh wounds and caustic washes all belong to grade X. The digestive itself has no modern evidence (grade D).

2. Lister and carbolic acid: the antiseptic idea and its rival

Record. On 12 August 1865 Joseph Lister dressed the open leg fracture of James Greenlees, a boy run over by a cart, at Glasgow Royal Infirmary with lint soaked in carbolic acid (phenol) under tin foil (RCPSG n.d.). His 1867 series of 11 compound fractures had nine recoveries, one death from haemorrhage and one amputation (RCPSG n.d., secondary). In 1870 he reported amputation deaths in his wards falling from 16 of 35 (46%) in 1864 to 1866 to 6 of 40 (15%) in 1867 to 1870 (Lister 1870, via James Lind Library and RCS England). The library's handwashing report gives the same figures and marks them for checking (THRIVING library, HY-01). I found them in two independent secondary sources, but not the primary.

The rival. Lawson Tait of Birmingham rejected carbolic and relied on soap, boiled water and boiled instruments. Secondary accounts say his ovariotomy mortality was 38% in 50 cases under Listerism and 6% in the next 50 without it [VERIFY] (Birmingham History Forum n.d., Wikipedia, Lawson Tait). His 1880 paper was titled "The Antiseptic Theory Tested by the Statistics of One Hundred Cases of Successful Ovariotomy" (Tait 1880, title page only). He changed his technique and gained experience over the same period, so the comparison is confounded.

Science. Lister was right that germs cause wound infection. Tait was right that germs can be kept out without poisoning tissue. The modern evidence on wound fluids (section 5) sides with Tait for the inside of a wound. Antiseptics belong on intact skin and hands.

3. The First World War: excision, Carrel-Dakin and the Wright debate

On the manured farmland of the Western Front, shell wounds bred gas gangrene and tetanus. Three schools emerged.

Excision (débridement). The Belgian Antoine Depage revived the French practice of opening and exploring wounds. He combined it with excision of dead tissue and delayed closure timed by bacteriological sampling (Annals of Surgery 1998, abstract only). Henry Gray and E.T.C. Milligan published on excision in June 1915. Gray is credited with cutting mortality from open femoral fractures from about 80% to under 20%, with excision and the Thomas splint [VERIFY] (Wikipedia, Henry Gray). One history says gas gangrene fell from 5 to 6% of wounds in 1915 to a little over 1% by 1918 [VERIFY] (KUMC, gas gangrene). Excision, earlier operation and faster evacuation changed together. The Scottish Women's Hospital at Royaumont saw 107 cases of gas gangrene among 1,694 wounded in 1915 to 1916, or 6.3% (KUMC, Frances Ivens).

Carrel-Dakin. Dakin's solution was 0.4 to 0.5% sodium hypochlorite buffered with boric acid, described in August 1915 (Wikipedia, Dakin's solution). Alexis Carrel ran it through rubber tubes into every recess, renewing it about every 2 hours, and closed the wound when smears showed roughly one organism per microscope field or fewer. Sources differ on the exact count. His team claimed close to 99% success closing such wounds after 5 to 25 days (KUMC, Dakin's solution). The claims were uncontrolled, and the method needed constant nursing and a laboratory. The Rockefeller War Demonstration Hospital trained 998 people but treated only 237 patients (Wikipedia, Rockefeller War Demonstration Hospital).

Almroth Wright. Wright argued that antiseptics could not reach bacteria in the recesses of a wound and harmed the body's own defences. He favoured open drainage, hypertonic salt solution and later closure (Encyclopedia.com, Wright). Alexander Fleming's glass "artificial wounds" showed antiseptics acting only at the surface while killing white cells (Wikipedia, Alexander Fleming).

Verdict. Excision won. Early excision, leaving the wound open and delayed primary closure remain the core of ICRC war surgery (Dufour 1998, Giannou and Baldan 2009). Carrel-Dakin survives only as dilute hypochlorite washes. Wright's objection has been confirmed in the laboratory (section 8).

4. Trueta and the closed plaster: leave it alone

Record. Josep Trueta in Barcelona, building on the American Winnett Orr and possibly the Spaniard Manuel Bastos [VERIFY], treated open fractures in the Spanish Civil War with a fixed sequence. He operated early, ideally within 6 hours. He excised all dead tissue and controlled bleeding by pressure. He left the wound open, laid in vaseline gauze and enclosed the limb in an unpadded plaster without windows for weeks. Fever alone was no reason to open it. Primary closure was allowed only when operation was early and thorough, the wound closed without tension and the same surgeon could watch it for a week. Antitetanic serum was given and nerve and tendon repair delayed. Rendle Short's 1939 report, which I read in full, gives Trueta's results as 1,073 open fractures with 6 deaths, 976 satisfactory results and 91 poor results (secondary amputation, bone infection or non-union). Gas gangrene was "very seldom" seen (Rendle Short 1939). Coni adds that wounds were scrubbed first with soap, water and a nailbrush, with iodine on the skin, and that sulphanilamide was used in only a minority (Coni 2002). The 1938 bombing of Barcelona produced 2,200 casualties in three days (Coni 2002). Trueta published the method in English in 1939 (Wikipedia, Josep Trueta).

Science. No trial was run. These are a surgeon's own figures, without a control group or independent assessment. They are still the best evidence the book has that a wound properly cleaned and immobilised can heal without antibiotics, nurses or frequent dressings. That is why Trueta matters more after the Fall than Carrel does.

Verdict. Grade C for the closed plaster method as a whole. The principle behind it, clean thoroughly once, immobilise and then disturb as little as possible, is shared by the ICRC (Dufour 1998).

5. Irrigation: what fluid, how much and how hard

5.1 Fluid *Record.* The ICRC uses saline when it can and drinkable water when it cannot: "If you can drink it, you can put it into a dirty wound." Doubtful water can be treated with sodium hypochlorite to 0.025%, about 5 mL of household bleach per litre (Giannou and Baldan 2009).

Science. - The 2012 Cochrane review found tap water no worse than saline in adults with acute wounds. In three trials with 1,328 people the relative risk of infection was 0.66 (95% CI 0.42 to 1.04) (Fernandez and Griffiths 2012, via AAFP). TheNNT quotes 0.63 (0.40 to 0.99) from the same review (TheNNT n.d.), so summaries disagree on whether the difference was significant. In children (two trials, 535) it was 1.07 (0.43 to 2.64). - The 2022 update pooled eight trials with 2,204 people. Infection with tap water against saline was RR 0.84 (0.59 to 1.19), at very low certainty. Only one small trial (51 people) tested boiled and cooled water (Fernandez 2022, plain-language summary). - Moscati and colleagues found infection in 4.0% of lacerations after tap water and 3.3% after saline among 634 patients, which was not a significant difference. Bites, heavy contamination, wounds older than 8 hours and diabetics were excluded (Moscati 2007, via Mason and St John n.d.). Weiss and colleagues, in a double-blind trial of about 663 people, found a trend towards fewer infections with tap water (Weiss 2013, via AAFP).

Soap inside the wound. The FLOW trial randomised 2,551 adults with open fractures at 41 centres. Reoperation within 12 months was 14.8% (182 of 1,229) with castile soap and 11.6% (141 of 1,218) with saline (hazard ratio 1.32, 1.06 to 1.66, P=0.01) (FLOW Investigators 2015, abstract and secondary summary). This does not touch soap on the surrounding skin or hands, which every source keeps (Giannou and Baldan 2009, Coni 2002).

Antiseptic washes. Trials of povidone-iodine in laceration washes are small and conflicting. One trial of 500 reported 5% infection against 15% but lost over a fifth to follow-up. Another of 418 hand wounds found 4.6% against 5.3% (Morgenstern n.d., summarising Gravett 1987 and Roberts 1985). None justifies an antiseptic over clean water.

Verdict. Clean drinkable water equals saline (grade A for lacerations, B for open fractures). Soap stays out of deep fracture wounds (grade A, one large trial).

5.2 Pressure *Tradition.* Textbooks say irrigation needs at least 7 to 8 psi, a figure from animal work in the 1970s and 1980s (Mason and St John n.d.).

Science. Singer and colleagues measured real devices in 1994. A saline bottle pierced with a 19-gauge needle gave about 2 psi, a pierced bag about 6 psi, and 35 or 65 mL syringes with a 19-gauge needle 16 to 43 psi. In animal dye studies, 15 psi drove fluid into the tissue surface and 20 psi through the full thickness, so high pressure can push dirt and bacteria deeper (Mason and St John n.d.).

FLOW settled the question for open fractures. Reoperation was 13.2% at high pressure (over 20 psi), 12.7% at low pressure (5 to 10 psi) and 13.7% at gravity-fed very low pressure (1 to 2 psi), with no significant difference. The investigators judged very low pressure an acceptable low-cost choice (FLOW Investigators 2015). In their protocol, gravity flow meant a bag hung 6 to 8 feet (about 1.8 to 2.4 m) above the floor (FLOW Investigators 2010). The ICRC reached the same view from experience. Final irrigation is "gentle and copious", and a plastic bottle with holes cut in the top, squeezed with both hands, gives enough pressure (Giannou and Baldan 2009). Hollander found irrigation made no difference in clean facial and scalp lacerations (0.9% against 1.4%, not randomised) (Morgenstern n.d.), but the face is an exception and the leg is not.

Verdict. Gentle flow is enough (grade A for open fractures). The 7 to 8 psi rule is dogma (grade D).

5.3 Volume No trial compares volumes. - Emergency texts give about 50 to 100 mL per centimetre of laceration (Mason and St John n.d.). - FLOW used 3 litres for small open fractures (Gustilo type I) and 6 litres for larger ones (FLOW Investigators 2010). - The ICRC uses 1 to 3 litres for a war wound, more for big fractures (Giannou and Baldan 2009).

The sources agree once scaled to wound size. A practical rule is to pour until no more dirt comes out, then pour as much again [VERIFY, my inference].

6. Debridement: the dead-tissue rule

Record. Every war surgery source agrees that dead tissue and driven-in dirt feed bacteria and must come out. Nothing put on the wound substitutes for this. The ICRC says honey, sugar and salt are "not a replacement for adequate surgery" (Giannou and Baldan 2009).

The two ICRC manuals give matching rules, but differ on detail. - **Skin.** Dufour removes usually no more than 1 mm of skin edge, Giannou and Baldan no more than 2 to 3 mm. Both open the wound generously along its length. - **Fat and fascia.** Cut away contaminated fat and shredded fascia freely. - **Muscle.** Judge by the "four Cs": colour, consistency, contractility and capillary bleeding. Dead muscle is dark, mushy, does not twitch when pinched and does not bleed. Remove it in pieces no larger than about 2 cm (Dufour 1998, Giannou and Baldan 2009). Giannou and Baldan warn that shock, cold, a tourniquet and blood vessel spasm all change the signs. Contractility is the most reliable (Dufour 1998). - **Bone.** Remove loose fragments. Keep those still attached to soft tissue. - **Foreign matter.** Remove clothing, soil, grass and wood. Do not hunt for every metal fragment (Giannou and Baldan 2009).

Science. No trial compares debridement with none, and none will be run. The evidence is the fall in gangrene wherever excision was adopted (section 3).

Who can do it. Removing grit with forceps and a wash is household work. Cutting dead muscle from a deep wound needs light, anaesthesia, instruments and someone who has seen it done. I place it at the district rung [VERIFY, my judgement].

Verdict. Grade B, a consistent record where no trial is possible.

7. Time limits: the six-hour rule is tradition

Tradition. Wounds older than 6 hours must not be closed, and open fractures must reach theatre within 6 hours. The ICRC still quotes it: "Do not close contaminated wounds or clean wounds that are more than 6 hours old" (Giannou and Baldan 2009).

Record. The rule traces to Friedrich's 1898 guinea pig experiments and Robson's 1973 finding that wound bacteria reached 100,000 per gram after about 5 hours (as described in Jaman 2021 [VERIFY]). Textbooks place the "golden period" anywhere from 3 to 24 hours (Jaman 2021).

Science. - **Open fractures.** In 103 open tibial fractures, 12 became infected (11.6%), seven operated within 6 hours and five after (Kamat 2011). A meta-analysis of seven studies found no difference before or after 6 hours for infection (RR 1.32, 0.54 to 3.23) or non-union (Prodromidis and Charalambous 2016, abstract). A review of 16 cohorts with 3,539 fractures found no difference at any threshold (Schenker 2012 [VERIFY authors], abstract). - **Lacerations.** Jaman and colleagues reviewed nine studies and found no golden period. Diabetes, site, length and foreign bodies mattered more than time (Jaman 2021, read in full). In 5,521 lacerations, 3.5% became infected, with diabetes raising the odds about 6.7-fold and a foreign body 2.6-fold (Hollander 2001 [VERIFY], secondary summary). In about 2,663 patients, closure before or after 12 hours made no difference, but lower-limb site raised risk about fourfold (Quinn 2014 [VERIFY], secondary summary).

What remains true. Gas gangrene and necrotising infection are diseases of delay (Dufour 1998, Wong 2003). The rule after the Fall is "clean as soon as you can, and do not close what is dirty or old", not "after 6 hours it is too late".

Verdict. The six-hour cut-off is grade X. Early, thorough cleaning is grade B.

8. Antiseptics: on the skin, not in the wound

Cell damage. Lineaweaver and colleagues found that 1% povidone-iodine, 0.25% acetic acid, 3% hydrogen peroxide and 0.5% sodium hypochlorite were all toxic to human fibroblasts, the cells that build new tissue. Povidone-iodine and hypochlorite had dilutions that killed bacteria without killing fibroblasts. Peroxide and acetic acid did not (Lineaweaver 1985, abstract). A 1991 follow-up put the safe levels at about 0.005% hypochlorite and 0.001% povidone-iodine (Heggers 1991 [VERIFY authors], abstract via search summary). This matches Wright and Fleming in 1917.

Skin before surgery. Darouiche and colleagues randomised 849 patients before clean-contaminated surgery. Chlorhexidine-alcohol skin preparation gave 9.5% surgical-site infection against 16.1% for povidone-iodine (RR 0.59), so 17 patients needed treating to prevent one infection (Darouiche 2010, abstract and summary). It concerns intact skin, not open wounds.

Harms. - **Hydrogen peroxide.** The UK regulator warns against its use in closed cavities and deep or large wounds because of gas embolism. Several deaths are reported, five in the UK (MHRA 2014). - **Povidone-iodine.** On large wounds or severe burns it can cause metabolic acidosis, high sodium and kidney damage (EMC povidone-iodine SmPC, via search summary). Newborns have developed thyroid suppression (case reports via search summary [VERIFY]). - **Chlorhexidine.** Rare but potentially fatal anaphylaxis (MHRA 2012, via Palliativedrugs). Labels report chemical burns in premature newborns and corneal injury if it enters the eye (EMC chlorhexidine SmPC, via search summary).

Dilute hypochlorite. Three sources give recipes for modified Dakin's solution from household bleach, at two strengths. CHOC gives a quarter-strength solution of about 0.125% (CHOC n.d.). Familiprix and the ICRC give about 0.025%, roughly 5 mL of bleach per litre (Familiprix n.d., Giannou and Baldan 2009). The CHOC solution is five times stronger. Both are well above the non-toxic level found in the laboratory. I therefore treat hypochlorite as a wash for dirty, smelly or infected wounds, not for clean ones [VERIFY, my inference]. Recipes are in Protocol 6.

Verdict. Antiseptics on intact skin before cutting: grade A. Hydrogen peroxide in deep wounds: grade X. Other antiseptics poured routinely into fresh wounds: grade D. Dilute hypochlorite on dirty or infected wounds: grade C.

9. Dressings: moist, not dry

Science. In 1962 George Winter covered shallow wounds on pigs with polythene film. They re-grew skin about twice as fast as wounds left to form a dry scab (Winter 1962, abstract). This started the modern principle of moist wound healing. Its strongest evidence is in shallow wounds and burns.

Record. War surgery uses a different logic for deep contaminated wounds. Dufour's ICRC manual dresses them with bulky, dry, fluffed gauze, with no vaseline gauze and no tight packing, because packing plugs the wound and stops it draining. The dressing is left alone until delayed primary closure at about day 5, unless the patient becomes toxic or the wound gives off an offensive smell. Dufour notes that all wounds smell after about 4 days, so smell alone is not the test (Dufour 1998). Giannou and Baldan say that for wounds left to heal by themselves, the dressing should be changed and the wound washed gently with saline every 4 to 5 days. Daily changes are not needed while the dressing is dry (Giannou and Baldan 2009).

Moist and dry are not opposite schools. A deep fresh wound must drain, so its dressing is absorbent and open. A shallow clean wound, a graze or a granulating wound heals faster if it does not dry out.

Verdict. Moist healing for shallow wounds: grade B. Bulky absorbent dressings left undisturbed for days over a deep, cleaned and open wound: grade B (consistent war surgery record).

10. Honey

Tradition. Honey has been laid on wounds since antiquity, across unrelated cultures.

Science. The 2015 Cochrane review by Jull and colleagues covered 26 trials with 3,011 participants (Jull 2015). - **Partial-thickness burns.** Honey healed them 4.68 days faster than conventional dressings (95% CI 4.28 to 5.09, two trials, 992 people, high quality). - **Against grafting.** Early excision and grafting were 13.6 days faster than honey. - **Infected surgical wounds.** One trial of 50 people favoured honey over antiseptic washes and gauze (RR of healing 1.69, 1.10 to 2.61, moderate quality). - **Ulcers and other wounds.** The effect was unclear.

Jull told the press that health services should not use honey routinely for most wounds (Newswise 2015). Most burn trials came from one Indian surgeon, M. Subrahmanyam. His 1991 trial of 104 burns reported 91% of honey-treated wounds sterile at 7 days against 7% with silver sulfadiazine (Subrahmanyam 1991, abstract). A 2009 meta-analysis found eight studies with 624 people, all of low quality, six by the same investigator (Wijesinghe 2009, abstract).

How it works. High sugar leaves too little free water for bacteria. A little hydrogen peroxide is made as honey is diluted. The pH is about 4.4 (Molan and Rhodes 2015, Simon 2009).

The spore problem. Honey can carry *Clostridium* spores. Molan and Rhodes advise gamma irradiation rather than heat, since spores might germinate in dead tissue (Molan and Rhodes 2015). Heating to 120°C for 10 minutes kills botulinum spores but spoils the honey's activity (Simon 2009). I found no reported wound infection caused by honey, but no village will have an irradiator.

Practice. Keep honey in contact for at least 12 and preferably 24 hours under an absorbent dressing (Simon 2009, Molan and Rhodes 2015). About 5% of patients feel stinging. Infected newborn wounds healed with 5 to 10 mL of unprocessed honey twice a day, and blood glucose did not change in diabetics (Simon 2009). No source gave a standard volume per area of dressing [VERIFY]. The ICRC uses honey or sugar as an adjunct for deep, infected or neglected wounds, and for burns as equal parts honey and ghee or oil on gauze (Giannou and Baldan 2009).

Verdict. Medical honey for partial-thickness burns: grade A. For infected wounds: grade B. Unprocessed honey on fresh deep wounds: grade C, with an untested spore risk.

11. Sugar

Record. From the 1970s, surgeons in Argentina and the United States packed granulated sugar into infected wounds. Knutson and colleagues reported 605 patients over five years treated with sugar and povidone-iodine, with less grafting and fewer antibiotics, but without controls (Knutson 1981, abstract). The Argentine food scientist Jorge Chirife and colleagues showed in the laboratory that concentrated sugar solutions killed or stopped *E. coli*, *Pseudomonas*, *Klebsiella* and *Staphylococcus aureus* by lowering water activity (Chirife 1983, abstract). It is the principle that preserves jam.

Science. A 2023 evidence summary for resource-poor settings gives sugar a grade B recommendation "when modern dressings are not accessible" (Haesler 2023). Its key studies are small. - In 50 contaminated traumatic wounds with bone injury, 77% healed at 4 weeks with Eusol (hypochlorite and boric acid) and 66% with sugar (Bajaj, via Haesler 2023). - In 40 Malawian patients, honey wounds shrank 3.8 cm^2 a week against 2.2 cm^2 for sugar, and positive cultures at one week fell to 23% against 39% (Mphande 2007, via Haesler 2023). - Odour cleared in all 11 wounds by day 7 in one series (Murandu 2011, via Haesler 2023).

Practice (Haesler 2023). Use plain white granulated sugar without additives, packed to fill the cavity under an absorbent dressing. Change it ideally twice a day while exudate is heavy, since dissolved sugar loses its effect, and less often as exudate falls. Sugar can burn briefly. Glucose data in diabetics are mixed, and there is one report of acute kidney failure. It attracts fewer flies than honey. Northwick Park Hospital made sugar pastes with polyethylene glycol in the 1980s, but I could not find the exact recipe.

Verdict. Grade B for infected, smelly or neglected wounds where nothing better exists. It is probably a little less effective than honey, but cheap, storable and free of the spore question if taken from a sealed bag [VERIFY, my inference].

12. Plants

Broadleaf plantain, *Plantago major* L. (Plantaginaceae). Part used: the fresh leaf, crushed and laid on the wound, or an infusion as a wash. - *Tradition.* One of the most widespread wound herbs of Europe, carried to North America by settlers. Its use goes back to Dioscorides (Samuelsen 2000, bibliographic record only). - *Science.* A systematic review of animal studies screened 176 publications. Four met its criteria, all at high risk of bias, and it "did not find evidence about the in vivo effectiveness" (Cardoso 2021, via HMP summary). I found no human trials. - *Identification.* A flat basal rosette of broad oval leaves with three to five strong parallel veins that pull out as strings when torn. Flowers form a dense rat-tail spike on a leafless stalk (Minnesota Wildflowers n.d., MSU n.d.). - *Lookalikes.* Ribwort plantain, *Plantago lanceolata*, has narrow leaves and is used the same way. Young foxglove (*Digitalis* species) also forms a rosette, but its leaves are softly hairy or woolly with a net of veins (Minnesota Wildflowers n.d.). Foxglove contains heart-active glycosides [VERIFY in the library's poisons report]. Do not use a leaf of uncertain identity. - **Verdict.** Grade D. A clean crushed leaf on a washed wound is not a substitute for washing.

Aloe vera, *Aloe vera* (L.) Burm.f., syn. *Aloe barbadensis* Mill. (Asphodelaceae). Part used: the clear inner leaf gel. - *Science.* A Cochrane review of seven trials with 347 people found no high-quality evidence. Against silver sulfadiazine in burns the relative risk of healing was 1.41 (0.70 to 2.85). In surgical wounds left open to heal, aloe **delayed** healing by about 30 days (7.59 to 52.41) (Dat 2012). A 2007 meta-analysis of four burn studies with 371 patients found healing 8.79 days faster (Maenthaisong 2007, abstract). - *Harms and lookalikes.* The yellow latex under the leaf skin contains aloin and related compounds, which can irritate or sensitise. The sap of the century plant, *Agave americana*, causes irritant dermatitis (Botanical Dermatology Database, via search summary). Agave leaves are stiffer, usually with a sharp end spine [VERIFY]. - **Verdict.** Grade C for superficial burns. Grade X for open surgical or deep wounds.

Yarrow (*Achillea millefolium*) as a wash for small wounds is graded C in the bleeding report, and cobweb is graded X for tetanus (THRIVING library, WO-01). Calendula was not researched.

13. Maggots

Record. William Baer of Johns Hopkins saw soldiers in France in 1917 whose wounds had lain for days crawling with maggots and were clean. From 1929 he treated bone infection with maggots in Baltimore. Two children developed tetanus from unsterilised maggots, which led to sterile rearing (Johns Hopkins Medical Archives n.d., secondary). Hundreds of American hospitals used the method before antibiotics displaced it.

Science. VenUS II randomised 267 patients with sloughy leg ulcers to loose maggots, bagged maggots or hydrogel. Maggots cleaned the wound about twice as fast (hazard ratio 2.31, 1.65 to 3.2). Time to healing did not differ (HR 1.13, 0.76 to 1.68), and maggots hurt more (Dumville 2009, abstract). The usual dose is 5 to 10 larvae per cm^2 for 48 to 72 hours (Healio 2012).

Harms. In a German series, 5 of 24 patients (21%) developed bloodstream infection traced to contaminated larvae of *Protophormia terraenovae*. After better disinfection and a switch to *Lucilia sericata*, none of 45 did (Nuesch 2002, via search summary). Flies whose larvae eat living tissue, above all the New World screwworm *Cochliomyia hominivorax*, are the real danger. It has spread again in Central America since 2023 (Indiana Department of Health n.d.). Maggots from an unknown fly are not therapy.

Verdict. Sterile *Lucilia sericata* larvae: grade A for debriding chronic wounds, C for acute wounds. ICRC experience is "anecdotal", and most patients refuse them (Giannou and Baldan 2009). Wild maggots: grade X.

14. Leaving it open, and when to close

Fresh wounds that are clean and small can be closed (THRIVING library, WO-03, not yet in the library). Every war surgery source agrees that contaminated, crushed, bitten, old or deep wounds should be cleaned, debrided and left open. Closure follows at day 3 to 7 if the wound is clean (Dufour 1998, Giannou and Baldan 2009). Dufour gives the timing by region: face, neck and scrotum about day 3, trunk and arm days 4 to 5, and leg days 5 to 7. Closure is seldom possible after day 8. Face, neck, scalp and genitals may be closed at once because their blood supply is so good (Dufour 1998). Giannou and Baldan also warn against "a few sutures" to bring a dirty wound together loosely (Giannou and Baldan 2009). A wound that cannot be closed heals by itself, slowly, from the bottom up.

15. Signs of infection and of healing

Ordinary wound infection. Increasing pain, redness spreading from the edge, swelling, warmth, pus and a wound that opens up. The 2014 American guideline on skin infections advises opening and draining an infected surgical wound. Antibiotics are added if redness and hardening extend more than 5 cm from the edge, or if temperature is above 38.5°C, pulse above 110 or white cell count above 12,000 (Stevens 2014, via CIDRAP summary).

Gas gangrene (Dufour 1998). Usually within 3 days and often within 24 hours, occasionally weeks later. - The first sign is sudden severe pain in the wound. - Then come swelling, a thin watery brown discharge and a pulse rising faster than the temperature, which is rarely above 38°C. The patient is anxious or oddly cheerful, and pale. - The skin becomes tense, white and marbled, then bronze, with blisters and a sweetish smell. Gas under the skin is a late sign. - Delay in cleaning is the main cause. Early excision and penicillin have nearly eliminated it.

Necrotising soft tissue infection. - Pain out of all proportion to the wound, swelling beyond the redness, blisters, grey skin and crackling under the fingers. - Delay in surgery of more than 24 hours raised mortality about 9-fold in one series of 89 patients (Wong 2003, abstract). - A meta-analysis found surgery within 12 hours cut the odds of death by more than half (OR 0.41) (Nawijn 2020 [VERIFY authors], abstract via search summary).

Signs of healing [VERIFY, these are standard descriptions that I did not find set out in a source I read in full]. - Pain eases day by day. - The base turns from yellow or grey to moist, bright red and granular, and bleeds easily when touched. - The edges creep in with a thin pink or white rim of new skin. - Discharge decreases and becomes thin and clear.

16. Infection rates by method

The table brings together figures from the sections above. They come from different eras, wounds and definitions, and cannot be compared directly.

Setting and method	Outcome	Source
Lister, amputations before and after carbolic	Death 46% to 15%	Lister 1870 via JLL
Western Front, gas gangrene 1915 to 1918	5 to 6% to about 1% [VERIFY]	KUMC
Royaumont 1915 to 1916	Gas gangrene 6.3%	KUMC
Trueta, closed plaster, 1,073 open fractures	0.6% death, 8.5% poor result	Rendle Short 1939
Open fractures, any pressure (FLOW)	Reoperation about 13%	FLOW 2015
Open fractures, soap against saline	14.8% against 11.6%	FLOW 2015
Open tibia, Kamat	Infection 11.6%	Kamat 2011
Lacerations, tap against saline	4.0% against 3.3%	Moscati 2007
Lacerations, all comers	2.6 to 3.5%	Quinn 2014, Hollander 2001 [VERIFY]
Clean-contaminated surgery, skin prep	9.5% chlorhexidine-alcohol, 16.1% povidone-iodine	Darouiche 2010
Infected wounds, honey against sugar	Culture-positive at 1 week 23% against 39%	Mphande 2007 via Haesler 2023

Evidence grades

Grades: A, randomised trials or systematic reviews. B, consistent observational or clinical series. C, convergent traditional use or a credible uncontrolled record with plausible mechanism. D, a single tradition, anecdote, convention or theory. X, shown ineffective or harmful.

Practice	Tradition	Record	Science	Grade
Boiling oil, cautery of fresh wounds	Da Vigo's poison theory	Paré's comparison	Tissue destruction	X
Drinkable water for washing	Universal	ICRC standard	Equal to saline, Cochrane	A (lacerations), B (fractures)
Soap inside an open fracture	Common	n/a	Worse than saline, FLOW	X
Soap and water on surrounding skin	Universal	Trueta, ICRC	Plausible, not trialled alone	B
Low or gravity pressure	n/a	ICRC squeeze bottle	Equal to high pressure, FLOW	A
7 to 8 psi minimum	Textbook	Animal work	Not supported	D
Volume 50 to 100 mL per cm, or 1 to 6 L	n/a	Convention	No trial	D

Practice	Tradition	Record	Science	Grade
Debridement of dead tissue and dirt	War surgery	Falling gangrene rates	No trial possible	B
Four Cs for muscle	Teaching	Subjective	Poor match with microscopy	C
Six-hour rule as a cut-off	Universal teaching	Animal origins	No effect in meta-analyses	X
Leave dirty wounds open, close days 3 to 7	War surgery	ICRC record	No modern trial	B
Closed plaster (Trueta)	n/a	1,073 fractures, 6 deaths	Uncontrolled	C
Carrel-Dakin tubes	n/a	Claimed 99%	Uncontrolled, labour-heavy	D
Dilute hypochlorite on dirty wounds	n/a	ICRC, clinics	Cytotoxic above 0.005%	C
Hydrogen peroxide in deep wounds	Common	Gas embolism deaths	Cytotoxic	X
Povidone-iodine in laceration wash	n/a	Mixed small trials	Cytotoxic at 1%	D
Chlorhexidine-alcohol on intact skin before cutting	n/a	n/a	Better than povidone-iodine	A
Moist healing of shallow wounds	n/a	n/a	Winter, burn trials	B
Medical honey, partial-thickness burns	Ancient	n/a	4.68 days faster	A
Medical honey, infected wounds	Ancient	ICRC	One trial of 50	B
Raw honey, fresh deep wounds	Ancient	Some series	Spore risk, untested	C
Sugar, infected or neglected wounds	Argentine and US practice	605-patient series	Small trials, slightly less good than honey	B
Plantain leaf	Pan-European	n/a	Four poor animal studies	D
Aloe gel, superficial burns	Widespread	n/a	Mixed reviews	C
Aloe gel, open surgical wounds	n/a	n/a	Delayed healing by 30 days	X
Sterile maggots for slough	Battlefield observation	Baer	Faster debridement, same healing	A (chronic), C (acute)
Wild maggots	n/a	Tetanus, sepsis	Screwworm eats living tissue	X

Means ledger

Practice	Hands	Hearth	Garden and still	Village dispensary (300)	District infirmary (3,000)	Hospital before the Fall
Washing	Pour from a clean vessel	Boiled and cooled water in a clean jug	Same, stored in sealed bottles	Squeeze bottles, gravity bags, measured litres	Same, plus saline made by weight	Sterile saline, pulsed lavage
Skin cleaning	Soap and water	Soap, brush	Distilled spirit for hands and skin [VERIFY strength]	Salvaged povidone-iodine or chlorhexidine	Same	Chlorhexidine-alcohol
Foreign matter	Fingers, rinse	Boiled tweezers, light	Same	Forceps, magnification, local anaesthetic if salvaged	Formal exploration under anaesthesia	Theatre, X-ray
Debridement	No	Trim loose shreds only	No	Trained person, small wounds only	Excision of dead muscle by a trained surgeon	Same, plus second look at 48 hours
Closure	Strips for small clean cuts	Same	Same	Suture of small clean wounds (WO-03)	Delayed primary closure days 3 to 7	Same, grafts, flaps
Dressing	Clean cloth	Boiled cotton, dried and wrapped	Sugar, honey from clean stock	Gauze, sugar, honey, dilute hypochlorite	Plaster immobilisation, records of outcomes	Commercial dressings, negative pressure
Infection treatment	Recognise and send	Open and drain a simple collection	Same	Drainage, antibiotics if any (IN-07)	Re-excision, amputation if needed	Antibiotics, surgery, intensive care

What each rung changes. Hands alone can wash a wound if the water is clean. The hearth adds boiled water and boiled cloth, which brings small wounds to roughly modern standards. The garden and still add sugar or honey stock, spirit for hands and labelled supplies made in advance. The village adds trained hands, light, forceps and a written record of each wound, so that problems are seen early. The district adds the step that no lower rung can provide: cutting out dead tissue under anaesthesia, delayed closure and immobilisation in plaster. Most deaths from crushed or dirty wounds are deaths from that missing step.

Harm test

- **Boiling oil, cautery, caustics.** Destroy tissue (Paré 1575). Do not use.
- **Soap inside deep wounds.** Raised reoperation by about a third in FLOW (FLOW Investigators 2015).
- **High-pressure jets.** Drive dirt and bacteria deeper (Mason and St John n.d.). Use gentle flow.

- **Hydrogen peroxide in deep wounds or cavities.** Gas embolism, deaths reported (MHRA 2014). Do not use.
- **Strong antiseptics in wounds.** Kill the cells that heal (Lineaweaver 1985). Povidone-iodine on large wounds or burns can cause acidosis and kidney damage, and thyroid suppression in newborns (EMC SmPC). Chlorhexidine can cause anaphylaxis and eye injury (MHRA 2012).
- **Closing a dirty or old wound.** Traps bacteria and leads to abscess or gas gangrene (Dufour 1998, Giannou and Baldan 2009). Leave it open.
- **Tight packing.** Plugs drainage (Dufour 1998). Fill loosely.
- **Excessive debridement.** Removing healthy skin leaves a wound that cannot be closed (Dufour 1998).
- **Unsterilised honey.** Theoretical spore risk in dead tissue (Molan and Rhodes 2015). Use only on a wound already cleaned of dead tissue, and watch for gas gangrene signs.
- **Sugar.** Brief burning, possible glucose rise in diabetics, a single case of kidney failure (Haesler 2023).
- **Aloe on open surgical wounds.** Delayed healing (Dat 2012).
- **Wild maggots, cobweb, soil, dung.** Tetanus, sepsis and screwworm (Johns Hopkins Medical Archives n.d., Nuesch 2002, THRIVING library, WO-01).
- **Waiting.** Delay is the main cause of gas gangrene and of death in necrotising infection (Dufour 1998, Wong 2003).

Red flags

Send to the district infirmary at once, or start emergency steps, if any of these appear. 1. Pain out of proportion to the wound, or suddenly worse after a quiet period. 2. Crackling under the skin, blisters, grey, bronze or black skin, or a sweet, rotten smell with a thin brown discharge. 3. Pulse rising faster than temperature, confusion, anxiety or odd cheerfulness. 4. Redness spreading more than 5 cm from the edge, temperature above 38.5°C or pulse above 110. 5. Red streaks up the limb or swollen, tender glands. 6. Any wound with bone showing, a crushed limb, a deep puncture into a joint, or a bite. 7. Jaw stiffness or muscle spasm in the days after any dirty wound (tetanus). 8. Wounds in people with diabetes, and wounds of the lower leg, both of which carry several times the usual infection risk (Quinn 2014, Hollander 2001). 9. A wound still producing pus or slough after 2 weeks.

The case against

- **Lawson Tait** against Lister: cleanliness, not chemistry, prevents infection. He was largely right for wounds, though his own figures were confounded (Wikipedia, Lawson Tait).
- **Almroth Wright and Alexander Fleming** against wartime antiseptics: they cannot reach the bacteria and they kill the defenders (Wikipedia, Alexander Fleming). Laboratory work since supports them (Lineaweaver 1985).
- **The FLOW investigators** against soap and against the belief that high pressure is better (FLOW Investigators 2015).
- **Jaman, Prodromidis and colleagues** against the six-hour rule (Jaman 2021, Prodromidis and Charalambous 2016). The danger is that discarding a rule also discards urgency, and delay still kills in gas gangrene and necrotising infection (Wong 2003).
- **Andrew Jull and the Cochrane wound group** against routine honey: the benefit is real only in burns, and the burn evidence comes largely from one investigator (Jull 2015, Wijesinghe 2009).
- **Peter Molan's honey research** was a lifetime's work, and it is cited by makers of honey dressings. I found no evidence of bias, but readers should know the strongest advocate was also the main researcher [VERIFY].
- **Cochrane reviewers on aloe and Cardoso on plantain**: plant evidence is thin, and aloe delays healing in open surgical wounds (Dat 2012, Cardoso 2021).
- **VenUS II** against the claim that maggots heal wounds faster. They debride faster but healing is the same and they hurt more (Dumville 2009).

- **The broad case against this whole report.** In the laceration studies, the patient (diabetes, the leg) and the wound (dirt, foreign bodies) predicted infection far better than any choice of fluid, pressure or timing (Hollander 2001, Quinn 2014, Jaman 2021). Fussing over method may matter less than finding and removing the dirt.

10-line summary

1. Do no harm first: no boiling oil, caustics or hydrogen peroxide in deep wounds.
2. Drinkable water is as good as saline for washing a wound.
3. Gentle flow from a squeezed bottle or a raised bag is enough. High pressure adds nothing.
4. Soap goes on the skin and hands, not into the depths of an open fracture.
5. Wash with litres for large wounds, not cupfuls, and keep going until no dirt comes out.
6. Get all dirt and dead tissue out. Nothing put on a wound replaces this.
7. Leave dirty, crushed, bitten or old wounds open, and close clean ones at day 3 to 7.
8. The six-hour rule is not a cliff edge, but delay still kills through gas gangrene.
9. Sugar or honey under an absorbent dressing helps infected, smelly wounds. Honey speeds burn healing.
10. Watch for pain out of proportion, spreading redness and a rising pulse, and act at once.

Open questions

1. What volume of honey per area of wound did the trials use? I could not find it.
2. How often does unprocessed honey carry clostridial spores, and has it ever caused a wound infection?
3. How well does boiled and cooled water perform? Only one trial of 51 people tested it.
4. What were Gustilo and Anderson's original infection rates by fracture type? I could not read the 1976 paper.
5. Could a district rear sterile *Lucilia sericata* reliably, and how would it disinfect eggs without modern chemicals?
6. What is the best home-made sugar paste without polyethylene glycol?
7. Does dilute hypochlorite at 0.025% improve outcomes in fresh contaminated wounds, or only reduce smell?
8. Can a village worker learn to judge dead muscle safely, and how much training does that need?

Sources to read in full

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3. FLOW Investigators, NEJM 2015. I read only the abstract and summaries.
4. Jull and colleagues, Cochrane review of honey, 2015.
5. Haesler, WHAM evidence summary on sugar, 2023.
6. Trueta J. The Treatment of War Wounds and Fractures, 1939, which I could not find.
7. Paré A. Les oeuvres, 1575, the Turin passage in the original French.
8. Fernandez and colleagues, Cochrane review of water for wound cleansing, 2022.

At the bedside after the Fall

The household

- **Minimum viable version.** Wash hands with soap. Wash the skin around the wound with soap and water. Pour drinkable or boiled and cooled water through the wound from a clean bottle until no dirt shows. Pick out visible grit. Cover with boiled cloth. Small clean cuts can be held together with strips. Anything deep, dirty, crushed or bitten is left open and taken to the dispensary.

- **What it needs to start.** Soap, a clean plastic bottle with a small hole in the cap, a pot and fire, tweezers, cotton cloth boiled and dried in a closed container, and a sealed bag of white sugar.
- **First failure to expect.** Closing a dirty wound because it looks better closed. The second is pouring a strong antiseptic or hydrogen peroxide into it.

The village of 300

- **Minimum viable version.** One trained wound keeper and a clean room with good light. The keeper washes with litres of water from squeeze bottles or a gravity bag, removes foreign matter and trims loose shreds. They leave contaminated wounds open under bulky dressings, use sugar or honey on infected wounds and record each wound on a card. Wounds needing excision are sent to the district.
- **What it needs to start.** Training of one or two people by someone who has done it. Stocks of boiled cloth, sugar and honey, bleach of known strength, forceps and scissors that can be boiled, a lamp, record cards and a stretcher route to the district.
- **First failure to expect.** Daily dressing changes that disturb the wound, waste cloth and let flies in, or a deep wound left with dead muscle in it because the keeper has no one to send it to.

The district of 3,000

- **Minimum viable version.** A surgeon or trained surgical worker who can do excision under anaesthesia, delayed primary closure at day 3 to 7 and plaster immobilisation in the Trueta style. Saline is made by weight. Outcomes are recorded so that the district learns from its own results.
- **What it needs to start.** Anaesthesia (see the library's anaesthesia report when it exists), instruments, plaster of Paris or an alternative, a clean theatre, an assistant, a laboratory microscope if possible and a supply of antibiotics, however small (IN-07).
- **First failure to expect.** Too many wounds arriving too late, already infected, because the villages held on to them. The second is running out of dressings by changing them daily.

Protocols

Protocol 1: Washing a small fresh wound (household)

1. Stop the bleeding first (THRIVING library, WO-01).
2. Wash your hands with soap and water for 40 to 60 seconds, the length HY-01 recommends before touching a wound (THRIVING library, HY-01).
3. Wash the skin around the wound with soap and water, outwards from the edge. Keep soap out of the wound itself.
4. Irrigate with drinkable water, or water boiled and cooled in a covered pot. Use about 50 to 100 mL per centimetre of wound length, and at least half a litre for any wound (Mason and St John n.d.) [VERIFY, minimum is my inference].
5. Use a clean bottle with a hole in the cap or a jug held about 30 cm above the wound. Gentle flow is enough.
6. Pick out visible dirt with boiled tweezers. Irrigate again.
7. Clean small cuts of the face, scalp or hand may be closed with strips or sutures (WO-03). All others are covered with a dry, clean dressing.
8. Look at it again at 48 hours, or earlier if pain increases.

Protocol 2: Squeeze-bottle or gravity irrigation of a large wound (village)

1. Two people. One holds the limb, one washes. Explain to the patient and give what pain relief exists.
2. Scrub the surrounding skin with soap, water and a soft brush.

3. Volume: 1 litre for a hand-sized wound, 3 litres for a large wound, and up to 6 litres for a wound with broken bone (Giannou and Baldan 2009, FLOW Investigators 2010).
4. Pressure: squeeze a 1 to 2 litre plastic bottle with several holes cut or pierced in the cap, with both hands. Or hang a bag or jug with tubing 1.5 to 2 metres above the floor (FLOW Investigators 2010, Giannou and Baldan 2009). Do not use a syringe and needle at full force on a deep wound.
5. Flush every pocket. Lift flaps gently so that water reaches under them.
6. Remove clothing, grass, soil and wood. Do not dig for metal.
7. Leave the wound open. Fill it loosely with fluffed gauze or boiled cloth and cover with a bulky absorbent layer.
8. Splint the limb if bone or a large muscle is involved.
9. Send to the district any wound with dead muscle, exposed bone, a joint or heavy contamination.

Protocol 3: The closure decision (village and district, see WO-03)

- **Close at once:** clean, sharp, fresh wounds, and wounds of the face, scalp, neck and genitals after thorough washing (Dufour 1998).
- **Leave open:** crushed, dirty, bitten or deep wounds, gunshot and blast wounds, wounds with dead tissue, wounds over 12 to 24 hours old outside the face, and any wound in doubt (Dufour 1998, Giannou and Baldan 2009, Jaman 2021).
- **Close later:** wounds left open that are clean, red and without pus at the first dressing change. Face and neck about day 3, trunk and arm days 4 to 5, leg days 5 to 7. Seldom after day 8 (Dufour 1998).
- **Never** close a wound with pus, spreading redness or a bad smell. Never put "a few loose stitches" in a dirty wound.

Protocol 4: Sugar dressing for an infected or smelly wound

Sources: Haesler 2023, Giannou and Baldan 2009, Knutson 1981. 1. Wash and remove loose slough and pus first. 2. Use plain white granulated table sugar from a sealed bag, with no additives. 3. Pack it into the cavity to fill it, about a finger's depth in a deep wound [VERIFY quantity]. 4. Cover with gauze or boiled cloth, then a thick absorbent layer. 5. Change twice daily while the dressing is wet with dissolved sugar. Reduce to daily, then every few days, as exudate falls. 6. Rinse out the old sugar with water at each change. 7. Watch blood sugar in diabetics if it can be measured. Stop if the skin around blisters or the wound worsens.

Protocol 5: Honey dressing

Sources: Molan and Rhodes 2015, Simon 2009, Jull 2015. 1. Use only on a wound already washed and cleared of dead tissue. 2. Prefer honey from a sealed, single-use container. Do not heat it to sterilise, which destroys its activity. 3. Spread honey thickly on the dressing pad, not the wound. Volume per area was not found in any source [VERIFY]. Simon reports 5 to 10 mL twice daily for small newborn wounds. 4. Cover with an absorbent layer, and seal edges if flies are about. 5. Change when the honey is diluted and runny, daily at first, less often as exudate falls. 6. For burns, equal parts honey and ghee or oil on gauze (Giannou and Baldan 2009). 7. Stinging in about 1 in 20 patients usually passes. Stop at any sign of gas gangrene.

Protocol 6: Dilute hypochlorite wash (modified Dakin's), for dirty or infected wounds only

Sources: Familiprix n.d., Giannou and Baldan 2009, CHOC n.d. 1. Use plain, unscented household bleach of known strength, without detergent. 2. **Weak solution, about 0.025%:** 5 mL of 5% bleach in 1 litre of boiled and cooled water (Giannou and Baldan 2009). With 4% bleach, use 5 mL in 800 mL. With 6% bleach, 5 mL in 1,200 mL (Familiprix n.d.). 3. **Quarter-strength, about 0.125%:** about 950 mL of water boiled 15 minutes, half a teaspoon of baking soda and 24 mL of regular bleach (CHOC n.d.). This is a clinic strength, used for short periods. 4. Make it fresh daily for home use, in a covered container out of light. 5. Rinse or soak the wound once or twice a day, then

rinse with boiled water. Protect the skin around it with petroleum jelly or oil if it becomes sore. 6. Stop once the wound is clean and red. Long use slows healing (Familiprix n.d.). 7. Never mix bleach with vinegar or ammonia, or with other cleaners [VERIFY, standard safety advice, not from a source I read].

Protocol 7: Dressing changes and inspection

1. A deep wound left open under a bulky dressing is not disturbed for 4 to 5 days, unless the patient becomes feverish and unwell or the wound smells offensive and the patient is worse (Dufour 1998, Giannou and Baldan 2009).
2. Check the patient daily, not the wound: pulse, temperature, pain, the skin beyond the dressing and the toes or fingers.
3. At each change, wash hands, remove the dressing, irrigate gently and look. Record size, colour, smell and discharge on the card.
4. A clean, red, granular base means the wound can be closed or left to heal. Grey, yellow or black tissue means more cleaning. Pus means drainage.
5. Escalate at any red flag.

Numbers to carry

1. **"If you can drink it, you can put it into a dirty wound"** (Giannou and Baldan 2009). Tap against saline, infection RR 0.84 (Fernandez 2022).
2. **1 to 2 psi works.** Gravity irrigation gave 13.7% reoperation, high pressure 13.2% (FLOW Investigators 2015).
3. **1 to 3 litres** for a war wound, **up to 6 litres** for a large open fracture (Giannou and Baldan 2009, FLOW Investigators 2010).
4. **Soap in the wound: 14.8% against 11.6%** reoperation (FLOW Investigators 2015).
5. **1 to 3 mm** is the most skin to trim from a wound edge (Dufour 1998, Giannou and Baldan 2009).
6. **Days 3 to 7** for delayed closure, **seldom after day 8** (Dufour 1998).
7. **5 mL of bleach per litre**, about 0.025% (Giannou and Baldan 2009, Familiprix n.d.).
8. **4.68 days** faster healing of partial-thickness burns with honey (Jull 2015).
9. **Redness over 5 cm, temperature over 38.5°C, pulse over 110** mean a spreading infection (Stevens 2014).
10. **More than 24 hours' delay** in surgery for necrotising infection, about 9 times the risk of death (Wong 2003).

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