WO-14 Tetanus, gas gangrene and the infected wound: prevention and the old treatments

HEALING after the FALL, research library, WO-14

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

This report covers three killers of the wounded: tetanus, gas gangrene and the ordinary infected wound (cellulitis, abscess and infected bone). It builds on two library reports. Wound cleaning, excision, honey, sugar and maggots are in (THRIVING library, WO-02). Closure and the closed abscess are in (THRIVING library, WO-03). Where those reports already give a protocol, this one points to it.

Of the related prompts in the brief, only WO-02 and WO-03 exist in the library. HY-10, MA-05, IN-05 and IN-07 were not there on 10 October 2026, so neonatal tetanus and cord care are treated here in full.

No plant remedy is central to this subject. The organisms are bacteria: *Clostridium tetani* (tetanus) and *Clostridium perfringens* with its relatives (gas gangrene). What works against them is surgery, nursing, vaccine, antitoxin and a few drugs. For each drug I give doses that two or more sources print, the signs of overdose, and what each rung can honestly do. I give no manufacturing method. Claims I could not confirm, and my own inferences, carry [VERIFY].

Findings by section

Part 1. Tetanus

1.1 What it is and how it kills *C. tetani* is a strict anaerobe whose spores live in soil and dung. In a wound without oxygen the spores germinate and make tetanospasmin. The toxin travels along nerves to the spinal cord and brainstem and blocks the signals that let opposing muscles relax (Giannou and Baldan 2009). WHO puts the estimated minimum lethal dose at 2.5 ng/kg (WHO 2017).

The early signs are neck stiffness, trismus (a locked jaw) and difficulty swallowing. Then comes risus sardonicus, the fixed grimace. In severe cases the autonomic nervous system fails, so pulse, blood pressure and temperature swing out of control. The spasms are very painful and **the patient remains conscious throughout**. The greatest danger is suffocation from spasm of the larynx or from inhaled vomit (Giannou and Baldan 2009).

Once the toxin is bound to nerves, antitoxin cannot neutralise it (Giannou and Baldan 2009). Antitoxin only mops up toxin still circulating. Everything after that is keeping the patient alive for the weeks the nerves take to recover.

Forms. Among 736 cases, 88% were generalised, 12% localised (spasm near the wound, case-fatality under 1%) and 1% cephalic. Cephalic tetanus follows head wounds, has an incubation of only 1 to 2 days and kills 15 to 30% (WHO 2017).

Incubation. It is 3 to 21 days, median 7, occasionally up to 178 days, and longer the further the wound is from the central nervous system (WHO 2017). Under 7 days bodes badly (WHO 2010).

Severity. The ICRC uses three degrees. Mild means no generalised spasms. Moderate means generalised spasms when provoked. Severe means spontaneous spasms with an arched back (opisthotonus) (Giannou and Baldan 2009).

1.2 Case-fatality with and without treatment **The old record.** Hippocrates describes a ship's commander whose finger was crushed by an anchor and who died of tetanus within days (Galassi 2024). The library report on natural history quotes Osler in 1892: traumatic tetanus had a mortality "not less than eighty per cent" (THRIVING library, FO-02).

Setting	Case-fatality	Source
No medical intervention	approaches 100%	WHO 2017
Intensive care available	10 to 20%	WHO 2017
Range even with intensive care	10 to 80%	WHO 2010
Adults in hospital, 22 studies, 1,618 patients	32.0% (27.1 to 37.0)	Chen 2025
Adults in Africa, 27 studies, 3,043 patients	43.2% (36.9 to 49.5)	Woldeamanuel 2016
Guangdong, 2,567 cases	11.8% in 2012, 3.5% in 2021	Liu 2026
Mogadishu, 50 patients, 80% unvaccinated	26%	Mohamed 2026
Aceh after the 2004 tsunami, 106 cases	18.9%	Pascapurnama 2016
Yogyakarta after the 2006 earthquake, 71 cases	36.6%	Pascapurnama 2016

In the African series, 26% of studies had no ventilator at all. Deaths came from autonomic failure, aspiration pneumonia, lack of oxygen and sepsis (Woldeamanuel 2016). In Mogadishu, respiratory failure caused 69.2% of deaths (Mohamed 2026).

Chen's meta-analysis gives these risk ratios for death: autonomic dysfunction 4.84, Ablett grade III or above 3.40, needing ventilation 2.46, incubation under 7 days 2.10, under 2 days from first symptom to first spasm 2.06, and age 40 or over 1.89 (Chen 2025).

After the Fall. A district with no ventilator should expect something near the African figure: four in ten adults with generalised tetanus die. A village with no drugs should expect most to die. Osler's 80% is the best historical anchor, but it reflects hospital care in the 1890s [VERIFY].

1.3 The Great War and after Nocard showed in 1897 that antitoxin given to animals before wounding prevented tetanus. Ramon developed toxoid in 1923 (Galassi 2024).

The British figures below come from secondary summaries of Sir David Bruce's analyses. I could not read the primaries, so all are [VERIFY].

- In September 1914, tetanus struck about 8.8 to 9 per 1,000 wounded. Prophylactic antitoxin began in mid-October and the rate fell to about 1.4 per 1,000 by December 1914 (Bruce 1918, secondary summary).
- The official history gives 2,529 cases in France, 1.47 per 1,000 (Bruce 1920, secondary summary).
- Once tetanus set in, the death rate stayed high: 57.7% in home hospitals in 1915 and 49.2% in 1916. In France in 1916, Leishman and Smallman counted 118 deaths among 160 cases, 73.7% (Bruce 1918, secondary summary).

The lesson. Antitoxin given at wounding prevented most cases. It did little for established disease.

The Second World War. The US Army adopted toxoid in 1941. It recorded about 70 tetanus cases per million wounded in the First World War and only 12 cases in the whole of the Second, mostly in men not fully immunised. Among Japanese prisoners in Manila in 1945 there were 473 cases and 389 deaths (MSMR 2025). Active immunisation before wounding is what ended tetanus in armies.

1.4 The toxoid stockpile: how long it keeps and who gets the last doses **What it does.** An antibody level above 0.01 IU/mL is usually protective. Six doses in childhood and adolescence count as lifelong protection, or five if the series starts in adulthood. Doses must be at least 4 weeks apart, and a 2-month gap gives a better response. Boosters still work 25 to 30 years after priming. After only three infant doses, antibody levels at 15 years are about the same as in the unvaccinated (WHO 2017).

Pregnancy. A woman with no reliable history needs two doses of Td four weeks apart, the second at least two weeks before birth. A third dose six months later gives at least five years of protection (WHO 2017). Two or more doses cut neonatal tetanus deaths by 94% (80 to 98) (Blencowe 2010).

Heat. Tetanus toxoid is among the most stable vaccines (WHO 2006):

- Potency is unchanged after 3 to 7 years at 4 to 8°C. The labelled shelf life is usually 3 years for TT and Td.
- Loss is insignificant over 1.5 years at 18°C, 6 to 12 months at 24°C and 2 to 6 months at 37°C.
- At 53°C potency fell 17% in 4 days and 47% in 8 days. At 60°C the toxoid is destroyed in 3 to 5 hours.

Cold is the worse enemy. Adsorbed toxoid freezes between minus 5 and minus 10°C. In one manufacturer's tests, potency after one, two and three freeze-thaw cycles was 85%, 39% and 40%. Yet in one study every recruit given frozen toxoid still reached a protective level, though the mean response was lower (WHO 2006). WHO still says known-frozen vials must not be used. The shake test detects freeze damage (Protocol 8).

Beyond the date. I found no study of toxoid years past its labelled expiry. Unchanged potency for 3 to 7 years at 4 to 8°C (WHO 2006) suggests a stock kept cool, never frozen and never heated keeps useful potency for some years past its label [VERIFY]. A trial in Chad reportedly found toxoid kept up to 30 days at up to 40°C as good as cold-chain toxoid. I saw only a search summary [VERIFY].

Who gets the last doses. No source sets a triage order for a finite stock. This order is my inference [VERIFY]:

1. **Pregnant women, two doses each.** One course protects two people, and neonatal tetanus kills most of its victims without a ventilator (Blencowe 2010, WHO 2017).
2. **Tetanus survivors.** The disease does not confer immunity (Giannou and Baldan 2009).
3. **People in the dirtiest work**, and anyone going to fight. Toxoid given at wounding does not protect an unprimed person in time, so the primary series matters more than a booster at injury.
4. **Children completing the series.** Three infant doses alone give little protection by 15 (WHO 2017), so complete a few children rather than starting many.

1.5 Prevention at the wound UK guidance counts as tetanus-prone any puncture wound acquired in a contaminated environment and any wound with a foreign body. It counts as high-risk heavy contamination with soil or manure, extensive dead tissue, and surgery delayed more than 6 hours (PHE 2018). The ICRC adds that small, deep, punctate wounds are the most dangerous, because they make the airless pocket the organism needs (Giannou and Baldan 2009).

Excision. Early, adequate removal of dead tissue, with the wound left open, is "vital" (Giannou and Baldan 2009). WO-03 documents the old disaster of stitching dirty wounds shut, and notes that boiling does not reliably kill clostridial spores (THRIVING library, WO-03). Excision is the one preventive measure that needs no stockpile.

Toxoid and antitoxin. The ICRC gives 0.5 mL toxoid to every war-wounded patient whatever their history. If the patient is unimmunised or unsure, it adds human tetanus immunoglobulin (TIG), 500 IU for adults and 250 IU under 15 (Giannou and Baldan 2009). UK guidance gives 250 IU, or 500 IU if more than 24 hours have passed, contamination is heavy or after burns, the same for adults and children (PHE 2018). All sources put toxoid and antitoxin in separate syringes at separate sites. The ICRC also gives penicillin to every war wound (Giannou and Baldan 2009). Doses are in Protocol 1.

1.6 Recognising tetanus, and the spasm mistaken for something else Diagnosis is clinical. Trismus, risus sardonicus or painful muscle spasms with a history of injury are enough (WHO 2010).

The spatula test. Apte and Karnad touched the back of the throat with a spatula in 400 patients with suspected tetanus. In tetanus the jaw clamped on the spatula in 94%. In other diagnoses no patient clamped down. They gagged and pushed it out. The test was 94% sensitive and 100% specific (Apte 1995). It needs a clean flat stick and nothing else. It is the most useful single fact here for a healer without a laboratory.

How it is missed. Trismus has many causes and patients go to the wrong specialist (Giannini 2016). One man saw seven health professionals, including a dentist and a facial surgeon, before anyone diagnosed tetanus (Papadiochos 2016). An older adult in China was first treated for a stroke (Rao 2026). A 2026 review lists functional (psychogenic) dystonia and catatonia among the causes of trismus, beside tetanus (Falletti 2026).

A frightened, rigid patient with a locked jaw can therefore be labelled hysterical. I found no published case explicitly diagnosed as hysteria and later proven to be tetanus. The pattern is plausible from the cases above, but the specific claim is [VERIFY]. One reported case went the other way: a functional disorder first treated as tetanus (search summary [VERIFY]).

Three signs point to tetanus: full consciousness during spasms (Giannou and Baldan 2009, Rao 2026), spasms set off by touch, noise and light (WHO 2010), and a positive spatula test (Apte 1995).

1.7 Treatment of established tetanus The ICRC and WHO give the same skeleton. Their doses differ, and both are set out in Protocol 2.

1. **Clean the wound.** Excise it widely. The ICRC prefers spinal or regional anaesthesia and advises against ketamine, because patients waking from it are often restless and hallucinating, which may set off spasms (Giannou and Baldan 2009).
2. **Neutralise circulating toxin.** WHO gives 500 units of TIG. The ICRC gives 3,000 to 10,000 IU intravenously, or equine antitoxin 20,000 IU after a test dose (WHO 2010, Giannou and Baldan 2009). A Vietnamese trial of 272 adults found 3,000 IU human antitoxin no better than 21,000 U equine: 45% against 44% needed ventilation (Van Hao 2022). Antitoxin into the spinal fluid looked useful in an older meta-analysis, RR 0.71 (0.62 to 0.81) (Kabura 2006). The better recent trial found only a non-significant gain, 43% against 50% ventilated (Van Hao 2022). Reversible paraplegia has been reported after the intrathecal route (Rodrigo 2014).
3. **Kill the organism.** Metronidazole or penicillin. A trial of 161 patients found no difference between penicillin regimens and metronidazole. An older trial found metronidazole lowered mortality. Large doses of penicillin also block GABA-A receptors, the inhibitory pathway the toxin attacks, which is a theoretical concern (Rodrigo 2014).
4. **Control spasms** (1.8 and 1.9).
5. **Protect the airway.** If laryngeal spasm persists, decide early on tracheostomy (Giannou and Baldan 2009, WHO 2010).
6. **Fluids and food.** Sweating can be profuse. A tube through the nose may provoke spasms, so the ICRC suggests an early surgical feeding tube through the abdominal wall (gastrostomy) (Giannou and Baldan 2009).

7. **Nursing.** "Excellent nursing care is fundamental." Turn every four hours, with extra sedation first if movement triggers spasms. Keep skin, mouth and bowels clean. Give chest physiotherapy (Giannou and Baldan 2009). Careful nursing improved survival in the 1920s and 1930s, before modern drugs. A patient supported through 1 to 2 weeks has a much better chance (WHO 2010).
8. **Complete immunisation after recovery** (Giannou and Baldan 2009).

1.8 The dark quiet room **Tradition.** Tetanus patients were kept in darkened, silent rooms.

Record. WHO asks for a separate quiet, shaded area, protected from touch and noise (WHO 2010). The ICRC asks for a dark, quiet room as free of stimulation as possible (Giannou and Baldan 2009). The African meta-analysis notes that darker, quieter rooms reduce spasms (Woldeamanuel 2016).

Science. Spasms are reflexes set off by stimuli. Fewer stimuli means fewer spasms, less sedative and fewer laryngeal spasms. No trial has tested the room. It costs a curtain and a rule about doors and voices. **Grade B**, and the cheapest life-saving measure in this report.

1.9 Magnesium and the sedatives **Benzodiazepines.** WHO titrates diazepam intravenously in 5 mg steps until spasms stop, with totals up to 600 mg a day cited. The ICRC runs it up to 20 mg an hour "or more" and adds chlorpromazine or thiopental if diazepam fails (WHO 2010, Giannou and Baldan 2009). Both titrate to effect. The ICRC's warning applies at every rung: **"Oversedation can be as fatal as the disease."** WHO warns that propranolol and similar beta-blockers have caused low blood pressure and sudden death (WHO 2010).

Magnesium: history and action. Blake used magnesium for tetanus in 1906, and James and Manson revived it as an infusion in 1985. It relaxes muscle at the nerve junction and blunts the adrenaline surges behind autonomic storms (Rodrigo 2014). Its value is that it lets the healer use less sedative.

The Vietnam trial. 256 adults with severe tetanus were randomised to magnesium or placebo for 7 days. Magnesium did not reduce the need for ventilation (odds ratio 0.71, 0.36 to 1.40) or deaths. The magnesium group needed far less midazolam (1.4 against 7.1 mg/kg/day) and less paralysing drug, and needed verapamil 4.7 times less often. Adverse events did not differ (Thwaites 2006). Critics noted a low loading dose, no titration, serum levels of only 2 to 2.5 mmol/L and only 7 days of treatment (Rodrigo 2014).

The Sri Lankan series. Attygalle and Rodrigo titrated magnesium in 40 patients. Spasms were controlled in 38 at serum magnesium of 2 to 4 mmol/L. 57% were never ventilated. Mortality was 12%, five deaths, all over 60. The mean stay in intensive care was 23.1 days, with magnesium for 18.2 days (Rodrigo 2014). In Chandigarh, magnesium alone sufficed in only 6 of 33 patients, all with mild disease (Rodrigo 2014, citing Mathew 2010).

Pooled evidence. Three trials (275 patients) showed no mortality benefit: RR 0.80 (0.41 to 1.58) against placebo and 1.11 (0.70 to 1.75) against diazepam (Rodrigo 2012). A review of 13 studies found no mortality benefit but fewer spasms, less autonomic instability, less ventilation, 3 to 7 days shorter stays and very low toxicity (Nepal 2021).

Vellore. The brief names a Vellore series. The only Vellore publication I found is a single case: a 7-year-old with very severe tetanus who recovered on a magnesium infusion (Puliyel 2009). The lead is unconfirmed.

Doses from three sources differ by half (Protocol 3). The ICRC calls its regime "still under investigation" (Giannou and Baldan 2009).

Magnesium overdose. Before every repeat dose, breathing must be at least 16 a minute, the knee-jerk must be present and urine must be at least 30 mL an hour over four hours. If any fails, the dose is delayed or stopped. Overdose shows as loss of tendon reflexes, nausea, flushing, drowsiness, confusion, slurred speech, double vision, weakness and a slow pulse, then a sharp fall in blood pressure, respiratory paralysis, coma and cardiac arrest. Poor kidneys bring toxicity at lower doses. The antidote is calcium gluconate 1 g (10 mL of 10%) intravenously over three minutes, with bag-and-mask breathing (WHO PQ 2022). A pharmacology review puts the therapeutic window at 2.0 to 3.5 mmol/L, loss

of reflexes at about 4.0 to 5.0 and respiratory depression at about 5.0 to 7.5 (Xia 2026). WHO's tetanus note puts loss of reflexes at about 4 mmol/L (WHO 2010).

The reflex goes before breathing fails. That is why the knee-jerk is the bedside monitor in every source. A village without a laboratory can still test a knee. The Sri Lankan series also saw low calcium, which recovered within 48 hours (Rodrigo 2014).

1.10 Neonatal tetanus and the cord **Burden.** WHO estimates 7,700 neonatal tetanus deaths in 2021, 84% fewer than the 46,898 of 2000 (WHO 2026). Roper and colleagues put the toll at about 180,000 a year in the mid-2000s (Roper 2007).

Signs. A baby who fed well stops sucking, cries excessively and has spasms (WHO 2026).

How deadly. In Ekiti, Nigeria, 52.6% died. The authors say case-fatality can be close to 100% in poor settings and fall to about 50% with basic care and experienced staff (Ogundare 2021). In Kilifi, Kenya, 62% of 191 babies died, unchanged over 15 years, and 98% had been born at home (Ibinda 2015). Low birth weight predicted death, OR 2.09 across 16 studies (Lambo 2013).

What goes on the cord. Ghee on the cord was a risk factor in Pakistan (Traverso 1989). A larger study found the risk lay in ghee heated over dung fuel, which points to the dung (Bennett 1999). In Bangladesh, among 359 cases, dung on the cord raised the odds (OR 2.31), while maternal toxoid (OR 0.50), the attendant washing hands (OR 0.64) and an antimicrobial applied to the cord (OR 0.21) lowered them (Parashar 1998).

Chlorhexidine. Three community trials with 54,624 newborns found chlorhexidine on the cord cut all-cause neonatal deaths by 23%, RR 0.77 (0.63 to 0.94). Omphalitis fell 27 to 56%. Cord separation was 1.7 days later. Soap and water was no better than dry care (Imdad 2013, through a summary of the abstract). An earlier review of 21 mostly high-income trials found no advantage of antiseptics over clean dry care (Zupan 2004). The two fit together: antiseptic care saves lives where births happen at home in a dirty setting, and adds little where the birth is clean. A village after the Fall will be the first kind. WHO's recommended form is 7.1% chlorhexidine digluconate, giving 4% chlorhexidine (Amponsah-Kodua 2025).

The hot compress. In Ekiti the commonest cord care among babies who got tetanus was a hot-water compress (48.5%), and only 9% of mothers had cleaned the cord properly (Ogundare 2021). This describes cases and does not prove harm [VERIFY]. Hand hygiene at birth is covered in (THRIVING library, HY-01).

Part 2. Gas gangrene

2.1 Signs and speed *C. perfringens* and its relatives cause a fast, swelling death of muscle in deep wounds that lack oxygen. Risk rises with soil in the wound, wounds closed without excision, tourniquets left on, tight plaster, and wounds of the leg and perineum (Giannou and Baldan 2009).

Speed. Incubation is almost always under three days, mostly under 24 hours, as short as 6 hours and occasionally up to six weeks (Giannou and Baldan 2009).

Signs, in the ICRC's order: sudden, increasing pain at the wound. Swelling, with thin watery or bloody discharge. A pulse that rises markedly while temperature rarely passes 38°C. Anxiety or odd euphoria. Skin that is tense, pale and marbled, later bronze with dark blood blisters. A sweetish smell, which is unreliable. Gas crackling under the fingers, whose spread does not match the dead muscle. The skin may look normal over massive gangrene. At operation the muscle goes from pinkish-grey to brick red to green-purple (Giannou and Baldan 2009). WO-02 gives the same signs from Dufour (THRIVING library, WO-02).

2.2 Excision is the treatment Treatment is excision of dead tissue, which may mean urgent amputation. The limit is dead muscle, not the extent of the gas. Cutting continues until muscle is healthy, red, bleeding and contracting

(Giannou and Baldan 2009). Antibiotics are given but cannot reach dead muscle. One review gives penicillin G 4 million units every 4 hours for 10 to 14 days (Hussain 2024).

Mortality. Untreated, it is universally fatal. Treated, 20 to 30% die, as few as 5 to 10% in some series and 67% or more in the immunocompromised (Hussain 2024).

In war, as a share of wounds: about 1% in the First World War (6% of open fractures), 0.7% in the Second, 0.2% in Korea, 0.002% in Vietnam and none in the Falklands (Hussain 2024).

The change of 1915. Wound excision was first published in June 1915 by Henry Gray in the *Journal of the Royal Army Medical Corps* and by E.T.C. Milligan in the *BMJ*. Gray had to fight surgeons who still relied on antiseptics alone (Scotland 2017).

Bowlby. The brief names Bowlby. Sir Anthony Bowlby was Consulting Surgeon to the Forces in France from September 1914. A December 1914 note refers to his work with Rowland on a Lister Institute investigation of gas gangrene aimed at a serum, not at excision (search summary). I found no excision paper by him. The lead is unconfirmed, and the credit belongs to Gray and Milligan.

Disaster. After the Wenchuan earthquake of 2008, 19 of 226 open limb injuries developed gas gangrene. Patients reached hospital after a mean of 72 hours. There were 16 open amputations and one death. The authors cite mortality of 25% after trauma and 50 to 80% after natural disasters (Wang 2013).

At the district rung the choice is often a limb or a life. WO-02 records that delay beyond 24 hours in necrotising infection raised mortality about ninefold (THRIVING library, WO-02).

2.3 Hyperbaric oxygen Brummelkamp in Amsterdam treated clostridial infection with oxygen at three atmospheres in the 1960s (Brummelkamp 1965). Finnish series combining surgery, antibiotics and oxygen at 2.5 atmospheres reported 22.6% mortality in 53 patients (Korhonen 1999) and 28.1% in another series (Hirn 1988). A 1996 review found no prospective human data (Stephens 1996). A pressure chamber is beyond every rung below the reference hospital. The history matters because even the best adjunct did not replace excision.

Part 3. The infected wound

3.1 Cellulitis and erysipelas before antibiotics The ICRC separates contamination (every war wound), local sepsis (cellulitis and abscess with little general illness) and invasive infection, with fever, fast pulse and sepsis. Invasive streptococcal infection starts as cellulitis with pain out of proportion to what is seen, spreads within hours and needs excision, drainage and large doses of penicillin (Giannou and Baldan 2009).

A systematic review of papers from 1900 to 1950 gives the best numbers (Spellberg 2009):

Infection	No antimicrobials	Sulphonamides	Penicillin
Cellulitis or erysipelas, deaths	2,528 of 23,657 (10.7%)	35 of 1,593 (2.2%)	1 of 325 (0.3%)
Cellulitis or erysipelas, cured	66%		98%
Wound or ulcer infection, cured	36%	73%	83%
Major abscess, deaths	64 of 1,016 (6%)		0 of 337
Major abscess, cured	76%		96%

Ultraviolet light, a popular pre-antibiotic treatment, was linked to 8.3% mortality in cellulitis (Spellberg 2009). These are not randomised comparisons.

After the Fall. Without drugs, about one in ten people admitted with cellulitis or erysipelas died. A district that keeps a penicillin stock saves more lives with it here than almost anywhere else [VERIFY, inference].

Lymphangitis. I found no pre-antibiotic series reporting red streaks separately. The library treats spreading redness over 5 cm, temperature over 38.5°C and pulse over 110 as signs of systemic infection (THRIVING library, WO-02). I treat red streaks as cellulitis with spread [VERIFY].

3.2 The abscess **Tradition.** "Where there is pus, let it out."

Record. Without drugs, major abscesses killed 6% (Spellberg 2009). Two American trials show drainage alone cures most skin abscesses. After drainage, placebo cured 73.6% and trimethoprim-sulfamethoxazole 80.5% (Talan 2016). In abscesses of 5 cm or less, placebo cured 68.9%, clindamycin 83.1% and trimethoprim-sulfamethoxazole 81.7% (Daum 2017).

Packing. In 433 patients with perianal abscess, packing made dressings more painful, and fistula and recurrence did not differ significantly (Newton 2022). Eight trials of skin abscesses (485 patients) found no benefit (Mohamedahmed 2021). Prolonged packing may delay healing (Kim 2024). **Grade X** for routine packing.

Hot compresses. I found no trial on abscesses. Evidence summaries found too little evidence for local warming of chronic ulcers (WHAM 2024). Heat is comfort on intact skin. It does not empty pus, which needs a knife. **Grade D.**

3.3 Dressings Honey and sugar are covered with protocols in WO-02 (THRIVING library, WO-02). The ICRC uses honey, sugar or salt-saturated saline on neglected wounds as adjuncts, "not a replacement for adequate surgery" (Giannou and Baldan 2009). A review of 27 trials found iodine neither delayed healing nor harmed the thyroid, though it was weaker than crude honey in one trial (Vermeulen 2010). Iodine exists after the Fall only as stock. WO-02 covers maggots and the two tetanus cases from unsterilised larvae. The ICRC adds that most patients refuse maggots (Giannou and Baldan 2009).

Neglected wounds. Excise dead tissue, remove dead bone, leave the wound open, and change dressings every 4 to 5 days rather than daily, because "every dressing is a trauma to a healing wound". The six hours after wounding are critical, because bacteria multiply steeply after that (Giannou and Baldan 2009).

3.4 Osteomyelitis and the sequestrum Infection reaches bone through the blood, mostly in children, or through an open fracture. Dead bone separates as a **sequestrum**. The living periosteum lays down a new shell, the **involucrum**. Bacteria on dead bone form a biofilm that shields them from antibiotics, so the dead bone must come out (Giannou and Baldan 2009).

Before antibiotics. Acute haematogenous osteomyelitis killed about 20% and left 50% with lasting damage. Kennedy saw mortality fall from 23% to 3.5% with sulphonamides. Bick warned in 1941 that chemotherapy did not replace surgical judgement (Nade 1983). Search summaries also report 36% mortality in one series from 1936 to 1940, and 20% in 670 cases in Toronto. I could not identify or read either paper [VERIFY].

In Africa now. In a review of paediatric cases, 83.5% were already chronic and *Staphylococcus aureus* caused 43.9% (Ipomai 2026). In Douala, 48.1% of children came more than three months late and 25.9% had sickle cell disease (Mantho Fopa 2026).

Staged surgery. A Ugandan series treated 23 children with bone gaps after osteomyelitis. Sequestrectomy came first and a bone graft from the child's own body about 12 weeks later. Bone united at first in 61% and in all within

five years. Infection recurred in 8.7% (Loro 2025). An Ethiopian case used Dakin's solution for three weeks after debridement (Negussie 2026).

Timing. The old rule is to wait until the sequestrum has separated and the involucrum can bear load before removing dead bone. I read it only in a search summary and in Loro's staging. King's *Primary Surgery*, which would confirm it, was not accessible [VERIFY].

Evidence grades

Grades: A trials or reviews, B consistent clinical series or pre-antibiotic record, C convergent tradition with plausible mechanism, D single tradition or anecdote, X ineffective or harmful.

Practice	Record	Grade
Toxoid before injury	12 US Army cases in the Second World War, 94% fewer neonatal deaths	A
Antitoxin at wounding	British rate fell about sixfold in 1914 [VERIFY]	B
Antitoxin for established tetanus	mops up unbound toxin only, human equals equine	B
Intrathecal antitoxin	older meta-analysis positive, best trial not significant	B, uncertain
Excision, wound left open	the decisive change of 1915 to 1918	B
Dark quiet room	WHO, ICRC and African authors all advise it	B
Intensive nursing	credited with gains in the 1920s and 1930s	B
Diazepam titrated	universal, oversedation lethal	B
Magnesium sulphate	spares sedatives, no mortality benefit	A for both findings
Metronidazole or penicillin	similar in trials	A, small trials
Beta-blockers for autonomic storm	hypotension, sudden death	X
Chlorhexidine cord care, home births	23% fewer neonatal deaths	A
Dung or dung-heated ghee on the cord	raises tetanus risk	X
Hot-water compress on the cord	common among cases	D, probably harmful [VERIFY]
Excision or amputation for gas gangrene	untreated fatal, treated 20 to 30%	B
Hyperbaric oxygen	retrospective only	C at best, not available
Drainage of abscess	cures 69 to 74% alone	A
Packing the cavity	no benefit, more pain	X
Hot compress on an abscess	no trial	D
Iodine dressing	no harm, no delay	A for safety
Sequestrectomy after separation	staged surgery heals most children	B
Ultraviolet light for erysipelas	8.3% against 10.7% mortality	D

Means ledger

Need	Hands and knowledge	Hearth	Garden and still	Village dispensary (300)	District infirmary (3,000)	Hospital before the Fall
Tetanus prevention	never close a dirty wound, spatula test	boiled water, clean cloth, boiled cord tie and blade	spirit for hands	wound cleaning, toxoid if stocked, dose register	excision under anaesthesia, TIG if stocked	full schedule
Toxoid stock	none	none	none	cool cellar, never frozen, shake test	cold store if power, allocation register	2 to 8°C chain
Tetanus treatment	dark corner, sips, turning	fluids, soft food	nothing more	oral diazepam if stocked, metronida-zole tablets	IV diazepam, magnesium with knee-jerk checks, antibiotics, TIG, tracheostomy, gastrostomy	ventilation, ICU
Expected adult case-fatality	likely above 80% [VERIFY]	similar	similar	perhaps 50 to 60% [VERIFY]	about 40% (African pooled)	10 to 20%
Neonatal tetanus prevention	clean hands, nothing dirty on the cord	boiled blade and tie, dry cord	clean dry care	chlorhexidine if stocked, maternal toxoid	maternal toxoid campaign	standard
Gas gangrene	no tight bindings, recognise pain with racing pulse	carry to surgery at once	nothing	open the wound, carry on	excision or amputation, penicillin	plus oxygen chamber
Cellulitis	rest, raise, mark the edge	clean dressings	nothing proven	penicillin if stocked	IV penicillin, drain pus	full range
Abscess	recognise fluctuance, never seal	boiled blade	spirit on skin	incise and drain, no packing	deep and complex abscesses	imaging
Osteomyelitis	bone pain with fever in a child	rest, splint	nothing	drain pus, splint, refer	sequestrectomy, later graft	imaging, long courses

Hands and hearth can prevent much by never closing dirty wounds and by keeping cords clean and dry, and they can recognise the killers early. They cannot cure tetanus or gas gangrene. The district is where excision, amputation, intravenous magnesium and tracheostomy become possible. It needs a surgeon, someone to give anaesthesia, a nurse for each severe tetanus patient for three weeks, and stocks it cannot make: toxoid, antitoxin, diazepam, injectable magnesium, calcium gluconate, penicillin and metronidazole.

Can they be made? Equine antitoxin was made in institutes that kept horses, immunised them over months and tested each batch on animals. The Lister Institute was doing such work in 1914 (search summary) [VERIFY on the method]. That needs a laboratory, sterile technique and potency testing. Toxoid needs culture of a lethal organism and its inactivation. I found no record of failure or injury rates for small-scale production. A village could not do it. A district with a trained microbiologist might, after years [VERIFY].

Harm test

1. The closed abscess. Sealing pus in, by stitching a dirty wound, by tight plaster or by a crust over a deep collection, gives anaerobes the closed space they need. Gas gangrene is seen "particularly in wounds sutured closed without debridement". Tetanus comes most often from small deep wounds. Undrained dead tissue becomes an abscess, while drained tissue is expelled in about 10 days (Giannou and Baldan 2009, THRIVING library, WO-03). Any wound that is hot, swollen and throbbing under a closure must be reopened.

2. Tetanus mistaken for hysteria. Trismus is often put down to dental, joint, neurological or psychiatric causes, and diagnosis is delayed (Giannini 2016, Papadiochos 2016, Falletti 2026). Every day of delay leaves toxin unneutralised and the wound uncleaned. Sending a fully conscious, rigid, frightened patient home without airway care is the likeliest fatal error at the village rung [VERIFY, inference]. The spatula test separates the two (Apte 1995).

3. Magnesium overdose. Reflexes go first, then breathing, then the heart. Poor kidneys bring it on at lower doses. Without blood tests the knee-jerk, breathing rate and urine output are the only guards, and calcium gluconate must be at the bedside first (WHO PQ 2022).

4. Oversedation. Diazepam, barbiturates, chlorpromazine and magnesium add to each other (Giannou and Baldan 2009).

5. Equine antitoxin needs a test dose first (Giannou and Baldan 2009). I did not read modern rates of anaphylaxis or serum sickness.

6. Beta-blockers have caused hypotension and sudden death in tetanus (WHO 2010).

7. Ketamine and nasal feeding tubes may provoke spasms (Giannou and Baldan 2009).

8. Dung on the cord, dung-heated ghee and possibly hot compresses raise neonatal tetanus risk (Parashar 1998, Bennett 1999, Ogundare 2021).

9. Packing an abscess causes pain without benefit (Newton 2022, Mohamedahmed 2021).

10. Tourniquets left on lead to gas gangrene (Giannou and Baldan 2009).

11. Frozen toxoid loses potency invisibly unless shake-tested (WHO 2006).

12. Early sequestrectomy, before the involucrum can bear load, risks fracture [VERIFY].

Red flags

- Stiff jaw or neck, or difficulty swallowing, within three weeks of any wound. Check consciousness and do the spatula test.
- A newborn who fed well and then stops sucking, cries constantly or stiffens.
- Sudden severe pain in a wound within three days of injury, with a racing pulse and little fever.
- Crackling under the skin, bronze or marbled skin, blood blisters, thin watery discharge.
- Pain out of all proportion to what is seen.
- Spreading redness over 5 cm, temperature over 38.5°C, pulse over 110, or red streaks towards armpit or groin (THRIVING library, WO-02).
- A child with fever who will not use a limb.

- During magnesium: no knee-jerk, breathing under 16 a minute, urine under 30 mL an hour.
- During diazepam: the patient cannot be roused, or breathing slows.
- Spasms with sweating and a swinging pulse and blood pressure.
- A closed wound that is hot, swollen and throbbing.

The case against

Against magnesium. Pooled trials show no mortality benefit (Rodrigo 2012, Nepal 2021), and the largest trial found no fall in ventilation (Thwaites 2006). The case for it rests on sparing sedatives. That matters most where ventilators are absent, which is exactly where serum magnesium cannot be measured. Magnesium is a tool for the district with trained staff, not for the village.

Against intrathecal antitoxin. The older meta-analysis was positive (Kabura 2006), the better recent trial was not significant (Van Hao 2022), and a lumbar puncture under poor conditions has its own risks.

Against the dark room. No trial supports it. I keep it because it costs nothing and rests on consistent practice and reflex physiology.

Against antiseptic cord care. It brought no benefit in high-income settings and delays cord separation (Zupan 2004). Its benefit depends on setting (Imdad 2013).

Against routine amputation for gas gangrene. Some limbs are saved by excision alone (Wang 2013). But no source showed that waiting is safe. The case against amputation is a case for skilled, aggressive excision, not delay.

Against the historical numbers. Spellberg's figures pool decades and hospitals and were compiled to set margins for drug trials, not to compare treatments fairly (Spellberg 2009). The First World War tetanus figures come from secondary summaries [VERIFY].

Against my toxoid triage. It is inference. A community might reasonably put fighters first if its survival depends on defence [VERIFY].

Disagreement with FO-02. FO-02 quotes Osler's 80% for traumatic tetanus. I agree with it as history but would not use it as the post-Fall baseline without care. Osler's patients had hospital nursing, and WHO says mortality without intervention approaches 100% (WHO 2017). The true untreated village figure probably lies between the two [VERIFY].

10-line summary

1. Tetanus kills about 4 in 10 hospitalised adults in Africa and nearly all the untreated. Toxoid is the only reliable defence.
2. Two maternal doses cut neonatal tetanus deaths by 94%. Pregnant women should get the last toxoid.
3. Toxoid keeps for years cool, months warm and weeks at 37°C. Freezing ruins it, and the shake test shows it.
4. At wounding, excise dead tissue and leave the wound open. Give toxoid, and antitoxin if unprimed.
5. The spatula test (94% sensitive, 100% specific) and full consciousness separate tetanus from hysteria.
6. Treat tetanus with a dark quiet room, excision, metronidazole or penicillin, antitoxin, careful diazepam, airway care, food, fluids and turning, for two to three weeks.
7. Magnesium spares sedatives but does not save lives in trials. Watch the knee-jerk and keep calcium gluconate ready.
8. Gas gangrene starts within a day, with sudden pain and a racing pulse. Only excision or amputation cures it.
9. Without drugs, about 1 in 10 with cellulitis and 1 in 17 with a major abscess died. Drainage alone cures most abscesses, and packing does not help.
10. Infected bone needs drainage, then removal of dead bone once it has separated, then splinting and time.

Open questions

- How long does toxoid keep useful potency past its labelled expiry at cellar temperature?
- What is the case-fatality of tetanus nursed in a dark room with oral diazepam alone?
- Is there a Vellore series on magnesium for tetanus? Only a single case was found.
- What does King's *Primary Surgery* say on sequestrectomy timing and abscess drainage? Not obtained.
- What do Bruce's primary papers actually say? Only secondary summaries were read.
- Does the hot-water cord compress cause neonatal tetanus, or only accompany it?
- What were the failure and injury records of small institutes making equine antitoxin?
- Can magnesium be given safely by intramuscular injection where no drip can run? Not covered by the tetanus sources read.

Sources to read in full

1. Giannou and Baldan 2009, ICRC *War Surgery* volume 1, chapters 10 to 13 (read). Volume 2, on bone infection, was not read.
2. WHO 2010, tetanus in humanitarian emergencies (read).
3. Rodrigo, Fernando and Rajapakse 2014 (read).
4. Thwaites 2006, full trial report (abstract only read).
5. Spellberg 2009, for the pre-antibiotic tables.
6. WHO 2006, temperature sensitivity of vaccines (read).
7. King M (ed.), *Primary Surgery*. Not obtained.
8. Bruce 1920, tetanus in 1,458 cases. Not obtained.
9. Imdad 2013 and its later update, on chlorhexidine cord care.

At the bedside after the Fall

A man comes in five days after stepping on a nail in a byre. His jaw aches and he cannot open his mouth properly. He is frightened and sweating, but he answers every question.

Do not call it nerves. Touch the back of his throat with a clean flat stick. If his teeth clamp on it instead of his gag pushing it out, he has tetanus.

Clear the room of noise and draw the curtain. Find the wound and open it. If there is antitoxin, give it now, because every hour more toxin binds. Start metronidazole or penicillin if you have them. Give diazepam in small doses and watch his breathing between them.

Someone must sit with him day and night for two to three weeks. They turn him every four hours, keep his mouth clear, give water and food when the spasms allow, and count his breaths. If there is magnesium and a trained hand to run a drip, it lets you use less diazepam. Test his knee-jerk before every increase, and keep calcium gluconate in the room. When he recovers he is not immune. He needs the full course of toxoid.

A baby born at home stops feeding on the seventh day. Look at the cord and ask what was put on it. Keep the next baby's cord dry, or use chlorhexidine if you have it, and never dung. Give the next mother two doses of toxoid before she gives birth.

A woman's leg wound, washed and stitched yesterday by a neighbour, is agonising today. Her pulse races but she has little fever. Cut the stitches. If the muscle beneath is grey or brick-coloured, or the skin crackles, she needs a surgeon to cut out dead muscle today, or to take the limb. Waiting kills.

Protocols

Doses are for trained hands at the district rung unless stated. Where sources differ, both are given.

Protocol 1: The tetanus-prone wound

1. **Is it tetanus-prone?** Puncture, foreign body, soil or manure, dead tissue, or more than 6 hours to treatment (PHE 2018, Giannou and Baldan 2009).
2. **Clean, excise dead tissue and leave open** for delayed closure (THRIVING library, WO-03).
3. **Toxoid** 0.5 mL IM (Giannou and Baldan 2009, WHO 2010).
4. **If unvaccinated or unknown, add TIG** in a separate syringe at a separate site: 250 IU IM (PHE 2018), or 500 IU for adults and 250 IU under 15 (Giannou and Baldan 2009). Give 500 IU if over 24 hours, heavy contamination or burns (PHE 2018).
5. **Complete the course.** Second dose at 4 weeks (ICRC) or 1 to 2 months (WHO). Third at 6 months (ICRC) or 6 to 12 months (WHO).
6. **Antibiotic** for war wounds: penicillin or metronidazole (Giannou and Baldan 2009).
7. **Tell the patient** to come back at once if jaw, neck or swallowing stiffen within three weeks. Tolerance: incubation 3 to 21 days, rarely months (WHO 2017).

Protocol 2: Established tetanus without a ventilator

1. **Confirm.** Trismus, grimace or spasms, full consciousness, positive spatula test (Apte 1995).
2. **Room.** Separate, shaded, quiet. Handling grouped and kept to a minimum (WHO 2010, Giannou and Baldan 2009).
3. **Antitoxin at once.** Human TIG 500 units IM or IV (WHO 2010), or 3,000 to 10,000 IU IV (Giannou and Baldan 2009). Equine 20,000 IU after a test dose (Giannou and Baldan 2009). The sources differ widely. A trial found 3,000 IU human equal to 21,000 U equine (Van Hao 2022).
4. **Excise the wound.** Spinal or regional anaesthesia if possible. No ketamine (Giannou and Baldan 2009).
5. **Antibiotic, 7 to 10 days** [VERIFY on duration]. Metronidazole 500 mg every 6 hours (WHO 2010) or every 8 hours (Giannou and Baldan 2009). Or penicillin G 100,000 to 200,000 IU/kg/day (WHO 2010) or 5 million IU four times daily (Giannou and Baldan 2009).
6. **Spasm control.** Diazepam IV in 5 mg steps for adults (WHO 2010), by infusion up to 20 mg an hour or more (Giannou and Baldan 2009). Children 0.1 to 0.2 mg/kg every 2 to 6 hours (WHO 2010). Titrate to stop spasms while the patient stays rousable.
7. **Magnesium** only with trained staff (Protocol 3).
8. **Airway.** Nurse on the side, clear secretions, decide early on tracheostomy if laryngeal spasm recurs (WHO 2010, Giannou and Baldan 2009).
9. **Fluids and urine.** Replace sweat losses. Measure urine by catheter (Giannou and Baldan 2009).
10. **Food.** High-energy diet. Consider an early surgical feeding tube if spasms last days (Giannou and Baldan 2009).
11. **Nursing.** Turn every 4 hours, sedating first if needed. Mouth, skin, bowels, chest physiotherapy (Giannou and Baldan 2009).
12. **Never** propranolol or similar beta-blockers (WHO 2010).
13. **Expect** two to three weeks. The Sri Lankan patients averaged 23 days in intensive care (Rodrigo 2014).
14. **On recovery**, the full toxoid course (Giannou and Baldan 2009).

Protocol 3: Magnesium sulphate, with overdose watch

1. **First,** calcium gluconate 10% at the bedside, 1 g (10 mL) drawn up, and a bag and mask (WHO PQ 2022).
2. **Loading dose.** 5 g or 75 mg/kg IV (WHO 2010), 75 to 80 mg/kg over 30 minutes (Rodrigo 2014), or 40 mg/kg over 30 minutes (Giannou and Baldan 2009).
3. **Maintenance.** 2 to 3 g an hour (WHO 2010), 1 to 3 g an hour (Giannou and Baldan 2009), or 2 g an hour under 60 and 1 g an hour at 60 and over (Rodrigo 2014).

4. **Before every increase, and at least hourly** [VERIFY on frequency]: knee-jerk present, breathing 16 or more a minute, urine 30 mL an hour or more over 4 hours (WHO PQ 2022).
5. **Knee-jerk lost:** stop until it returns, then restart lower (WHO 2010, WHO PQ 2022).
6. **Breathing stops:** bag and mask, and calcium gluconate 1 g IV slowly over 3 minutes (WHO PQ 2022).
7. **With a laboratory:** target 2 to 4 mmol/L in tetanus (Rodrigo 2014). Reflexes go at about 4 to 5, breathing at about 5 to 7.5 (Xia 2026).
8. **Poor kidneys:** reduce the dose (WHO PQ 2022).

Protocol 4: Clean cord and neonatal tetanus

1. **Vaccinate the mother:** two doses 4 weeks apart, the second at least 2 weeks before birth (WHO 2017).
2. **At birth:** attendant washes hands with soap (Parashar 1998). Boiled or new blade, boiled tie.
3. **Cord care:** chlorhexidine 7.1% digluconate once daily if stocked (Amponsah-Kodua 2025, Imdad 2013). Otherwise clean and dry (Zupan 2004).
4. **Never** dung, dung-heated ghee or ash (Parashar 1998, Bennett 1999). No hot compresses on the cord [VERIFY].
5. **Teach the danger signs:** stops sucking after feeding well, constant crying, stiffness (WHO 2026).
6. **If tetanus develops:** dark quiet room, diazepam 0.1 to 0.2 mg/kg every 2 to 6 hours (WHO 2010), antitoxin, metronidazole, clean the navel, expressed breast milk by tube or spoon between spasms [VERIFY]. Expect about half to die even in hospital (Ogundare 2021, Ibinda 2015).

Protocol 5: Suspected gas gangrene

1. **Suspect it:** sudden severe wound pain within 3 days, mostly within 24 hours, with a rising pulse and temperature under 38°C (Giannou and Baldan 2009).
2. **Open every closure.** Remove tight plaster and tourniquets.
3. **Carry to a surgeon at once.** No dressing treats it.
4. **Excise** to healthy, bleeding, contracting muscle. The limit is dead muscle, not gas. Amputate if the limb cannot be cleared (Giannou and Baldan 2009).
5. **Penicillin** about 4 million units every 4 hours for 10 to 14 days (Hussain 2024), or metronidazole (Giannou and Baldan 2009).
6. **Support** with fluids, blood and oxygen if available (Giannou and Baldan 2009).
7. **Look again within 24 hours** and excise further if needed [VERIFY].

Protocol 6: Draining an abscess

1. **Find the soft, fluctuant point** under red, hot skin. Make sure the swelling does not pulsate before cutting [VERIFY].
2. **Clean the skin.** Local anaesthetic if available.
3. **Incise** over the softest point, long enough to drain freely. Break up pockets with a finger [VERIFY].
4. **Irrigate** with boiled, cooled water (THRIVING library, WO-02).
5. **Do not pack.** Cover with a clean absorbent dressing (Newton 2022, Mohamedahmed 2021).
6. **Antibiotic** only for spreading redness, fever or a large abscess. In trials an antibiotic added about 7 to 14 points of cure to drainage (Talan 2016, Daum 2017).
7. **Review at 48 hours.** Reopen if it re-forms.
8. **Dressings** for a neglected cavity: sugar or honey per WO-02 Protocols 4 and 5 (THRIVING library, WO-02).

Protocol 7: Osteomyelitis in a child

1. **Suspect it** in fever with bone pain or refusal to use a limb.

2. **Antibiotic early** if stocked. Mortality fell from about 20% to under 4% with chemotherapy (Nade 1983).
3. **Drain pus** and splint the limb (Giannou and Baldan 2009).
4. **Chronic infection:** remove the separated sequestrum once the involucrum is solid [VERIFY on timing]. Dress the cavity with Dakin's solution (Negussie 2026), made as in WO-02 (THRIVING library, WO-02).
5. **Bone graft** for large gaps about 12 weeks after clearance (Loro 2025).
6. **Expect** months to years.

Protocol 8: The toxoid store

1. **Store** at 2 to 8°C if possible (WHO 2017). Otherwise the coolest place that never freezes [VERIFY].
2. **Heat limits:** potency holds 1.5 years at 18°C, 6 to 12 months at 24°C, 2 to 6 months at 37°C (WHO 2006).
3. **Never freeze.** Discard any vial found solid (WHO 2006).
4. **Shake test** for a suspect batch (WHO 2006): freeze a control vial of the same batch overnight at minus 20°C until solid [VERIFY on the sign, lost in the text]. Thaw it without heat. Shake control and test vial together for 10 to 15 seconds and stand them side by side. If the test vial settles more slowly than the control, use the batch. If at the same rate or faster, discard it.
5. **Keep a register** of each person's doses and dates.
6. **Allocate** (inference [VERIFY]): pregnant women, then tetanus survivors, then the dirtiest trades and fighters, then children completing their series.

Numbers to carry

Item	Number	Source
Tetanus incubation	3 to 21 days, median 7	WHO 2017
Adult case-fatality, hospital pooled	32%	Chen 2025
Adult case-fatality, Africa pooled	43%	Woldeamanuel 2016
Neonatal case-fatality in hospital	53 to 62%	Ogundare 2021, Ibinda 2015
Two maternal toxoid doses	94% fewer neonatal deaths	Blencowe 2010
Chlorhexidine cord care	23% fewer neonatal deaths	Imdad 2013
Spatula test	94% sensitive, 100% specific	Apte 1995
Toxoid dose	0.5 mL IM	Giannou and Baldan 2009, WHO 2010
Toxoid stability	years at 4 to 8°C, 2 to 6 months at 37°C	WHO 2006
Freeze-thaw potency	85%, then 39%	WHO 2006
TIG prophylaxis	250 to 500 IU IM	PHE 2018, Giannou and Baldan 2009
Metronidazole	500 mg every 6 to 8 hours	WHO 2010, Giannou and Baldan 2009
Magnesium load	40 to 80 mg/kg, or 5 g	Giannou and Baldan 2009, Rodrigo 2014, WHO 2010
Magnesium maintenance	1 to 3 g an hour	Giannou and Baldan 2009, WHO 2010
Magnesium stop signs	no knee-jerk, breathing under 16, urine under 30 mL an hour	WHO PQ 2022
Antidote	calcium gluconate 1 g IV over 3 minutes	WHO PQ 2022
Gas gangrene onset	mostly under 24 hours	Giannou and Baldan 2009

Item	Number	Source
Gas gangrene, treated	20 to 30% die	Hussain 2024
Cellulitis without drugs	10.7% died	Spellberg 2009
Major abscess without drugs	6% died	Spellberg 2009
Drainage alone	69 to 74% cured	Daum 2017, Talan 2016
Osteomyelitis before drugs	about 20% died	Nade 1983
Critical window after wounding	6 hours	Giannou and Baldan 2009

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