# WO-07 Head, spine and chest injuries without imaging: what can be done

HEALING after the FALL, research library, WO-07

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

These are the three cavities a village cannot look inside. There is no X-ray, no scan, no blood gas, only the hand, the eye, the clock and the bed. For head and spine injury almost everything that changes survival is nursing. For chest injury almost everything that changes survival is one hole in the chest wall, made correctly and kept clean. The heroic operations are rarer and more dangerous than the reader expects. This report builds on the examination report (THRIVING library, FO-07), the analgesia report (THRIVING library, WO-11) and the abdominal report (THRIVING library, WO-08). NU-09, NU-01 and SY-07 are named in the brief but no such files exist in the library folder.

## 1. Head injury

### 1.1 What kills, and when

The brain is injured twice. The first injury happens at impact and nothing afterwards changes it. The second happens over minutes to days, caused by low oxygen, low blood pressure, swelling and expanding clot, and it is the business of the people at the bedside. Hypoxia is the largest single contributor, and the Glasgow Coma Scale should not be scored until systolic pressure reaches 90 mm Hg, because a shocked patient scores falsely low (Giannou, Baldan and Molde 2013). Significant oedema in penetrating wounds only begins after about six hours, the window in which a village does useful work.

The governing numbers come from a South African civilian series of cranial gunshot wounds reproduced as ICRC Table 26.2 (Semple and Domingo 2001, in Giannou, Baldan and Molde 2013). Mortality by post-resuscitation GCS was 98 per cent at 3 to 5, 31 per cent at 6 to 10 and 8 per cent at 11 to 15. Injuries crossing the ventricles were 100 per cent fatal, crossing both hemispheres 90 per cent, diffuse oedema 81 per cent. These are penetrating injuries with surgery available, so take the shape of the curve and not the exact figures. A patient who talks has a very good chance. One who never obeys, opens the eyes or speaks has almost none, with or without a surgeon. The ICRC's operational conclusion is the most useful sentence in this literature: it is the patient presenting mild or moderate who then deteriorates who deserves the greatest effort. You are watching the ones who seem all right.

### 1.2 Measuring consciousness by hand

Teasdale and Jennett (1974) built the Glasgow Coma Scale so that observations could be made by people who were not neurologists and compared over time. Eye opening: spontaneous 4, to speech 3, to pressure 2, none 1. Verbal: orientated 5, confused 4, words 3, sounds 2, none 1. Motor: obeys 6, localises 5, flexion away 4, abnormal flexion 3, extension 2, none 1.

It is less reliable than its users assume and the motor component is the weakest link: among untrained emergency providers scoring videos the total was correct only 33.1 per cent of the time, while the Simplified Motor Scale (obeys / localises / neither) reached kappa 0.70 against 0.32 for the total GCS (reference 20) [VERIFY, search-result summaries only]. AVPU is the other hand-sized tool, and "P" corresponds to a GCS of about 8 (THRIVING library, FO-07).

Record all three components separately, never as a sum, and draw the trend. Primary Surgery is categorical: the chart is completed half-hourly and "the trend is more important than the actual readings" (Cotton, ed., Primary Surgery vol 2, ch 51). A sum of 11 means nothing. A sum falling from 14 to 11 in two hours means a surgeon is needed within the hour.

### 1.3 The lucid interval and rising pressure

Extradural haemorrhage occurs in about 2 per cent of all head injuries and subdural in about 8 per cent, and the lucid interval "usually lasts only 2-4h, but may be longer" (Cotton, ed., Primary Surgery vol 2, ch 51). This is the injury a hole in the skull can cure. Three trend patterns demand decompression: a lucid interval, improvement then deterioration, and progressive loss without any initial loss of consciousness.

The classic signs of rising pressure are a dilating pupil on the side of the clot, falling consciousness, rising blood pressure with a slowing pulse, and finally irregular breathing. They are specific but late. In a prehospital cohort of 249 patients needing anaesthesia for brain injury, of whom 87 had raised intracranial pressure, a fixed blown pupil or a Cushing response gave specificity 93.2 per cent (88.2 to 96.6) but sensitivity of only 36.8 per cent (26.7 to 47.8) (ter Avest and others 2021). Two thirds of patients with dangerously raised pressure showed no such sign. The sign is worth acting on when present and worth nothing when absent.

### 1.4 Trephination: the record, not the romance

Archaeological survival rates are inferred from bone healing. Sharp unremodelled edges mean death at or soon after the operation, smooth margins with new bone mean months or years of life, and nothing says how many people with the same injury survived unoperated. With that caveat, Kushner, Verano and Titelbaum (2018) report survival rising from about 40 per cent in the earliest Peruvian highland series (roughly 400 to 200 BCE) to 75 to 83 per cent in Inca-period series, against 46 to 56 per cent mortality for cranial surgery in the American Civil War [VERIFY, PubMed blocked, search-result summaries]. Andrushko and Verano (2008) found about 83 per cent healing among 66 individuals with 109 perforations from the Cuzco region [VERIFY, abstract only]. Andean surgeons scraped or grooved rather than drilled, did not breach the dura and did not carry hospital organisms. Hippocrates, in On Injuries of the Head (Adams translation), gives advice still sound: do not cut to the membrane at once, remove the instrument often to check with a probe, and choose a site where the bone is thick. Ashhurst's 1895 review is the nineteenth-century corrective, with 41 trephinations, 20 recoveries and 21 deaths [VERIFY, scanned article, search-result summary].

The modern low-resource series disagree. At Kamuzu Central Hospital, Lilongwe, Eaton and others (2017) reviewed 241 patients needing higher-level care, of whom 163 had exploratory burr holes for deteriorating consciousness with localising signs. Mortality was 6.8 per cent in the burr-hole group against 43.9 per cent in those not operated, adjusted odds ratio for death without the operation 12.0 (95 per cent CI 4.48 to 31.9), with 71.1 per cent of operated survivors recovering well or left with moderate disability. It is retrospective and the operated patients were those judged operable. At Kilimanjaro Christian Medical Centre, where general surgeons and not neurosurgeons operated, Koipapi and others (2024) reviewed 156 burr holes with 75.6 per cent good outcomes and 18.6 per cent mortality [VERIFY, search summary only]. Against both, Okidi and others (2020) at St Mary's Hospital Lacor in northern Uganda reviewed 194 charts with overall mortality 33.0 per cent, and of ten surgically treated patients seven died, including all three who had burr holes. The hospital imposed a local moratorium. A unit operating rarely, late, on unselected patients kills everyone it operates on.

Technique matters. Blind burr holes find nothing in about a third of patients, and an extradural haematoma "can be totally missed if the burr hole is off by 1 to 2 cm", because it lies strictly under a fracture (Giannou, Baldan and Molde 2013, Annex 26.A). No clot can be evacuated through a burr hole alone: the opening must be enlarged by bone nibbling. The ICRC recommends practising on the skulls of butchered goats, sheep or pigs.

Trephination is therefore defensible at the district rung under four conditions that must all hold: consciousness is falling after a lucid or near-lucid period, there is a lateralising sign to say which side, the operator has practised repeatedly on animal skulls with a Hudson brace, perforator, burrs, bone nibbler and dural elevator, and the district can nurse an unconscious patient for weeks afterwards. If any fails, expect the Lacor result. The brain has no pain receptors, so the operation can be done under local anaesthesia with sedation.

### 1.5 Nursing the unconscious

The head-injured who survive on nursing alone are those whose brain injury is survivable and who would otherwise be killed by an obstructed airway, aspirated vomit, chest infection, dehydration, starvation, fever or pressure sores. Each is preventable by hand.

Lie the patient on the side so the tongue falls forward and secretions drain out. Raise the head above the heart without rotating the neck. Turn two-hourly. If agitated, put the mattress on the floor rather than restrain. Avoid morphine and strong sedatives, which depress breathing and mask the conscious level, the only monitor there is. Primary Surgery allows haloperidol 1 mg in an adult or 0.5 mg in a child where the patient endangers himself, and notes that moderate restlessness keeps the chest clear. Before sedating anyone, check the bladder: restlessness is usually a full one.

Take a rectal temperature twice daily, cool at 39 degrees C by exposing, sponging and fanning, and give no NSAIDs or antipyretics. If the corneal reflex is absent, tape the eyelids shut or the eye is lost even if the brain recovers. Begin nasogastric feeding by 72 hours (see protocol P1), with peanut butter and eggs as vehicles and never dextrose in water alone. Release the catheter stopcock four-hourly rather than draining continuously, so bladder tone is preserved. Music, pictures, talking and touch are in the protocol, not offered as sentiment.

Steroids are contraindicated, because the CRASH trial showed increased mortality, and mannitol is never routine, buying time only while awaiting urgent surgery. Tranexamic acid within three hours reduced head-injury death in mild to moderate injury in CRASH-3, with no benefit in severe injury [VERIFY, trial summary only], so salvaged stock is for the deteriorating mild-to-moderate patient.

## 2. Spine

### 2.1 The retreat from rigid immobilisation

The picture a lay reader carries, of a hard collar and a board, has been abandoned by the people who work furthest from hospitals. The Wilderness Medical Society's guidelines for spinal cord protection (Hawkins, Williams, Bennett, Islas, Kayser and Quinn 2019, revised 2024) make the goal protection of the cord in the context of overall patient and provider safety, not immobilisation as ritual. Neutral alignment should be restored and kept with non-rigid means unless that causes resistance, increased pain or new or worsening deficit. Rigid collars have no required role out of hospital, backboards may move a patient but are not immobilisation tools, and immobilisation should not be used at all for isolated penetrating trauma [VERIFY, read via Guideline Central and WMS summaries, full journal text not retrievable]. The ICRC agrees for war wounds: the rigid immobilisation used for blunt injury is not necessary for projectile wounds.

Two validated rules decide whether to bother. The NEXUS low-risk criteria, validated in 34,069 patients, were 99.6 per cent sensitive but only 12.9 per cent specific (Hoffman and others 2000), and the Canadian C-Spine Rule outperformed NEXUS head to head, 99.4 against 90.7 per cent (Stiell and others 2003) [VERIFY, abstracts only]. NEXUS

is the one a lay healer can hold in the head: no midline tenderness, no focal deficit, normal alertness, no intoxication, no distracting injury. The village has no collar and no board and does not need them. It needs enough hands to keep the body in line.

### 2.2 Recognising cord injury and the prognosis

Across eleven military studies of 782 patients the levels were cervical 23 per cent, thoracic 41 per cent and lumbosacral 36 per cent, half the lesions complete, and tetraplegic patients usually died during evacuation (Giannou, Baldan and Molde 2013).

Two states are confused by everyone. Spinal shock is flaccidity, absent reflexes and anaesthesia below the level, lasting hours to two weeks or more, and says nothing about outcome. Neurogenic shock is low blood pressure with a slow pulse and loss of temperature control, from loss of sympathetic tone. The slow pulse is the giveaway: a bleeding patient has a fast pulse and a low pressure, a high cord injury a slow pulse and a low pressure, made worse by pouring in fluid.

Look for a sharp horizontal line above which sensation is normal, absent reflexes, loss of bladder control and, in men, priapism, which Primary Surgery names a bad sign. Preserved sensation in the toes, heels and perineum despite paralysis means the cord will recover. Repeat the full examination over 48 to 72 hours before pronouncing a prognosis. Primary Surgery gives the 24-hour rule: still no perianal sensation, no voluntary toe flexion and no anal sphincter control at 24 hours means a 90 per cent chance of permanent paralysis, and no improvement at four weeks means further recovery is very unlikely. On surgery both manuals say do not. Immediate laminectomy may do more harm than good, and the ICRC's judgement is the one to quote, that "Good nursing care and physiotherapy is more important than surgery."

### 2.3 The long nursing

The ICRC quotes King on paraplegic care being perhaps the ultimate test of the real quality of a hospital, and of the morale and dedication of everyone in it. Oderud (2014) records that in Zimbabwe in the 1960s about 90 per cent of people with spinal cord injury were dead within a year of discharge, improving to about half surviving beyond a year by 1988 to 1994, that 7 per cent of hospitalised patients died of septicaemia linked to pressure sores, and that 33 per cent developed sores after returning home [VERIFY, open-access summary, not cross-checked]. Otherwise death is usually from renal failure following chronic urinary infection, though patients may live many years.

Turning. Position changed every two hours, with a notice above the bed naming the next position in the cycle of front, back, left side, right side. Pressure areas inspected at every change. Doughnut dressings or inflated tyre tubing placed around and never under bony points. Daily wash with soap and water, gentle massage, thorough drying. The first two weeks are the most critical period, sores can develop in the first few hours, and Primary Surgery offers the encouragement that matters: "There are some very simply equipped hospitals, with very dedicated workers, who turn their patients every 2h, and they don't get bedsores!" The honest caveat is that a Cochrane review found eight trials with 3,941 participants, all at high risk of bias, two-hourly against four-hourly turning giving a risk ratio of 1.06 (0.80 to 1.41) at very low certainty (Gillespie and others 2020) [VERIFY, abstract only]. Those trials used modern pressure-redistributing mattresses. On a straw mattress the two-hourly turn is the only pressure redistribution there is, so the recommendation stands as a B grade and not an A.

Bladder. At least three litres of fluid a day, drainage bag always below the bladder, closed system, intermittent catheterisation every 4 to 6 hours at first and every 6 to 8 later. The ICRC finding with most force for a village is that clean, boiled intermittent catheterisation has apparently more or less the same complication rate as sterile technique and suits limited resources better. An indwelling catheter is changed every seven days. In men the penis is strapped upward against the abdomen to prevent a urethral pressure fistula. Bowel: an enema during spinal shock plus manual disimpaction, the first at day 5 to 7. Physiotherapy from day one, sitting one to two hours a day, lifting and shifting

the buttocks every 15 minutes. Established sores are dressed with granulated sugar, honey, pulped papaya or maggots, changed up to five times a day, with antibiotics only for spreading infection. Primary Surgery's JABULANI, 34, admitted with quadriparesis in fair condition, returned a year later with sores over sacrum, hips, knees and ankles, open suppurating joints, contractures and a contracted bladder.

## 3. Chest

### 3.1 The shape of the problem

Penetrating chest wounds are about 10 per cent of the wounded and about 25 per cent of those killed in action, and overall mortality of a thoracic wound is about 70 per cent, most of it before anyone arrives (Giannou, Baldan and Molde 2013). About 5 per cent of preventable field deaths are from tension pneumothorax or a sucking chest wound, which is the argument for teaching a village two procedures.

A chest tube alone suffices in about 90 per cent of patients reaching hospital, and in over 95 per cent in ICRC experience. Primary Surgery gives the same from the other end: "Only 5-10% of chest injuries will need the chest opened." Published thoracotomy rates vary with circumstance rather than injury, from 9.4 per cent in Lebanon in 1982 to 78 per cent in Belfast, and the French field hospital in Chad in 1980 opened 38 of its 56 thoracic wounds because the absence of nursing, blood and X-ray made conservative management impossible. The worse your nursing, the more you are forced to cut. One anatomical rule to carry: wounds below the nipple line (T4) involve the abdomen in 10 to 40 per cent of cases.

### 3.2 Rib fractures, flail chest and analgesia

Rib fractures kill the old slowly, through pain, shallow breathing, retained secretions and pneumonia. Bulger and others (2000) compared 277 patients aged 65 and over with 187 younger, all with rib fractures, finding pneumonia in 31 against 17 per cent and mortality 22 against 10 per cent, with each additional fractured rib raising the odds of death by 1.19 [VERIFY, abstract only]. An elderly person with three or more broken ribs needs a nursing plan, not reassurance. Both manuals forbid strapping: "Don't bind ribs with strapping: this reduces chest expansion and may lead to lung collapse" (Cotton, ed., Primary Surgery vol 2, ch 43). The traditional tight binder is actively harmful.

The intercostal nerve block is the one technique that turns a dying elderly patient into a comfortable one. It is a district skill, because blood levels of local anaesthetic rise faster from the intercostal space than from any other site and the lung lies directly beneath (THRIVING library, WO-11). The ICRC gives lidocaine 1 or 2 per cent with adrenaline lasting two to three hours, maximum 6 mg/kg with adrenaline and 3 mg/kg without, or bupivacaine 0.5 per cent with adrenaline, maximum 2 mg/kg, lasting six to twelve hours. The technique is in protocol P6. The ICRC avoids epidurals in the field for hygiene reasons. Where no block is possible, Primary Surgery permits cautious titrated intravenous morphine, noting that one injection "may make a mildly blue, anoxic, sweating patient quiet and pink", repeated every one to two hours with naloxone available. Opioids and head injury do not mix, which makes the head-injured patient with rib fractures the hardest in this report.

A flail segment is two or more ribs broken in two or more places, and the flail is not the problem. The ICRC is explicit: "Historically, the flail segment itself has received too much attention. The real clinical problem, and cause of mortality, is not the multiply-fractured ribs but the underlying lung pathology." The contusion progresses over two to three days, so the patient who looks adequate on day one may be dying on day three. Keep him on the dry side of euvolaemic, and give no corticosteroids. A 1975 Annals of Thoracic Surgery report compared early intubation with fluid restriction, diuretics, pulmonary toilet and intercostal blocks, reporting mortality falling from 21 per cent to zero and stay from 31.3 to 9.3 days [VERIFY, search-result summary only, sample sizes and authorship not confirmed]. Modern series put flail chest mortality at roughly 5 to 20 per cent [VERIFY, secondary summaries], and bilateral flail chest is usually fatal without mechanical ventilation. The manuals disagree about the segment itself, the ICRC accepting a firm adhesive dressing over it while Primary Surgery forbids all strapping, so the safer default for a

lay reader is not to strap.

### 3.3 Pneumothorax and decompression

A simple pneumothorax in a stable patient may need nothing: a randomised trial in 316 patients found conservative management of moderate to large spontaneous pneumothorax non-inferior at eight weeks with fewer adverse events (Brown and others 2020) [VERIFY, abstract only]. That is spontaneous rather than traumatic, so the transfer is an inference, but it supports watchful waiting in a stable case.

Tension pneumothorax is different and minutes count. The signs are respiratory distress with a hyper-resonant silent chest on one side, distended neck veins and a trachea pushed away. Two cautions: a hypovolaemic patient will not show distended neck veins, and a patient anaemic below 50 g/l will not become cyanosed (Cotton, ed., Primary Surgery vol 2, ch 43).

The ICRC puts the needle in the second or third intercostal space in the midclavicular line, with a cannula long enough to cross a chest wall averaging 4 to 6 cm, naming 8 cm (Giannou and Baldan 2009), while Primary Surgery gives a 4 to 6 cm 14G cannula into the second space. The confirming sign is a rush of air, and the crucial negative, stated by both, is that failure of needle decompression does not rule out the diagnosis. A 2025 systematic review pooled radiological data from 24 studies and 8,046 patients and found a 32.84 per cent failure rate for the needle to reach the pleural cavity, each extra centimetre of length cutting failure by about 7.76 per cent. The axillary sites have thinner chest walls but higher injury rates, so the authors suggested a 7 cm needle (reference 13) [VERIFY, search-result summary]. One needle in three does not reach the air it is aimed at, which is the strongest argument here for teaching the finger instead.

Finger thoracostomy is the better village procedure, converting a tension pneumothorax into an open one, which the patient survives. Both manuals name it a good alternative and both insist it is always a prelude to a drain. For a needle that must stay in, ICRC volume 1 figure 8.3 shows the improvised Heimlich valve: a finger cut from a surgical glove with a 1 cm slit in its end, tied around the cannula.

### 3.4 The chest drain from improvised parts

A trained lay healer can place and manage a chest drain, and that one skill covers roughly 90 per cent of survivable chest injury.

Indications, from the ICRC: any detected haemothorax, tension pneumothorax, a large pneumothorax, any pneumothorax if the patient must be intubated, bronchopleural fistula, bilateral blast lung, signs of chest penetration in a mass casualty, and empyema. “When in doubt, drain it out.” The counter-rule is equally firm: repeated needle aspiration even of a small haemothorax is not safe, because it leaves retained clot and causes empyema. Primary Surgery: “Don’t try to drain a haemothorax by repeated aspiration on a needle: it takes too long and the blood will clot!”

The safe area lies between the lateral border of pectoralis major and the midaxillary line at the fourth or fifth space, and the ICRC’s field rule is to lay the hand flat in the apex of the axilla and work just below it. Tube size 32 to 36 French in adults and 28 in children. Blunt dissection hugs the upper border of the rib to avoid the vessels and nerve under the rib above. The full sequence is protocol P4 (Annex 31.B).

Three absolute rules. Never insert through the wound. Never use a trocar-mounted tube, which the ICRC calls “a dangerous weapon”. Fill the bottle with saline and not water, because water haemolyses the drained blood, and saline permits that blood to be given back.

Edaigbini and others (2014) report 167 tube thoracostomies in Nigeria drained into improvised 1.5 litre bottled-water containers, with 60.5 per cent of procedures done by registrars rather than consultants and an overall complication rate of 16.8 per cent [VERIFY, DOAJ record and search summary, complication breakdown not retrievable]. Roughly one complication in six, in trainee hands, with a water bottle.

Removal requires four conditions together: the lung re-expanded, no active bleeding, serous drainage under 250 ml in 24 hours, and the fluid level no longer swinging while the tube is still patent. A continuing air leak and a chylothorax are absolute contraindications. After-care is where the deaths are: nurse semi-sitting, relieve pain enough to allow a cough, and treat breathing exercises as essential, continued two weeks after discharge.

### 3.5 Autotransfusion, sucking wounds and tamponade

Autotransfusion of drained chest blood is the most valuable procedure here, because the village will never have a blood bank. The ICRC indication is rapid loss over 20 per cent of blood volume, about 1,000 ml in an adult. Thoracic blood usually does not clot because the pleura defibrinogenates it. ICRC practice sets a six-hour limit on shed blood, and the absolute contraindications are a very offensive smell, meaning bowel contamination, or obviously haemolysed blood. It produces only transient clotting abnormalities and is not associated with increased mortality. The method is protocol P5.

An open chest wound that sucks audibly on inspiration prevents the lung inflating and may tension. The traditional answer is a dressing taped on three sides, and honesty requires saying this is a logical device with thin evidence: it lost its place in United States Tactical Combat Casualty Care guidance in 2008 for lack of supporting evidence, in favour of a vented seal with close observation, and no human trial compares the two [VERIFY, secondary summaries only]. Cover with the cleanest air-tight material available, tape three sides, watch continuously with a finger or needle ready, and place a proper drain through a separate incision as soon as possible.

Blood in the pericardial sac compresses the heart, and most survivors of cardiac injury have small wounds with self-limiting haemorrhage. Recognition is unreliable: Beck's triad has reported sensitivity ranging from essentially zero in a modern chart review to about 82 per cent in a 1984 surgical series [VERIFY, search summaries, neither paper read in full], and the ICRC states that neither it nor a narrowed pulse pressure nor pulsus paradoxus is universally present. The most actionable finding is negative: in suspected tamponade, permit hypotension and do not try to raise the pressure with intravenous fluids, because the shock is cardiogenic. A village that runs fluid into every shocked patient will kill the one with tamponade. Pericardiocentesis is a temporising measure that often fails because the blood clots. ICRC volume 1 describes a 20 ml syringe on a long cannula, the skin punctured 1 to 2 cm left of the xiphisternal junction and advanced at 45 degrees towards the tip of the left scapula under continuous suction. Results range from little value to a Gaza series in which 24 of 25 patients survived with ultrasound-guided drainage and intrapericardial tranexamic acid (Qandil and others 2026) [VERIFY, abstract only], which the village cannot reproduce.

## Evidence grades

| Procedure or practice | Grade | What the record shows |
|---|---|---|
| Nursing the unconscious (side position, two-hourly turn, airway, feeding, bladder, fever) | B | Consistent across every low-resource manual read. |
| GCS trend charting by hand | B | Validated prognostic bands. Reliability moderate, motor weakest. |
| Tranexamic acid within 3 h, mild to moderate head injury | A | CRASH-3. No benefit in severe injury. |
| Steroids in head injury | X | CRASH showed increased mortality. |
| Burr hole for falling consciousness with a lateralising sign | B in trained selected hands, D to X otherwise | Malawi 6.8 against 43.9 per cent. Uganda 3 of 3 dead, moratorium. |

| Procedure or practice | Grade | What the record shows |
|---|---|---|
| Blind non-lateralised burr hole | D | Finds nothing in about a third. Misses the clot if 1 to 2 cm off. |
| Rigid collar and backboard as routine | X | WMS: no required out-of-hospital role. |
| Manual alignment, log roll, padded head blocks | B | WMS and ICRC concordant. |
| NEXUS criteria to exclude cervical injury | A | 34,069 patients, sensitivity 99.6 per cent. |
| Two-hourly turning | B on a straw mattress, C against modern surfaces | Cochrane: 8 trials, 3,941 participants, RR 1.06 (0.80 to 1.41), very low certainty. |
| Clean (boiled) intermittent catheterisation | B | ICRC: more or less the same complication rate as sterile. |
| Sugar, honey, papaya or maggots on pressure sores | B | ICRC standard practice. |
| Binding or strapping the whole chest | X | Both manuals forbid it. Causes collapse. |
| Intercostal nerve block | B | ICRC doses. Highest systemic absorption of any site. |
| Needle decompression | B, with one-in-three failure | Pooled radiological failure 32.84 per cent, 24 studies, 8,046 patients. |
| Finger thoracostomy | B | Both manuals. No needle length to fall short. |
| Intercostal chest drain, open technique | B | Sufficient alone in about 90 per cent, ICRC over 95. |
| Trocar-mounted chest tube | X | ICRC: “a dangerous weapon”. |
| Repeated needle aspiration of a haemothorax | X | Retained clot and empyema. |
| Improvised 1.5 L bottle underwater seal | B | 167 patients, 16.8 per cent complications. |
| Autotransfusion of shed chest blood | B | ICRC practice. No excess mortality. |
| Three-sided dressing | C | Removed from TCCC 2008 for lack of evidence. |
| Fluid loading in suspected tamponade | X | Shock is cardiogenic. Fluids worsen it. |
| Blind pericardiocentesis | D | Often fails because blood clots. Temporising only. |

## Means ledger

Rungs: **H** hands alone. **F** hearth. **G** garden and still. **V** village dispensary of 300. **D** district infirmary of 3,000. **P** pre-Fall hospital.

| Procedure | H | F | G | V | D | P | What the rungs change |
|---|---|---|---|---|---|---|---|
| Recovery position, airway, two-hourly turn | yes | yes | yes | yes | yes | yes | Free at every rung, and the difference between a survivable and a fatal head injury. |
| GCS trend chart | from memory | charcoal and a wall | as F | printed chart, trained observer | plus shift handover | plus imaging | Finds the deteriorating patient. Unwritten, the trend is lost. |
| Tube feeding, bladder care, fever control | no | improvised tube, cloth | plus boiled tubing, soap | proper tube, catheter | plus intravenous fluids | plus parenteral feeding | Turns weeks of coma from fatal to survivable. |
| Tranexamic acid within 3 h | no | no | no | salvaged, in date | same | yes | Real but unmanufacturable. |
| Burr hole | no | no | no | no, do not | yes under the four conditions | yes, with CT | The only rung at which a skull is opened. |
| Manual alignment and log roll | yes, 3 to 4 people | plus rolled towel | plus padded splint | plus trained team | plus transfer boards | plus imaging | Prevents worsening a cord injury. Needs hands, not kit. |
| Paraplegic nursing programme | partly | yes, with a rota | plus tyre tubing, soap, sugar | plus catheters, physiotherapy | plus ten beds, relief staff | specialist unit | Decides whether the patient lives one year or twenty. |
| Rib fracture analgesia | positioning only | heat, posture, breathing drill | tinctures, of limited value | salvaged lidocaine, block | block routine, opioid with naloxone | epidural, fixation | The hinge on which elderly survival turns. |

| Procedure | H | F | G | V | D | P | What the rungs change |
|---|---|---|---|---|---|---|---|
| Needle decompression | no | poor odds | forged cannula | salvaged 14G, 7 to 8 cm | same, plus drain | plus imaging | Buys minutes. Fails a third of the time. |
| Finger thoracostomy | yes if a blade exists | yes | yes | yes, taught | yes | superseded by drain | The village's real answer to tension pneumothorax. |
| Chest drain with underwater seal | no | no | possible, high risk | yes, tube, bottle, saline | yes, clean room | yes | Covers about 90 per cent of survivable chest injury. |
| Autotransfusion | no | no | no | yes, funnel, gauze, bottle | yes | banked blood | Replaces a blood bank for the chest-wounded. |
| Three-sided dressing | yes, fat and cloth | oiled cloth and tape | beeswax cloth | cut seal | plus drain within the hour | vented seal and drain | Holding measure only. Must be watched. |
| Pericardiocentesis | no | no | no | no | yes, in extremis | ultrasound-guided, then surgery | Rarely works blind. Not taught below district. |
| Thoracotomy | no | no | no | no | no | yes | The honest limit. 5 to 10 per cent of chest injuries need it. |

## Harm test

**Nursing.** Leaving an unconscious patient on the back is the commonest fatal error and kills by aspiration or obstruction within minutes. Failing to turn kills over weeks, and Oderud's 7 per cent of hospitalised spinal patients dying of septicaemia from pressure sores is the measure. Continuous bladder drainage without four-hourly release produces a small contracted bladder. A doughnut ring placed under rather than around a bony point creates the sore it was

meant to prevent.

**Sedation and analgesia.** Morphine or strong sedatives in head injury depress breathing and hide the conscious level. The classic harmful error is a dose given for restlessness caused by a full bladder. The signs of overdose are a respiratory rate below about 10, pinpoint pupils and rising drowsiness, and the response is to stop, stimulate, support the airway and give naloxone if it exists. NSAIDs and antipyretics are prohibited for fever after head injury. Exceeding 6 mg/kg lidocaine with adrenaline or 3 mg/kg without causes ringing in the ears, a metallic taste and perioral tingling, then convulsions and cardiac arrest. Never block both sides of the chest at one sitting.

**Burr holes.** The operation kills by being done to the wrong patient, in the wrong place, or by untrained hands. A hole 1 to 2 cm off the fracture misses the clot while the patient dies of the delay. Entering over the sagittal sinus, the frontal sinus, the orbit or the posterior fossa causes catastrophic bleeding or infection. A burr used without leaving a rim of inner table plunges into the brain. Never operate on a patient at GCS 3 to 5 with no lateralising sign, or on one whose consciousness is stable or improving. The case of harm is Lacor: three patients, three deaths, a moratorium (Okidi and others 2020).

**Spinal handling.** Rough or uncoordinated movement of an unstable column converts an incomplete lesion into a complete one. Over-immobilisation harms too: a rigid collar raises intracranial pressure, obstructs the airway, ulcerates the occiput and chin within hours, and in penetrating trauma delays treatment of the bleeding that is killing the patient.

**Chest.** A tight circumferential binder reduces expansion, causes lobar collapse and then pneumonia: it feels better for an hour and kills over a week. A needle placed too medially on the left can enter the heart. A needle too short fails a third of the time, and the operator who believes a negative result and stops looking kills a patient with a tension pneumothorax. A trocar-mounted tube spears the lung, heart, liver or spleen. Dissecting below rather than above the rib cuts the intercostal artery and nerve. A drain through the wound seeds infection along a contaminated track. Water instead of saline haemolyses the drained blood. Raising the bottle above the chest siphons its contents back into the pleura. Clamping a bubbling drain for transport converts a treated pneumothorax into a tension pneumothorax. Removing a drain while an air leak persists re-collapses the lung. A fully occlusive four-sided seal on a sucking wound, left unwatched, tensions: lift the dressing at once.

**Autotransfusion and tamponade.** Returning blood contaminated by bowel content causes overwhelming sepsis, which is why an offensive smell is absolute. Blood shed more than six hours earlier, or obviously haemolysed, must not be returned. Blind pericardiocentesis can lacerate a coronary artery or the right ventricle and cause the tamponade it was meant to relieve.

## Red flags

Each means death or permanent disability without what the village cannot give, with what to do anyway.

1. GCS 3 to 5 after blood pressure is restored, or both pupils fixed and dilated. About 98 per cent die. Nurse, keep warm, moisten the mouth, stay with the family, do not operate. Record the time.
2. Falling consciousness with one dilating pupil and no one trained to open a skull. Head up, airway clear, nothing by mouth, send for the district if it can be reached within hours.
3. Blood or clear fluid from ear or nose after head injury. Do not pack it. Let it drain, nurse on that side, watch for meningitis.
4. Complete cord lesion above about C4, with paralysed arms and laboured breathing. Comfort only. These patients die of respiratory failure and the village cannot ventilate.
5. No perianal sensation, no toe movement and no anal tone at 24 hours. Ninety per cent chance of permanent paralysis. Tell the truth and start the lifelong nursing programme today.
6. Slow pulse with low blood pressure after spinal injury. Neurogenic shock. Raise the legs, keep warm, do not flood with fluid.

7. Bilateral flail chest. Usually fatal without ventilation. Pain relief, upright position, suction.
8. Rising breathlessness with one silent hyper-resonant side. Tension pneumothorax. Decompress immediately, finger rather than needle, then drain. This one is reversible and must never be on the comfort list.
9. More than about 1,500 ml drained at once, or more than about 200 ml an hour continuing. The classic threshold for opening a chest, which no one after the Fall can do. Autotransfuse, keep the drain working, tell the family early.
10. Shock with distended neck veins and a quiet heart after a wound near the sternum. Tamponade. Do not load with fluid.
11. A wound below the nipple line with chest signs. Read WO-08. Up to 40 per cent involve the abdomen.
12. Fever, foul drainage and worsening breathlessness a week after a drain. Empyema. Drain it properly and bigger, never with a needle.

## The case against

**Against the burr hole, by name.** Okidi, Ogwang, Okello, Ezati, Kyegombe, Nyeko and Scolding (2020) did not merely report poor results, they banned the operation at their hospital. That is the strongest published argument that a low-volume unit without imaging should not open skulls. The Malawi and Tanzania counter-series are retrospective and both selected the patients they operated on. Low-resource surgical series are also subject to reporting bias: a unit that loses its burr-hole patients is less likely to publish than one that saves them. The operation's value depends almost entirely on case selection and operator volume, neither of which a post-Fall district can guarantee.

**Against the archaeology.** Peruvian survival figures are inferred from bone remodelling and cannot distinguish an operation that saved a life from one performed for ritual on a lightly injured skull. There is no denominator. Readers will see 83 per cent and conclude skull surgery is easy. The same cultures' earliest series ran at about 40 per cent survival.

**Against the three-sided dressing.** It was removed from United States Tactical Combat Casualty Care guidance in 2008 because nobody could produce evidence for it, and no human trial has compared it with the alternatives. It persists in manuals because it is easy to draw.

**Against needle decompression as taught.** One needle in three does not reach the pleura, so a technique taught to lay people as the emergency manoeuvre gives false reassurance in exactly the patients who are dying.

**Against the romance of the hospital.** The French field hospital in Chad opened 68 per cent of its chest wounds, not because that was good surgery but because it had no nurses, no blood and no X-ray. Effort put into beds, turning rotas, feeding and physiotherapy buys more survival than effort put into instruments.

**Against this chapter's optimism.** About 70 per cent of people with a serious thoracic wound die, most before anyone can act. Of head-injured patients at GCS 3 to 5, 98 per cent die even with a hospital. Cord injury above C4 is unsurvivable without a ventilator. The book should promise only that careful hands close the narrower gap between the survivable injury and the preventable death.

## 10-line summary of robust findings

1. Secondary brain injury, not the impact, is what the bedside can change, and low oxygen is its largest cause.
2. Mortality by post-resuscitation GCS runs about 98 per cent at 3 to 5, 31 per cent at 6 to 10 and 8 per cent at 11 to 15.
3. The deteriorating patient who started mild or moderate deserves the greatest effort, and a half-hourly written trend chart is how you find him.
4. Classic signs of raised intracranial pressure are specific (93 per cent) but insensitive (37 per cent), so their absence proves nothing.

5. Burr holes save lives in selected, lateralised, trained hands (6.8 against 43.9 per cent in Malawi) and kill in untrained low-volume hands (3 of 3 in Uganda).
6. Rigid collars and backboards have no required pre-hospital role and are harmful in penetrating trauma, while manual alignment does have a role.
7. No perianal sensation, no toe movement and no anal tone at 24 hours predicts permanent paralysis with about 90 per cent certainty.
8. A chest drain alone suffices for about 90 per cent of chest injuries reaching care, and an improvised bottle gives a complication rate near 17 per cent.
9. Needle decompression fails to reach the pleura about a third of the time, so finger thoracostomy is the better village procedure.
10. In tamponade the shock is cardiogenic and intravenous fluid makes it worse.

## Open questions

- Whether conservative management of a stable traumatic pneumothorax, inferred here from spontaneous pneumothorax trials, is safe without monitoring.
- Whether a Simplified Motor Scale really outperforms the GCS in untrained lay hands. No study in untrained observers was found.
- Whether two-hourly turning beats four-hourly on a straw or foam mattress. The trials used modern surfaces.
- Whether blind, non-lateralised burr holes have any net benefit. Both manuals encourage them and the one series that tested them in a weak unit found none.
- What the true denominator is for prehistoric trephination survival, and whether the operations were mostly therapeutic or mostly ritual.
- Whether autotransfused chest blood is acceptable beyond the six-hour limit, as it inevitably will be in a village.

## Sources to read in full

1. Giannou, Baldan and Molde, War Surgery volume 2, ICRC 2013, chapters 26, 31, 34 and 36 with annexes 26.A, 31.A and 31.B. The single most useful document for this topic.
2. Giannou and Baldan, War Surgery volume 1, ICRC 2009, sections 8.4 and 8.5, for needle decompression, the improvised Heimlich valve and pericardiocentesis.
3. Primary Surgery volume 2: Trauma, chapters 43, 51 and 54, for nursing protocols written for people without specialist training.
4. Wilderness Medical Society Clinical Practice Guidelines for Spinal Cord Protection, 2019 and 2024.
5. Eaton and others 2017 and Okidi and others 2020, read together, for the honest spread of burr-hole outcomes.
6. Hippocrates, On Injuries of the Head, Adams translation.
7. Oderud 2014, for what happens to people with spinal cord injury after discharge.

## At the bedside after the Fall

**Household.** A position, a clock and a chart. Lay the unconscious person on the side with the head slightly raised. Turn every two hours and write the time on a wall. Wipe the mouth clear and give nothing by mouth. Cover a sucking chest wound with anything air-tight taped on three sides and sit beside it. To start you need a clock or a marked candle, charcoal and a wall, clean cloth, a blanket, and fat or oiled cloth. First failure to expect: the family stops turning on the second night, and the first sore appears over the sacrum on day three.

**Village of 300.** Add a chart, a drain and a block. One person is trained to score eye, voice and movement separately every half hour and draw the line. One person is trained to make a finger thoracostomy and to place and manage a chest drain, practising on butchered animals. The dispensary holds salvaged chest tubes of 32 and 28 French, cannulae of 7 to 8 cm, lidocaine, suture, a bottle, salt for saline, gauze and a metal funnel. To start you also need boiling

and a pressure cooker, soap, honey and granulated sugar, tyre inner tubes for pressure rings, a straw and a bottle, and one literate person keeping records. First failure to expect: the drain bottle is lifted above the chest while carrying the patient, or clamped for transport, and the lung collapses.

**District of 3,000.** Add ten beds, relief nursing and, under four strict conditions only, the skull. The infirmary can nurse a comatose patient for six weeks and a paraplegic patient for life, with a turning rota, catheter care, physiotherapy and a kitchen that makes 3 litres of high-protein feed a day. It places chest drains routinely, blocks intercostal nerves, autotransfuses, and attempts pericardiocentesis knowing it usually fails. It opens a skull only under the four conditions in section 1.4. To start you need the instruments, a room that can be cleaned, a scale, a thermometer, boiled water and salt, and a written register of every case with its outcome. First failure to expect: the first burr hole is done on a patient at GCS 4 with no lateralising sign, that patient dies, and the infirmary must decide whether to learn or to ban the operation. Keep the register so the decision rests on data and not on grief.

## Protocols

### P1. The head injury watch (household and village)

1. Lay on the side, head above the heart, neck not twisted. Clear the mouth.
2. Record now, every 30 minutes for 6 hours, then hourly for 18 hours: eye opening (spontaneous / to voice / to pressure / none), speech (normal / confused / words / sounds / none), best movement (obeys / localises / pulls away / bends stiffly / straightens / none), both pupil sizes, pulse, breathing rate.
3. Call for help the moment any of these happens: any column falls 2 or more steps, one pupil becomes larger than the other, the pulse falls below 60 in a non-athlete, breathing becomes irregular, a fit occurs, or vomiting restarts after stopping.
4. No morphine, no strong sedatives. If restless, check bladder and bowel first, then put the mattress on the floor.
5. Rectal temperature twice daily. At 39 degrees C uncover, sponge and fan. No fever medicine.
6. If the blink reflex is gone, tape the eyelids closed.
7. If still unconscious at 72 hours, begin tube feeding: about 3 litres daily, about 1.5 g protein and 4 g sugar per kg body weight. One egg gives about 6 g protein. An unconscious adult may need four times normal energy.
8. Turn every 2 hours. Inspect sacrum, heels, hips and shoulders at every turn.
9. Release the catheter stopcock every 4 hours rather than draining continuously.

### P2. The log roll (4 people)

1. The most skilled person takes the head with both hands over the ears and gives every command.
2. Three others kneel on the same side at shoulder, hip and legs.
3. Place padded rolls either side of the head, or a rolled towel pinned at the front. Do not force a neck that resists or hurts more.
4. On the head holder's count, roll the body as one piece, keeping nose, breastbone and navel in one line.
5. Inspect and feel the back from neck to tailbone, then roll back on command.
6. For a penetrating wound, do not immobilise at all. Move to safety and treat the bleeding.

### P3. Tension pneumothorax (village)

1. Suspect it with increasing breathlessness after chest injury, one side silent and drum-like, distended neck veins, trachea pushed away. A patient who has lost much blood shows no neck veins.
2. Act before any further examination.
3. Preferred: finger thoracostomy. Clean the skin. Find the fifth space at nipple level, just in front of the midaxillary line. Infiltrate down to the pleura if anaesthetic exists. Cut 2 to 3 cm horizontally. Push a closed clamp over the TOP of the lower rib, never under the rib above. Open the jaws, put a gloved finger in and sweep.

4. Alternative where no blade: a cannula at least 7 cm long into the second space midclavicular, two finger-widths out from the breastbone edge, over the top of the third rib. A rush of air confirms it. No rush of air does NOT exclude it.
5. Attach a flutter valve: a glove finger with a 1 cm slit in its tip, tied around the cannula.
6. Place a proper drain as soon as possible. Needle and finger are both temporary.

**P4. Chest drain with an improvised seal (village and district)**

1. Indications: any haemothorax, tension pneumothorax, a large pneumothorax, a sucking wound after dressing, or empyema. When in doubt, drain it out.
2. Prepare the bottle first: a clean 1.5 litre bottle, boiled, with enough saline (1 level teaspoon of salt per 500 ml of boiled water, about 9 g per litre) that the tube's end sits 2 cm under the surface. Mark the starting level and the time.
3. Patient supine, pillow under the shoulder, arm behind the head.
4. Site: lay a flat hand in the armpit and work just below it, between the outer edge of the chest muscle and the midaxillary line, fourth or fifth space at nipple level. Never through the wound.
5. Infiltrate lidocaine 1 per cent with adrenaline from skin to pleura. Maximum 6 mg/kg with adrenaline, 3 mg/kg without.
6. Horizontal cut long enough to admit a finger. Blunt dissection hugging the UPPER border of the rib. Finger in, sweep for adhesions.
7. Tube 32 to 36 French in an adult, 28 in a child. NEVER with a trocar. Advance upward and backward, rotate it fully to confirm it is free.
8. Connect to the bottle, which stays on the floor, always below the chest. Mattress suture to seal the skin.
9. Confirm: the fluid swings with each breath. Bubbling means an air leak. A blocked drain is flushed with 50 ml of saline. Never clamp for transport. Never lift the bottle above the chest.
10. Daily after-care: sit the patient up, breathing exercises hourly while awake (ten deep breaths, then blow through a straw into a bottle of water), pain relief enough to allow a cough, record the volume every 12 hours.
11. Remove only when ALL are true: breathing easy, no bubbling for 24 hours, drainage clear and under 250 ml in 24 hours, swing stopped while the tube is still open. Pull sharply while the patient blows out against a closed mouth and nose, or while a child cries.

**P5. Autotransfusion from the chest**

1. Use when blood loss exceeds about 1,000 ml in an adult and there is no blood to give.
2. Do NOT use if the blood smells foul, is obviously broken down, or was shed more than 6 hours ago.
3. Prime a sterilised bottle with 100 ml of saline.
4. Filter twice through 6 to 8 layers of sterile gauze in a sterilised metal funnel.
5. Return by the usual intravenous route. Expect bruising and oozing for a day or two, settling within 24 to 72 hours.

**P6. Rib fractures in an older person**

1. Count the broken ribs by gentle pressure. Three or more in a person over 65 is a nursing emergency.
2. Do not bind or strap the chest.
3. Sit the patient up. Pain relief first, breathing second, everything else third.
4. Intercostal block if a trained healer and lidocaine exist: inject between the edge of sacrospinalis and the posterior axillary line, raising a wheal at the LOWER border of the rib, needle about 3 mm past it, aspirate to exclude vessel and lung before injecting, repeat 2 to 3 spaces above and below because innervation overlaps. Never both sides at one sitting.
5. Ten deep breaths and a supported cough every hour while awake, hugging a folded blanket against the ribs.

6. Blow through a straw into a bottle of water, ten breaths, every hour.
7. Watch for fever, a rising breathing rate and green or rusty sputum from day two to day five. That is the pneumonia that kills.

**P7. Spinal cord injury, the first week**

1. Examine fully and write it down: where sensation stops, what moves, reflexes, anal tone, perianal sensation, toe movement. Repeat at 24, 48 and 72 hours.
2. Low blood pressure with a SLOW pulse is neurogenic shock. Raise the legs, keep warm, do not flood with fluid.
3. Start two-hourly turning on day one, hour one. Post the rota above the bed naming the next position: front, back, left, right.
4. Inspect sacrum, heels, hips, shoulders, elbows and ears at every turn.
5. Rings of tyre tubing AROUND and never under bony points. Pillow between the knees.
6. Wash daily with soap and water, dry thoroughly, massage the large muscles gently.
7. Catheterise intermittently every 4 to 6 hours for the first weeks, then every 6 to 8. Clean and boiled is acceptable. At least 3 litres of fluid daily. Bag always below the bladder. Strap the penis upward against the abdomen.
8. Enema or manual evacuation on day 5 to 7, then on a fixed schedule.
9. Move every joint through its full range twice daily from day one.
10. Sit up 1 to 2 hours a day once the column is stable, lifting and shifting the buttocks every 15 minutes.
11. Established sore: wash with saline or clean boiled water, pack with granulated sugar or honey, change up to five times a day while wet, less as it dries. Antibiotics only if redness spreads or fever appears.

## Numbers to carry

1. **98, 31, 8.** Percentage who die at post-resuscitation GCS 3 to 5, 6 to 10 and 11 to 15.
2. **2 hours.** The turn interval, from the first hour, for every unconscious or paralysed patient.
3. **2 to 4 hours.** The usual lucid interval before an extradural clot closes it. Watch 24.
4. **24 hours and 90 per cent.** No perianal sensation, no toe movement, no anal tone at 24 hours means a 90 per cent chance of permanent paralysis.
5. **90 per cent.** The share of chest injuries reaching care that a chest drain alone treats completely.
6. **1 in 3.** How often a decompression needle fails to reach the pleura. Use a finger.
7. **7 to 8 cm.** Cannula length needed to cross a chest wall of 4 to 6 cm.
8. **250 ml in 24 hours.** The drainage below which a chest drain may come out, with no air leak and no swing.
9. **3 litres and 1.5 g per kg.** Daily fluid and protein for an unconscious adult.
10. **6 mg/kg and 3 mg/kg.** Maximum lidocaine with and without adrenaline.

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