NU-02 Fluids by mouth, tube and under the skin: hydration for the one who cannot drink

HEALING after the FALL, research library, NU-02

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

1. Findings by section

NU-01 argued that the household rung holds most of the effect of nursing (THRIVING library, NU-01). Here the hospital adds something a household lacks, and most of it can be clawed back by four routes that need almost no manufacturing, but none by a drip. HY-03 holds the drink and the plans, IN-04 the sepsis fluid argument and FEAST, WO-12 the sterilisation ladder and the needle-reuse record, HY-09 the feeding of the starving, IN-07 the wound-washing saline.

1.1 Two library disagreements, settled first

The household rehydration strength. HY-03 gives half a level 5 mL teaspoon of fine salt (about 3 g, 51 mmol/L sodium) and six level teaspoons of sugar per litre. IN-11 adds that it "may run short for heavily purging adults" but refuses to publish a stronger mix, because a strong mix is what kills infants (THRIVING library, IN-11).

I take HY-03's figure for every route in this report, and IN-11's refusal with it. The deaths in the record are all on the strong side: two Amsterdam infants given solution at about seven and two times strength, one dead and one brain damaged (Vreede and van der Vorst 1993, via HY-03), and a Kashmir child killed by a 21 g sachet made up in 200 mL (Quereshi et al. 2010, via HY-03). No series reports a child killed by a solution too weak. David Nalin's 47 hyponatraemic seizures against one hypernatraemic in 48,511 cholera patients concern low-sodium packet formulations given to purging adults with intravenous backup (via HY-03), not a household spoon. And **a tube abolishes the protection that keeps an awake drinker alive.** A conscious person given fluid that is too salty becomes thirsty and refuses it. A person fed 20 mL/kg per hour down a nasogastric tube cannot refuse anything. The fixed half-teaspoon scoop is the precondition for using a tube at all.

The saline figure. IN-07 gives normal saline as 9 g per litre and a household recipe of two level teaspoons per litre, which phase 3 corrected to about 12 g: a level 5 mL teaspoon of fine salt weighs about 5.9 g by the USDA sodium figure (via HY-03), so two are about 11.8 g, 1.2 per cent, roughly 202 mmol/L sodium against plasma's 135 to 145. For washing a wound that is harmless. **For anything given under the skin, into a vein or into a bone I take 9 g per litre and nothing else**, because 1.2 per cent is hypertonic, and hypertonic fluid under the skin is the error that killed infants in the 1950s and drove the technique out of medicine for thirty years (Gill et al. 2001).

1.2 The ladder, and the rule that governs it

Five routes exist below a sterile intravenous line: by mouth (the base, in HY-03, effective in over 90 per cent of acute diarrhoea), by nasogastric tube, under the skin, into the rectum, and into the bone. **The gut, the skin and the**

colon are filters, and a vein and a bone are not. Fluid crossing a membrane or subcutaneous fat is screened, slowed and buffered. Fluid pushed into a vein or a marrow cavity arrives whole, with its bacteria, its endotoxin and its full osmotic load.

1.3 The nasogastric tube and the deaths behind the alert

The record. In England, feeding through a misplaced gastric tube is a Never Event. Between September 2011 and March 2016, 95 such incidents were reported against more than three million tubes used, and 32 of those patients subsequently died, though many were critically ill beforehand (NHS Improvement 2016). That is roughly one catastrophic misplacement per 32,000 tubes and one death per 94,000 [VERIFY: my arithmetic from the alert's figures]. The NPSA first acted in 2005, after 11 deaths in two years, by abolishing the "whoosh test". The March 2011 alert followed 21 further deaths and 79 serious harms, a 2012 notice followed two deaths from flushing before confirmation, and a 2013 alert followed two deaths where electromagnetic devices replaced pH or X-ray. In the reference event a 26-year-old man, named only as Fabian, received in December 2018 about 1,450 mL of feed into his lungs and survived (HSSIB 2021). Without X-ray the rate must rise, but from far below the death rate of the child the tube is for. **The error that kills is feeding through a tube that was not checked.**

Measuring the length. The traditional method, NEX (nose to earlobe to xiphisternum), does not hold up. A systematic review of adult methods found NEX accuracy below 72.4 per cent and only NEX plus 10 cm reaching 97.4 per cent (American Journal of Clinical Nutrition 2022). A critical care review concluded NEX should no longer be used, because it approximates only the distance to the gastro-oesophageal junction and leaves the tip in the oesophagus (narrative review 2023).

Confirming position without an X-ray. The approved test is the pH of the aspirate. A 2014 study found that where an aspirate could be obtained, 98.9 per cent of 178 samples at pH 5.5 or below came from tubes in the stomach, and that auscultation had sensitivity 79 and specificity 61 per cent (International Journal of Nursing Studies 2014). Earlier work found auscultation specificity of 6.3 per cent in one series and 33.3 per cent in a 47-patient series, with sensitivity 100 per cent: a convincing whoosh is heard from stomach or lung.

The limit is getting anything to test. An aspirate came immediately in about half of placements and in 81.6 per cent after blowing air down the tube, turning the patient and waiting an hour, so one tube in five cannot be checked this way, and acid-suppressing drugs make the test falsely alarming. Red cabbage or other anthocyanin juice dried onto paper gives an acid indicator that could in principle be calibrated against vinegar, but **no source I found tests a home-made indicator against gastric aspirate, and the colour at pH 5.5 is not established** [VERIFY: my inference, not a finding]. What the village has instead, used together and never alone: a tube mark that has not moved, no coughing or voice change during insertion, aspirate that looks and smells like stomach content, and a patient awake enough to cough.

1.4 What goes down the tube

Rehydration solution. The WHO fallback where no drip can be reached is solution by tube at 20 mL/kg per hour for six hours, 120 mL/kg in all, seeking transfer after three hours without improvement (WHO 2005a, via HY-03). MSF, writing for teams who always have a drip, rejects the tube in severe dehydration or shock. HY-03 settled for WHO in the village, in a patient awake enough to protect the airway.

Nager and Wang randomised 96 outpatients aged 3 to 36 months to 50 mL/kg over three hours by tube or rapid intravenous fluid. Two of 48 nasogastric placements failed (4 per cent) against 27 of 44 intravenous attempts needing multiple procedures (61 per cent), and the tube was as efficacious and less complicated (Nager and Wang 2002). Rouhani and colleagues searched five databases to December 2009 and found 38 paediatric studies, 12 nasogastric, 16 intraosseous, 7 intraperitoneal, 3 subcutaneous and **none at all on rectal rehydration**, concluding that nasogastric rehydration is as effective as intravenous and should be second line after oral (Rouhani et al. 2011). GASTROSAM

randomised 272 severely malnourished children with moderate or severe dehydration to oral or intravenous rehydration, and at 96 hours 11 (8 per cent) and 9 (7 per cent) had died, with no evidence of a difference (GASTROSAM 2025).

Food down the tube. The FOOD trial's 5.8 per cent absolute reduction in death from early tube feeding after stroke was not statistically significant and may buy lives at the cost of more disabled survivors (Dennis 2005, via HY-09), while Finucane and colleagues found no evidence that tube feeding in advanced dementia prevents aspiration, prolongs survival or gives comfort (Finucane et al. 1999, via NU-01). For blenderised food, what a village will give, a 2024 systematic review of 17 studies and 1,585 paediatric patients found weak evidence that it may improve upper gastrointestinal symptoms, while reviews report more microbial contamination than commercial formula, more blockage and lower nutrient adequacy (Brekke et al. 2022). Make it fresh, strain it through cloth, give it lukewarm, flush with 20 to 30 mL of clean water before and after.

1.5 Under the skin: hypodermoclysis

The claim and the fall. Subcutaneous fat will take up a litre or two of salt water a day, and the route was widely used through the 1940s and 1950s before it collapsed. Gill, Dasgupta and Rochon attribute the fall to 1950s case reports of complications, most from inappropriately high rates or hypertonic solutions causing fluid shifts and cardiovascular collapse (Gill et al. 2001). The paediatric titles say it: Abbott and colleagues, "The danger of administering parenteral fluids by hypodermoclysis", Surgery 1952, and Israels and Wylie, "The Dangerous Hypodermoclysis in Infancy", Canadian Medical Association Journal 1959, 80(1):31 to 32. **Neither could be read, and the mechanism below is the reviews' account** [VERIFY]: an infant given electrolyte-free or hypertonic fluid under the skin gains no circulating volume, because sodium moves out of the blood into the subcutaneous depot and drags water after it, so the child becomes more shocked. **It is the absence of salt, not the absence of tonicity, that kills.**

The revival. In Rochon and colleagues' review, reported hydration rates ranged from 75 to 1,250 mL per hour, and because adverse events clustered at the high end they recommended 50 mL per hour in older people and urged caution with added potassium (Rochon et al. 1997). Slesak and colleagues randomised 96 dehydrated geriatric patients of mean age 85.3, 48 and 48, to subcutaneous or intravenous half-normal saline-glucose: median six days in both arms, the intravenous arm receiving more fluid (median 1,000 against 750 mL a day), adverse effects comparable (Slesak et al. 2003). Broadhurst and colleagues reviewed 26 systematic reviews and found the subcutaneous route at least as effective as intravenous, with less erythema and oedema (relative risks 0.43 and 0.42) against intravenous phlebitis 5.04, infection 3.70 and dislodgement 3.78, pain the same, and fluid overload at 0.003 episodes per therapy day. **Serious adverse events occurred at 480 to 675 mL per hour, with 5 per cent glucose, dextrose-Amigen or 10 per cent invert sugar, all hypertonic** (Broadhurst et al. 2020). A 2020 meta-analysis found fewer adverse effects with the subcutaneous route in its lowest-bias subgroup, relative risk 0.69 (0.53 to 0.88) (Danielsen et al. 2020).

How fast fat absorbs. Danielsen and colleagues infused 235 mL of labelled 0.9 per cent saline subcutaneously into six geriatric patients aged 78 to 84 over one hour. By the end 53 per cent had been absorbed, rising to 88 per cent an hour later, a mean rate of 127 mL per hour (90 to 164), with about 10 per cent still a depot at 90 minutes (Danielsen et al. 2022). Six patients only, but **fat takes up roughly 125 mL an hour and lags about an hour behind.**

The envelope. Gill gives about 1.5 L per site in 24 hours at 20 to 75 mL per hour, the catheter changed every 72 hours. Berger gives 1,500 mL at one site and 3,000 at two. A long-term care protocol gives 1 mL per minute, 1.5 L per site per day, up to 3 L at two sites, never faster than 1 L in two hours, by gravity through a 21 to 27 gauge butterfly at 45 to 60 degrees into a pinched fold (William Osler Health Centre, n.d.), and StatPearls gives children 24 or 25 gauge between the shoulder blades at 20 mL/kg over about an hour. **I take 1 mL per minute per site, 1.5 L per site per 24 hours, 3 L over two sites, and a 21 to 25 gauge needle**, inside every source and below Danielsen's measured absorption rate.

The fluid, and the limit. Broadhurst found 0.45 or 0.9 per cent sodium chloride and dextrose-saline most common,

and evidence insufficient for Ringer's lactate, while the long-term care protocol forbids 5 and 10 per cent dextrose outright. **The brief's lead lists "isotonic saline, 5 per cent dextrose, never hypertonic", and I disagree with the middle item**, because plain 5 per cent dextrose carries no electrolyte, appears among the fluids that produced serious adverse events, and is the class behind the 1950s infant deaths. The route is maintenance only. Contraindications: shock and circulatory collapse (unperfused skin leaves the fluid sitting), severe heart failure, pulmonary oedema, bleeding and clotting disorders, and any need for volume fast. One report describes severe haemorrhage from a site in which death may have resulted (O'Hanlon et al. 2009), groin and breast sites produced all four withdrawals for swelling in one series, and plastic cannulas outlasted metal needles by a mean of 6.7 days (Broadhurst et al. 2020).

1.6 Into the rectum: proctoclysis

The tradition and the named cases. Rectal infusion is traced to Egyptian papyri of about 1500 BC and to the clyster of Greece and Rome, and from the late 1870s to the early twentieth century enemata were the standard of care when the mouth could not be used (Macy et al. 2023). President James A. Garfield, shot in July 1881, was septic and unable to swallow by 3 August and was maintained on enemata of blood and beef extract until his death on 19 September. President William McKinley, shot on 6 September 1901, was given a saline enema immediately and from day three daily nutritive enemata of eggs, beef juice and whiskey, until the rectum would not retain them, and died on 14 September 1901 (Macy et al. 2023). The rectum kept both men hydrated and the bullet killed them anyway. John B. Murphy promoted the technique in JAMA in 1909 with gravity infusion of an average of 720 mL of saline over 40 to 60 minutes repeated every two hours, an average of 360 mL per hour, and reported daily volumes above 8 L as well tolerated on no empirical basis (Macy et al. 2023, quoting Murphy 1909, **the original was not read**). The method declined after the First World War as intravenous technique improved, and nutritive enemata fell earlier, when biochemistry found the rectum absorbs fat and protein poorly.

Modern evidence. Bruera and colleagues studied 78 terminally ill cancer patients across Canada, Argentina, Brazil and Mexico, using a 22 French tube inserted 40 cm into the rectum. Seventy-six received tap water and two normal saline, at 250 plus or minus 63 mL per hour for 15 plus or minus 8 days, averaging 1,038 mL a day, with up to 400 mL per hour tolerated in some cases. There were four episodes of leakage, five of pain during infusion and nine of enema effect, and no other complications. Four patients (5 per cent) stopped for the discomfort of insertion, and death was the reason for stopping in 60. The cost was about 8 Canadian cents a day against 4.56 dollars for hypodermoclysis (Bruera et al. 1998). Debongnie and Phillips measured a net maximum of about 5,700 mL of water absorbed over 24 hours when fluid was infused into the caecum of healthy subjects, with capacity overwhelmed if fluid enters rapidly (Debongnie and Phillips 1978), against normal net absorption of a few hundred millilitres a day.

The envelope. Macy and colleagues give: patient on the left side during and for 30 minutes after, so gravity carries fluid into the descending colon, never the right side. Bowels emptied first if feasible. Up to 400 mL per hour for one to two hours with rests of two to four hours, or boluses of up to 250 mL every 30 minutes, with non-emergency infusions kept at about 250 mL per hour or less. **Permitted fluids: hypotonic solutions (quarter or half-strength saline, water, oral rehydration solutions) and isotonic saline. Solutions with sugar are explicitly not recommended** (Macy et al. 2023). In the colon sugar is an osmotic load that pulls water the wrong way and provokes expulsion.

Two cautions. The first author of Macy and colleagues' review invented the Macy Catheter and holds salary and stock in the company that makes it, as the paper declares, though its figures agree with Bruera's. And alcohol by rectum bypasses first-pass metabolism and the vomiting reflex. Its documented harm is chemical proctocolitis, about 13 reported cases including a 2005 vodka-enema case (Mian et al. 2005, via a later case report). A fatal case with a post-mortem blood alcohol of 350 mg/dL and 500 mL of wine recovered from the colon circulates widely and **I could not trace it to a primary forensic source** [VERIFY]. Never put alcohol in a rectum.

1.7 Into the bone: intraosseous

The record. Cecil Drinker reported in the 1920s that fluids and dyes put into marrow entered the circulation rapidly, and Leandro Tocantins published "Rapid absorption of substances injected into the bone marrow" in 1940 and, with O'Neill, a companion paper documenting blood, plasma or saline into adult sternal marrow and into tibial or femoral marrow in infants, **though secondary accounts give the series as 14 cases and as 17** [VERIFY, and the 1940 papers were not read]. A national paediatric cohort of 417 children with 549 attempts gave overall success 98.3 per cent and first-attempt success 81.9 per cent. A systematic review of 1,339 cases aged 0 to 18 found complications in 7.8 per cent, a 467-patient retrieval cohort found extravasation in 8.6 per cent and compartment syndrome in 0.6 per cent, and a survey of 1,802 uses reported osteomyelitis at 0.4 per cent, evident from about day 10 in children.

Ebola. The brief's lead, that Ebola treatment centres used the route, is only partly confirmed. Sierra Leone practice ranged from no needles at all to intraosseous infusion and transfusion, and a CDC cohort of children under 13 found that of 178 with medication records, 99 per cent received oral rehydration solution and antimicrobials and only 19 per cent intravenous fluids, with case fatality 57 per cent, and **receiving intravenous fluid was not associated with survival** (CDC paediatric Ebola cohort 2016).

Feasibility. A forge can make a manual intraosseous needle, but three things cannot be improvised. The fluid must be pyrogen-free, because marrow drains straight into the central circulation. The site must be sterile, because osteomyelitis in a child's growth plate is crippling. And the operator must know the landmark, the flat medial surface of the tibia 1 to 2 cm below and medial to the tibial tuberosity, angled away from the growth plate. **This is a district skill, and the one route here a household must not try.**

1.8 Making the fluid, and why the vein stays shut

For washing and for the gut. Nine grams of plain salt in a litre of water boiled 15 minutes with the lid on, cooled covered and used within 24 hours serves as a wound wash, eye wash, mouth rinse, nasal irrigation and rectal infusion fluid (THRIVING library, IN-07). Everything in this report except the vein and the bone can use it.

The pyrogen problem. Boiling kills the organisms but not what they leave behind. Florence Seibert published "Fever Producing Substance Found in Some Distilled Waters" in the American Journal of Physiology in 1923, 67:90 to 104, establishing that the fevers distilled water sometimes caused came from a bacterial product unaffected by autoclaving, boiling and filtering (Seibert 1923, **the paper itself not read, account from secondary sources**). Her pyrogens are now called endotoxins. Li, Wilbur and Mintz measured the kinetics: a 5-log endotoxin reduction takes about 1 second of hydrothermal exposure at 250 °C, with D-values of 2.18 seconds at 210 °C and 0.229 at 250 °C, and dry heat needs 250 °C for 30 minutes for a 3-log reduction. Their autoclave figures of 121 °C for 18 minutes refer to killing microbes, not destroying endotoxin (Li et al. 2011). **A pressure cooker at 121 °C sterilises and does not depyrogenate**, so WO-12's pressure-cooker autoclave serves instruments, not injections (THRIVING library, WO-12). The human pyrogenic threshold is about 5 endotoxin units per kilogram.

What happens when the fluid is wrong. In 1970 and 1971, 378 patients in 25 United States hospitals developed Enterobacter septicaemia while receiving one manufacturer's intravenous products, traced to a newly changed elastomer liner in the screw caps, with 39.9 per cent of 1,007 caps tested carrying organisms. An early CDC snapshot in March 1971 recorded 150 bacteraemias in eight hospitals in seven states with nine deaths, and a later review gives a 13.4 per cent death rate among the 378, implying about fifty deaths [VERIFY: my arithmetic from the quoted rate]. The outbreak was not recognised for five months (Maki et al. 1976, CDC MMWR 1971). In Brazil in 2002, 28 of 355 patients fell ill a mean of 2.5 hours after exposure to implicated solutions, and bottles from the implicated Ringer's lactate lots held a mean of 88.3 endotoxin units per mL. A 1995 survey of infusion fluids from four Kenyan manufacturers found sterility failures in 10.5 to 28.6 per cent of samples.

The conclusion. If industrial plants with quality control could kill about fifty people through a cap liner, **a village cannot make fluid for a vein. The limit is not sterility, which is achievable, but endotoxin, which needs**

250 °C and is undetectable without a laboratory. No village check exists: the rabbit pyrogen test of USP XII, 1942, needs a laboratory and a colony of rabbits.

Coconut water. Campbell-Falck and colleagues report a single case from a remote Solomon Island with no standard fluid (Campbell-Falck et al. 2000). Pradera and colleagues gave it intravenously to 12 children in Cuba in 1942, and Eiseman, Lozano and Hager covered 157 patients in Bangkok, Honduras and St Louis in 1954 with minor reactions only. Its composition is closer to intracellular fluid, high in potassium and sugars, with sodium of 2.9 to 12.5 mEq/L, too little to treat dehydration (Fagundes Neto et al., via HY-03). **It is not a saline substitute, and its place after the Fall is a cup.**

1.9 When fluid kills

Too fast in the vein. FEAST, from IN-04: 3,141 African children, bolus arms 10.6 and 10.5 per cent dead at 48 hours against 7.3 per cent on maintenance, an excess of about 3.3 percentage points, relative risk 1.45 (Maitland et al. 2011, via IN-04). GASTRO randomised 122 children with severe dehydration, median age 8 months, to WHO Plan C or 100 mL/kg of Ringer's lactate over 8 hours flat with no boluses. Serious adverse events by 48 hours were 3 of 61 (5 per cent) and 2 of 61 (3 per cent), risk ratio 0.67 (0.12 to 3.85, p = 0.65), with no difference in time to correction or discharge (GASTRO, BMC Medicine 2019). **Nothing in the record punishes a village for going slowly.**

Too much salt, and too little. From HY-03's hypernatraemia record: above 150 mmol/L sodium there is thirst out of proportion to other signs, with convulsions usually above 165, especially when fluid is given fast (WHO 2005a, via HY-03). In the other direction, for Arieff, Ayus and Fraser (BMJ 1992), secondary accounts describe 16 children given hypotonic fluid of whom 10 died and 5 were left in a permanent vegetative state, alongside a review of 24,412 surgical admissions with 83 cases of postoperative hyponatraemia and 7 deaths (**the paper was not read and these figures come from citing works, so treat them as approximate**) [VERIFY]. A 2014 meta-analysis confirmed that hypotonic maintenance fluids raise hyponatraemia risk against isotonic fluids in hospitalised children. **Salt-free water in quantity, by any route, is a poison in a sick child.**

Too much in the dying. Bruera and colleagues randomised 129 hospice patients with advanced cancer to 1 L of normal saline daily or 100 mL as placebo over four hours. Hydration did not improve symptoms, quality of life or survival, and median survival was 21 against 15 days, p = 0.83 (Bruera et al. 2013). A 2026 systematic review found that randomised trials do not consistently show improvement from clinically assisted hydration (Alzahrani et al. 2026). **Fluid does not help the dying.** Keeping the mouth wet and clean is the treatment (NU-01).

Signs of overload in a house with no stethoscope. Puffy eyelids are the WHO sign that a rehydrated child has had enough: stop the solution and give breast milk or water, never a diuretic. In severe malnutrition a rise in breathing of 5 a minute and in pulse of 15 signals overload, with MSF using 10 and 20 for children generally (both via HY-03). For any route add new breathlessness, a wet cough, inability to lie flat, visible neck veins when propped up, and a hypodermoclysis swelling not absorbing within an hour.

2. Evidence grades

Route or practice	Grade	Tradition's claim	What the record shows	What science infers
Oral rehydration solution	A	salted sweet drinks worldwide	cholera fatality from about 50% to under 1% (HY-03)	glucose-coupled sodium uptake

Route or practice	Grade	Tradition's claim	What the record shows	What science infers
Rehydration by nasogastric tube	A	none	equals intravenous, 4% placement failure against 61% needing repeats (Nager and Wang 2002, Rouhani 2011)	gut absorbs and filters
Enteral rather than intravenous in severe malnutrition	A	none	8% against 7% death at 96 h in 272 children (GASTROSAM 2025)	the vein is not needed
Slow (8 h) against WHO Plan C	B	none	3% against 5% serious adverse events in 122 children, underpowered (GASTRO 2019)	slower is not worse
Hypodermoclysis, isotonic saline, older adults	A	1940s bedside practice	equal to intravenous, fewer adverse effects (RR 0.69), 88% absorbed in 2 h (Rochon 1997, Slesak 2003, Broadhurst 2020, Danielsen 2022)	fat is a rate-limited reservoir
Hypodermoclysis in children	C	not traditional	three studies, no trial in a low-resource setting (Rouhani 2011)	physiology same, dosing unknown
Hypodermoclysis with electrolyte-free or hypertonic fluid	X	"any fluid will do"	1950s infant deaths, serious events at 480 to 675 mL/h with sugar solutions (Gill 2001, Broadhurst 2020)	sodium moves into the depot, shock deepens
Proctoclysis, water or saline	B	clysters from 1500 BC, standard 1870s to 1910s	78 dying adults at 250 mL/h for 15 days, 4 leaks and 5 pains, colon takes up to 5.7 L/day (Bruera 1998, Debongnie 1978)	large spare absorptive capacity
Proctoclysis in children	D	historical use	no eligible studies found (Rouhani 2011)	nothing is known

Route or practice	Grade	Tradition's claim	What the record shows	What science infers
Rectal nutrition (beef, eggs, blood)	X	Garfield 1881, McKinley 1901	abandoned once fat and protein were found unabsorbed (Macy 2023)	the colon takes water and salt, not food
Rectal alcohol	X	folk and recreational	chemical proctocolitis in about 13 reports (Mian 2005 and later)	bypasses first-pass and vomiting
Intraosseous infusion	B	none	98.3% success in 417 children, complications 7.8%, osteomyelitis about 0.4% (Tocantins 1940, modern cohorts)	marrow is a non-collapsible vein
Coconut water intravenously	D	Pacific and Caribbean emergency use	about 170 patients 1942 to 2000, minor reactions (Campbell-Falck 2000, Eiseman 1954)	composition is intracellular, not plasma
Home-made fluid into a vein	X	"boiled water is clean"	about 50 deaths from industrial plants 1970 to 1971, Kenyan sterility failure 10.5 to 28.6% (Maki 1976)	endotoxin survives 121 °C, needs 250 °C (Li 2011)
Auscultation to confirm a tube	X	"listen for the whoosh"	specificity 6.3% to 61%, abolished in England 2005 after deaths	air gurgles audibly from stomach or pleura alike
pH 5.5 or below to confirm a tube	B	none	98.9% of 178 aspirates at pH ≤5.5 were gastric, obtainable in 50% rising to 81.6%	stomach is acid, lung and bowel are not
NEX measurement alone	X	standard teaching	accuracy under 72.4%, NEX+10 cm reaches 97.4%	NEX reaches only the gastro-oesophageal junction

Route or practice	Grade	Tradition's claim	What the record shows	What science infers
Hydrating the imminently dying	X	"she must not die thirsty"	1 L/day no better than 100 mL on symptoms or survival in 129 patients (Bruera 2013)	the dying body does not use it

3. Means ledger

Rung	What it can do	What it changes
Hands and knowledge alone	Assess the four signs. Spoon-feed a teaspoon every 1 to 2 minutes. Sit the patient up. Recognise overload. Never feed anyone who cannot be woken. Give fluid rectally with any soft tube and clean vessel	Most of the total effect (NU-01). A child who will drink needs nothing more
The hearth	Boiled water, salt and sugar by fixed scoop, cereal solution, 9 g/L saline for washing and the rectum, strained gruel, a marked litre jug, a warm room, a slate for the chart	Turns assessment into treatment. The vomiting child and the delirious elder can be held for days
Garden and still	A balance good to half a gram, a pressure cooker, boiled soft tubing for nose and rectum, a funnel and hung vessel for gravity, home-made indicator paper	Adds the nasogastric tube and measured fluid, so the drowsy but coughing patient becomes treatable. Nothing injectable
Village dispensary (300)	Salvaged pH strips and manufactured tubes while stock lasts, salvaged butterfly needles and giving sets with salvaged sterile saline, a lay healer who has passed fifty tubes, a register	Adds the route under the skin for the person who cannot drink for a week. Stock, not skill, is the limit
District infirmary (3,000)	Ten beds, night cover, a sterile room, salvaged intravenous and intraosseous equipment with salvaged fluid, isolation	Adds the vein, the bone and the ability to treat shock for as long as salvaged sterile fluid lasts, and no longer. Gains cross-infection, as NU-01 warns
Hospital before the Fall	Manufactured pyrogen-free fluid on demand, X-ray confirmation of every tube, electrolyte assays, pumps, central lines, dialysis	Adds measurement and unlimited vein access. Adds nothing to the nose, the skin, the rectum, the spoon or the chart

What the ledger shows. Four of the five routes need no manufacturing. The gap is shock, which needs the vein, which needs pyrogen-free fluid, which needs 250 °C. **After salvaged fluid runs out, a district infirmary is a**

village dispensary with more beds.

4. Harm test

Nasogastric tube. Kills by feeding into a lung through an unconfirmed tube, though 1,450 mL was survived in the published reference event (HSSIB 2021), and by aspiration in a patient too drowsy to cough, which NU-01 names the commonest fatal nursing error. Never in anyone who will not cough on it, in facial or base-of-skull injury, against resistance, or after a swallowed caustic. Signs: coughing, choking, voice change, breathlessness or falling alertness during insertion, and after feeding a fever with fast breathing at 12 to 48 hours. What to do: pull the tube, sit the patient up, give nothing.

Hypodermoclysis. Kills by the fluid, not the needle: electrolyte-free or hypertonic solutions deepen shock, as in the 1950s infant deaths (Abbott et al. 1952, Israels and Wylie 1959, titles only) [VERIFY]. Also causes cellulitis at a dirty site. Never in the contraindications listed in 1.5. Signs: a lump not absorbed within an hour, hardness, redness, heat, pain, new breathlessness. What to do: stop, remove the needle, do not massage an infected site, restart elsewhere more slowly.

Proctoclysis. Rarely kills. A stiff tube pushed can perforate, and rectal wall necrosis has been reported with balloon bowel-management devices (Macy et al. 2023). Forbidden in recent rectal surgery, tumour, severe haemorrhoids, impacted stool, neutropenia or a bleeding disorder. Too fast or sugared, it causes cramping, leakage and expulsion. Signs: blood on the tube, severe pain, a swelling belly. What to do: stop, halve the rate on restarting, check nothing sugared is in the mix.

Intraosseous. Maims rather than kills (section 1.7). Never in a fractured bone, through infected or burned skin, in a bone already attempted that day, or near a growth plate. Signs: a swollen calf, a tight shiny limb, loss of pulse. What to do: stop, remove the needle, elevate. A compartment syndrome without a surgeon loses the limb.

Home-made fluid into a vein or bone. Kills by pyrogen reaction and septicaemia. The sign is a shaking chill and fever about 2 to 3.5 hours after the infusion starts, sometimes with hypotension. What to do: stop, keep the bottle, treat for sepsis with what exists.

Reused needles. WO-12 has the largest harm in the domain: an estimated 21 million hepatitis B, 2 million hepatitis C and 260,000 HIV infections from contaminated injections in 2000 (Hauri et al. 2004, via WO-12). A new needle on an old syringe is not safe, because blood flows back into the barrel. **A butterfly needle is a needle and WO-12's rules apply to it in full.**

Who must never receive any of this. Infants under two months, outside a dispensary, because every volume and concentration error is multiplied. Anyone with a swollen, silent, tender abdomen, which is ileus, in whom WHO forbids oral and nasogastric fluid outright (via HY-03). Anyone who is dying and comfortable, for anything beyond a wet mouth.

5. Red flags

1. **Shock with no vein and no bone**: cold mottled limbs, capillary refill over 3 seconds, weak or absent radial pulse, altered consciousness. No route here restores volume fast enough. Do anyway: lay flat with legs raised, keep warm, give fluid by tube if the patient can cough and by rectum if not, 20 mL/kg per hour, and stop promising.
2. **Unconscious and unable to cough**: no safe route into the upper gut. Do anyway: the rectal route at 100 to 250 mL per hour. Keep the mouth wet, turn two-hourly as NU-01 sets out.
3. **Ileus**, a distended silent tender belly with vomiting: nothing may go into the gut. Do anyway: stop all oral and tube fluid, look for a cause (opiates, low potassium), and use the subcutaneous route if not shocked.

4. **Stool losses above 15 to 20 mL/kg per hour**, usually cholera: oral and tube therapy will be outrun. Do anyway: all the volume the patient will take, salted rice water, transfer if a drip exists anywhere.
5. **Fits in a dehydrated child who has had home-made solution**: assume the mix was too strong. Do anyway: stop everything made at home, give plain breast milk or water, give nothing fast, protect from injury, and know that correcting too quickly is itself dangerous.
6. **Breathlessness with crackles during any fluid**: overload. Stop at once, sit the patient upright, give nothing by any route for some hours, restart at half the rate.
7. **A tight shiny pulseless limb after intraosseous**: needs a surgeon within hours. Remove the needle, elevate, loosen everything, prepare the family for a limb.
8. **The dying person whose family wants fluid**, a red flag for the healer. Honest comfort: a litre a day changes nothing about symptoms or survival (Bruera et al. 2013), a dry mouth is treated by wetting the mouth every 20 minutes, and stopping fluid is not abandonment. Let the family do the mouth care.

6. The case against

The evidence is thin where it matters most. Rouhani and colleagues found three studies on subcutaneous and none on rectal rehydration in children (Rouhani et al. 2011). The hypodermoclysis literature is almost entirely in people over 80 in rich countries. The rectal literature is one open study of 78 dying adults and a century of surgical anecdote, as the modern review itself, written by the inventor of the device it recommends, concedes (Macy et al. 2023). **A critic would say this report hands a geriatric palliative technique and a surgical fashion of 1909 to families with sick children, on evidence that would not pass a licensing board.** That criticism is correct and the book must print it beside the protocols.

The intravenous romance cuts both ways. Gill and colleagues are clear that hypodermoclysis is not appropriate for severe dehydration (Gill et al. 2001), and Rouhani's reviewers say subcutaneous and intraperitoneal rehydration cannot be endorsed without more evidence. A critic would say the honest statement to a family with a shocked child is that nothing in this book will save them. That is partly right: **hypodermoclysis is a maintenance route and will not rescue shock.**

The counter-evidence on fluid itself. FEAST's excess of 3.3 per cent dead among African children given bolus fluid held under every shock definition tested (Maitland et al. 2011 and 2013, via IN-04). Andrews and colleagues found a number needed to harm of 7 from an aggressive fluid protocol in Zambian adults, and Jacob and colleagues advised African district hospitals to give only 1 mL/kg per hour where lung injury is suspected (both via IN-04). **The modern record keeps finding the fluid itself is the harm.** IN-04's reconciliation, which I accept: the patient who has lost fluid needs it back and the patient who has not needs maintenance. That is a judgement, not a trial result, and the book should say so.

Named critics to print: Kathryn Maitland and the FEAST investigators, the NPSA, NHS Improvement and HSSIB, Thomas Finucane on dementia feeding, Eduardo Bruera, advocate of the rectal route and author of the trial showing that hydrating the dying does nothing, and David Werner and David Sanders, whose Questioning the Solution argued that technical rehydration served suppliers rather than villages and neglected water and sanitation (via HY-03) [VERIFY: book not read].

7. Ten-line summary of robust findings

1. Gut, skin and colon filter and a vein does not, so four routes are feasible after the Fall.
2. Nasogastric rehydration equals intravenous in children, with 4 per cent placement failure against 61 per cent of intravenous attempts needing repeats.
3. In 272 severely malnourished dehydrated children, death at 96 hours was 8 per cent oral against 7 per cent intravenous.

4. The tube kills when fed through before confirmation: 32 deaths after 95 incidents in over three million English tubes.
5. Auscultation is not a test, with specificity of 6.3 to 61 per cent.
6. Aspirate at pH 5.5 or below means the stomach in 98.9 per cent, but comes in about half of placements, 81.6 per cent with manoeuvres.
7. Fat absorbs isotonic saline at about 125 mL per hour. One millilitre a minute per site, 1.5 L per site a day, is safe.
8. Hypodermoclysis kills through the fluid, not the route. Isotonic saline only.
9. The colon can absorb about 5.7 L a day, and dying adults took 250 mL an hour for 15 days.
10. A village cannot make fluid for a vein. Endotoxin survives 121 °C and needs about 250 °C.

8. Open questions

- **Can a home-made acid indicator confirm a tube?** Nothing tests anthocyanin paper against gastric aspirate. This is the most valuable experiment anyone could run before the Fall.
- **What is the right hypodermoclysis rate in a child?** StatPearls gives 20 mL/kg over an hour, about 200 mL per hour in a 10 kg child, three times the adult per-site rate. The HARK trial of hyaluronidase-assisted subcutaneous infusion against intravenous therapy in western Kenya has, as far as I could find, not reported.
- **Does rectal rehydration work in children?** No eligible study exists, for the route needing least equipment.
- **How much does dosing error rise when the hearth solution goes down a tube?** Nobody has measured error by route.
- **Is the 1950s hypodermoclysis mechanism as the reviews describe it?** Abbott 1952 and Israels and Wylie 1959 were not read.
- **Can a forge make a usable intraosseous needle, at what failure rate?** No source addresses it.
- **At what rate does blenderised feed block tubes?** No controlled study exists.

9. The sources to read in full

1. Broadhurst D, Cooke M, Sriram D, Gray B. Subcutaneous hydration and medications infusions (effectiveness, safety, acceptability): a systematic review of systematic reviews. PLoS ONE 2020, 15(8):e0237572.
2. Macy B, Paxton JH, Lam YWF. Current Updates in Rectal Infusion of Fluids and Medications. Current Emergency and Hospital Medicine Reports 2023. Read the conflict-of-interest statement first.
3. Rouhani S, Meloney L, Ahn R, Nelson BD, Burke TF. Alternative rehydration methods: a systematic review and lessons for resource-limited care. Pediatrics 2011, 127(3):e748.
4. HSSIB. Placement of nasogastric tubes: investigation report.
5. Danielsen MB and colleagues. Absorption rate of subcutaneously infused fluid in ill multimorbid older patients. PLoS ONE 2022, 17(10):e0275783.
6. Bruera E and colleagues. Proctoclysis for hydration of terminally ill cancer patients. Journal of Pain and Symptom Management 1998, 15(4):216 to 219.
7. Li L, Wilbur CL, Mintz KL. Kinetics of hydrothermal inactivation of endotoxins. Applied and Environmental Microbiology 2011, 77(8):2640 to 2647.
8. WHO. The Treatment of Diarrhoea: a manual for physicians and other senior health workers, 2005.

10. At the bedside after the Fall

The household. The minimum is a litre jug with a permanent mark, a fixed 2.5 mL salt scoop, a sugar scoop, a spoon, a cup, a pan, a soft tube about the thickness of a pencil with a funnel, and a chart on a slate. With that, and the four signs of dehydration, the half-teaspoon rule, the rule that nobody who cannot be woken gets anything in their mouth, and the left-side rule, a family can keep a vomiting child or a delirious grandparent hydrated by mouth and by rectum. **The first failure to expect is that the family will stop counting**, at three in the morning on the

fourth night. The second is deciding the child is better because it has stopped crying, when it has become too drowsy to cry.

The village of 300. At any time such a village will have perhaps two to five people who cannot drink enough, more during an outbreak [VERIFY: my estimate, consistent with NU-01's figure for bedridden patients]. It adds one trained person who has passed fifty tubes, a counted stock of tubing and butterfly needles, salvaged pH strips spent only where the stakes are highest, a balance good to half a gram, and a register of who is hydrated by what route and how much. Hypodermoclysis becomes possible here, while salvaged sterile saline lasts. **The first failure to expect is that salvaged needles will be reused because they seem too valuable to throw away, and that is how the hepatitis of WO-12 arrives.** Count needles like ammunition.

The district of 3,000. Ten beds, night cover, an isolation room for the cholera that will come, salvaged intravenous and intraosseous stock in a locked store with a ledger of expiry dates, a teaching programme producing one tube-competent person per hamlet, and the discipline to refuse the vein to all but those who cannot be saved any other way. **The first failure to expect is that salvaged intravenous stock will be spent in three months on patients who would have done as well on a tube, and be gone when the shocked child arrives.**

11. Protocols

Protocol 1. Decide the route

- ☐ Awake, drinking, keeping it down: **by mouth**, HY-03 Plan A or B. Stop here.
- ☐ Awake, drinking but vomiting: wait 10 minutes after a vomit, then a teaspoonful every 2 to 3 minutes. Most settle within 1 to 2 hours (WHO 2005a, via HY-03).
- ☐ Drowsy but coughs when the back of the throat is touched, gut working, belly soft: **nasogastric tube**, Protocols 2 and 3.
- ☐ Cannot be woken, or cannot cough, or facial injury, or swallowed caustic: **rectal**, Protocol 5.
- ☐ Cannot drink for days but is stable, not shocked, not breathless, and sterile isotonic saline and a clean needle exist: **under the skin**, Protocol 4.
- ☐ Swollen, silent, tender belly: **nothing into the gut.** Under the skin if not shocked, otherwise comfort only.
- ☐ Cold, mottled, no radial pulse, altered consciousness: shock. Nothing here will rescue it. Lay flat, legs up, keep warm, give what the patient will take by tube or rectum, send for a drip if one exists.

Protocol 2. Passing a nasogastric tube

- ☐ Never in anyone who cannot cough. Never in facial or head injury with blood or fluid from the nose. Never against resistance.
- ☐ Use the softest tube available, about 8 to 12 French in an adult (roughly 2.7 to 4 mm across), 5 to 8 French under 5 years, 8 French at school age.
- ☐ Measure nose to earlobe to the tip of the breastbone, **then add 10 cm in an adult.** Mark that point with thread or ink.
- ☐ Sit the patient as upright as they can manage, chin slightly down, never tipped back.
- ☐ Wet the tube with clean water or thin oil. Pass it along the floor of the nose, straight back, not upward.
- ☐ At the back of the throat ask the patient to swallow and advance with each swallow, giving sips of water if swallowing is safe.
- ☐ **Pull the tube out at once** for coughing, choking, voice change, breathlessness, blue lips, or inability to speak.
- ☐ Advance to the mark. Secure to the nose and mark where the tube meets the nostril.

Protocol 3. Confirming the tube before anything goes down it

- ☐ **Nothing goes down the tube until this is done.** Not water, not a flush, not medicine.

- ☐ Draw back with a syringe or suck gently. If fluid comes, test it.
- ☐ Acid fluid (pH 5.5 or below on a strip, or a clear acid colour on home-made indicator paper calibrated against vinegar) means the stomach in about 99 cases in 100.
- ☐ No fluid: blow 10 to 20 mL of air down the tube, turn the patient onto the left side, wait, try again. Wait an hour if needed.
- ☐ Still nothing, or pH above 5.5, or any doubt: **do not use the tube.** Pull it and start again, or change route.
- ☐ **Never accept a gurgle heard over the stomach as proof.** It is heard just as loudly when the tube is in a lung.
- ☐ Re-check the nostril mark before every feed, and re-test after any vomiting, coughing fit or sign of distress.

Protocol 4. Giving fluid under the skin

- ☐ Fluid: **0.9 per cent saline only. Exactly 9 g of plain salt per litre, weighed, not spooned.** Boiled 15 minutes, cooled covered, used within 24 hours. No sugar. Nothing stronger, nothing weaker than half-strength.
- ☐ Never in: shock, circulatory collapse, severe heart failure, breathlessness with crackles, bleeding or clotting problems, or when volume is needed fast.
- ☐ Equipment: a sterile 21 to 25 gauge butterfly needle or the finest available, sterile tubing, a vessel hung about a metre above the patient, a clean occlusive dressing.
- ☐ Site: a pinched fold of loose fat on the front of the thigh, the belly away from the navel, below the collarbone, or between the shoulder blades. Never groin, breast, over bone, or broken or infected skin.
- ☐ Clean the skin with alcohol or soap and water and let it dry. Prime the tubing. Pinch a fold and insert bevel up at 45 to 60 degrees. Secure and write the date on the dressing.
- ☐ **Rate: 1 mL a minute, which is 60 mL an hour, about 20 drops a minute with standard tubing.** Count the drops.
- ☐ **Ceiling: 1.5 L per site in 24 hours. 3 L across two sites. Never more than 1 L in 2 hours, and only as an overnight bolus in an adult.**
- ☐ Check the site at 30 minutes then hourly. A soft swelling that shrinks between checks is normal. **A lump still there after an hour means the rate is too fast. Halve it.**
- ☐ Stop and move the needle for hardness, redness, heat, pain or leakage. Change the site at least every 3 days.
- ☐ Stop everything for new breathlessness, a wet cough, inability to lie flat, or puffy eyelids.

Protocol 5. Giving fluid by rectum

- ☐ Fluid: clean warm water, oral rehydration solution, or 0.9 per cent saline. **No sugar solutions.** Warm to body temperature, tested on the inside of the wrist.
- ☐ Never in: recent rectal surgery or injury, a known rectal tumour, severe bleeding haemorrhoids, impacted hard stool, or a bleeding disorder.
- ☐ Have the patient empty the bowels first if they can.
- ☐ **Lay the patient on the left side and keep them there during the infusion and for 30 minutes after. Never the right side.**
- ☐ Use a soft tube about the thickness of a pencil, greased, inserted gently 20 to 40 cm. Never force it. Stop for blood or severe pain.
- ☐ Run in by gravity from a hung vessel.
- ☐ **Rate: start at 100 mL an hour. Raise toward 250 mL an hour if comfortable. Up to 400 mL an hour for one to two hours is tolerated, then rest two to four hours.**
- ☐ Or by push: up to 250 mL every 30 minutes, each 60 mL pushed over 15 to 30 seconds.
- ☐ Expect some leakage and put cloth underneath. About one patient in twenty refuses it for discomfort.
- ☐ Target about 1 L a day in an adult.
- ☐ Slow or stop for cramping, urgent expulsion, a swelling belly or blood.

Protocol 6. Rehydration solution down a tube, severe dehydration, no drip

- ☐ Only in a patient awake enough to cough. Confirm the tube by Protocol 3 first.
- ☐ **20 mL per kg per hour for 6 hours, 120 mL per kg in all** (WHO 2005a, via HY-03). A 10 kg child gets 200 mL an hour.
- ☐ Give by gravity, slowly, never by syringe push.
- ☐ Prop the patient at least halfway up throughout and for 30 minutes after.
- ☐ Reassess hourly: alertness, pulse, breathing, skin pinch, urine.
- ☐ **Slow down if the belly swells. Stop for repeated vomiting, puffy eyelids, breathing up by 5 a minute, pulse up by 15 a minute, or new breathlessness.**
- ☐ No better after 3 hours: this patient needs a vein. Send for one and keep going meanwhile.
- ☐ Start zinc after the first 4 hours and keep breastfeeding throughout (HY-03).

Protocol 7. Making and checking the fluids

- ☐ **For drinking and for the tube:** one litre of clean water, one level **2.5 mL** scoop of fine salt (about 3 g) and six level 5 mL teaspoons of sugar (HY-03). Grind coarse salt before measuring. Make fresh daily.
- ☐ **For washing wounds, eyes and mouths:** two level 5 mL teaspoons of salt per litre, about 12 g, which is 1.2 per cent. Slightly strong and harmless (IN-07, as corrected).
- ☐ **For under the skin:** 9 g of salt per litre, **weighed on a balance**, boiled 15 minutes, cooled covered, used within 24 hours. With no balance good to half a gram, do not use this route.
- ☐ **For a vein or a bone: nothing made at home, ever.** Boiling sterilises and does not remove pyrogen. Use salvaged manufactured fluid or no fluid.
- ☐ Check every batch: taste it (less salty than tears), hold it to the light for cloudiness or floating matter, smell it, and throw away anything made yesterday.
- ☐ Use only plain salt. Never curing salt, saltpetre, washing soda, caustic soda, salt substitute, fertiliser or plant-ash salt (HY-03).

Protocol 8. The fluid chart, kept by hand

- ☐ One slate or sheet per patient, six columns: time, in (what and how much), out (urine, stool, vomit), pulse, breaths, note.
- ☐ Record every amount given by every route as it is given, never from memory.
- ☐ Record every wet cloth and every stool, even as a count of marks.
- ☐ Weigh daily if a balance exists. A kilogram gained or lost is a litre.
- ☐ Total the day at the same hour and read the total aloud to whoever takes over.
- ☐ **A patient on two routes needs one chart, not two.** Most overdoses happen where two people are each giving half.

12. Numbers to carry

1. **Nine grams per litre for giving, twelve for washing.** Twelve must never go under a skin.
2. **One millilitre a minute per site, 1.5 litres per site a day, 3 litres over two sites.** Serious harm began at eight times that rate.
3. **20 mL per kilogram per hour for 6 hours**, 120 mL per kilogram in all, for severe dehydration with no drip.
4. **pH 5.5 or below is the stomach. A whoosh is nothing.**
5. **NEX plus 10 centimetres** in an adult. NEX alone is right under three times in four.
6. **100 to 250 millilitres an hour by rectum, patient on the left side, 30 minutes after.**
7. **125 millilitres an hour** is how fast fat absorbs saline. A lump still there at an hour means slow down.
8. **121 degrees sterilises, 250 degrees depyrogenates.** A village reaches only the first.

9. **5.7 litres a day** is the colon's spare absorptive capacity.
10. **Puffy eyelids, breathing up 5, pulse up 15.** Too much, by any route.

References

1. Broadhurst D, Cooke M, Sriram D, Gray B. 2020. Subcutaneous hydration and medications infusions (effectiveness, safety, acceptability): a systematic review of systematic reviews. PLoS ONE 15(8):e0237572. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0237572 (read to character 100,000, tables 1 and 2 are images and were not read)
2. Macy B, Paxton JH, Lam YWF. 2023. Current Updates in Rectal Infusion of Fluids and Medications. Current Emergency and Hospital Medicine Reports. https://doi.org/10.1007/s40138-023-00258-3 (read in full via the publisher's open-access PDF. The first author invented the Macy Catheter and holds a salary and stock in the company that makes it, as the paper declares)
3. Rouhani S, Meloney L, Ahn R, Nelson BD, Burke TF. 2011. Alternative rehydration methods: a systematic review and lessons for resource-limited care. Pediatrics 127(3):e748. https://pubmed.ncbi.nlm.nih.gov/21321023/ (abstract and secondary summaries only)
4. HSSIB. 2021. Placement of nasogastric tubes: investigation report. Health Services Safety Investigations Body. https://www.hssib.org.uk/patient-safety-investigations/placement-of-nasogastric-tubes/investigation-report/ (read to character 100,000 of a 231,900-character page, the remainder not read)
5. NHS Improvement. 2016. Patient Safety Alert: Nasogastric tube misplacement, continuing risk of death and severe harm, 22 July 2016, NHS/PSA/RE/2016/006. https://www.england.nhs.uk/wp-content/uploads/2019/12/Patient_Safety_Alert_Stage_2_-_NG_tube_resource_set.pdf (alert pages read in full from the PDF, the resource set was not read)
6. Danielsen MB, Jødal L, Riis J, Karmisholt JS, Valdórsson Ó, Jørgensen MG, Andersen S. 2022. Absorption rate of subcutaneously infused fluid in ill multimorbid older patients. PLoS ONE 17(10):e0275783. https://pmc.ncbi.nlm.nih.gov/articles/PMC9550057/
7. Danielsen MB and colleagues. 2020. Harms and Benefits of Subcutaneous Hydration in Older Patients: Systematic Review and Meta-Analysis. Journal of the American Geriatrics Society. https://agsjournals.onlinelibrary.wiley.com/doi/10.1111/jgs.16707 (search summary only, the full text returned HTTP 403)
8. Rochon PA, Gill SS, Litner J, Fischbach M, Goodison AJ, Gordon M. 1997. A systematic review of the evidence for hypodermoclysis to treat dehydration in older people. Journals of Gerontology Series A 52A(3):M169 to M176. https://www.ncbi.nlm.nih.gov/books/NBK67072/ (the DARE record page returned a verification screen. Figures taken from Broadhurst et al. 2020 and from search summaries, the original was not read)
9. Slesak G and colleagues. 2003. Comparison of subcutaneous and intravenous rehydration in geriatric patients: a randomized trial. Journal of the American Geriatrics Society 51(2):155 to 160. https://pubmed.ncbi.nlm.nih.gov/12558710/ (figures from search summaries and secondary reviews, the full text was not read)
10. Gill SS, Dasgupta M, Rochon PA. 2001. Hypodermoclysis in the Treatment of Dehydration. American Family Physician 64(9):1516 to 1520. https://www.aafp.org/pubs/afp/issues/2001/1101/p1516.html
11. Berger EY. 1984. Nutrition by Hypodermoclysis. Journal of the American Geriatrics Society 32. https://agsjournals.onlinelibrary.wiley.com/doi/10.1111/j.1532-5415.1984.tb02002.x (search summary only, cited for the 1,500 mL per site and 3,000 mL two-site figures)
12. William Osler Health Centre, Nurse Practitioner Led Outreach Team. n.d. Hypodermoclysis, a teaching resource for long-term care. https://centralwestoht.ca/wp-content/uploads/2023/01/Hypodermoclysis-LTC-Resource-Osler-Template.pdf (read in full from the PDF)
13. O'Hanlon S, Sheahan P, McEneaney R. 2009. Severe Hemorrhage From a Hypodermoclysis Site. American Journal of Hospice and Palliative Medicine. https://doi.org/10.1177/1049909108330033 (search summary

only. The American spelling is the published title)
14. Abbott WE and colleagues. 1952. The danger of administering parenteral fluids by hypodermoclysis. Surgery. (title and bibliographic record only, cited as reference 1 of Israels and Wylie 1959, not read) [VERIFY]
15. Israels S, Wylie K. 1959. The Dangerous Hypodermoclysis in Infancy. Canadian Medical Association Journal 80(1):31 to 32. https://pmc.ncbi.nlm.nih.gov/articles/PMC1830334/ (bibliographic record and reference list only, the article is a scanned image and was not read) [VERIFY]
16. Bruera E, Pruvost M, Schoeller T, Montejo G, Watanabe S. 1998. Proctoclysis for hydration of terminally ill cancer patients. Journal of Pain and Symptom Management 15(4):216 to 219. https://www.jpsmjournal.com/article/S0885-3924(97)00367-9/pdf (published abstract read, plus the detailed account in Macy et al. 2023)
17. Bruera E and colleagues. 2013. Parenteral Hydration in Patients With Advanced Cancer: A Multicenter, Double-Blind, Placebo-Controlled Randomized Trial. Journal of Clinical Oncology. https://ascopubs.org/doi/abs/10.1200/jco.2012.44.6518 (abstract and secondary summaries only. The route is given as parenteral and I could not confirm it was subcutaneous) [VERIFY]
18. Alzahrani M, Alabbasi A, Alqirnas MQ, Alzahrani Z, Sultan FA. 2026. Safety and Feasibility of Hypodermoclysis in Advanced Cancer: A Systematic Review and Meta-Analysis. American Journal of Hospice and Palliative Medicine. https://doi.org/10.1177/10499091261433975 (search summary only)
19. Murphy JB. 1909. Proctoclysis in the Treatment of Peritonitis. JAMA 52:1248 to 1250. doi:10.1001/jama.1909.25420420028003a (not read. All figures and quotations are taken from Macy et al. 2023, which reproduces the method) [VERIFY]
20. Paterson HJ. 1909. Note on Continuous Proctoclysis. The Hospital (London) 47(1210):64, 16 October 1909. https://pmc.ncbi.nlm.nih.gov/articles/PMC5202893/ (bibliographic record read, the page is a scanned image and the text was not read)
21. Debongnie JC, Phillips SF. 1978. Capacity of the human colon to absorb fluid. Gastroenterology. https://www.gastrojournal.org/article/0016-5085(78)90246-9/pdf (search summary and journal listing only, the 5,700 mL figure comes from quoted text in secondary sources)
22. Nager AL, Wang VJ. 2002. Comparison of nasogastric and intravenous methods of rehydration in pediatric patients with acute dehydration. Pediatrics 109(4):566 to 572. https://pubmed.ncbi.nlm.nih.gov/11927697/ (abstract, Cochrane summary and secondary accounts)
23. GASTROSAM investigators (Maitland K and colleagues). 2025. Oral rehydration for severe malnutrition in children with moderate and severe dehydration (GASTROSAM): a phase 2, open-label, superiority randomised controlled trial. Lancet Child and Adolescent Health. https://www.thelancet.com/journals/lanchi/article/PIIS2352-4642(25)00371-2/fulltext (search summary only, the full text returned HTTP 403)
24. Houston KA, Gibb JG, Mpoya A, Obonyo N, Olupot-Olupot P, Nakuya M, Evans JA, George EC, Gibb DM, Maitland K. 2017. Gastroenteritis aggressive versus slow treatment for rehydration (GASTRO): a pilot rehydration study for severe dehydration. Wellcome Open Research 2:62. https://pmc.ncbi.nlm.nih.gov/articles/PMC5571888/ (protocol read in full. Results published in BMC Medicine 2019, doi:10.1186/s12916-019-1356-z, read via search summary only)
25. Tocantins LM, O'Neill JF. 1940. Infusion of blood and other fluids into the circulation via the bone marrow, and Rapid absorption of substances injected into the bone marrow. Proceedings of the Society for Experimental Biology and Medicine. (not read. Case counts differ between secondary accounts, 14 in one and 17 in another) [VERIFY]
26. Ebola Virus Disease in Children, Sierra Leone, 2014 to 2015. 2016. Emerging Infectious Diseases 22(10). https://wwwnc.cdc.gov/eid/article/22/10/pdfs/16-0579.pdf (search summary only, authors not recorded) [VERIFY]
27. Campbell-Falck D, Thomas T, Falck T, Tutuo N, Clem K. 2000. The intravenous use of coconut water. American Journal of Emergency Medicine 18(1):108 to 111. https://experts.llu.edu/en/publications/the-

intravenous-use-of-coconut-water-2/ (abstract and bibliographic records only)
28. Young coconut water for use as intravenous and oral rehydration fluid. 2013. Global Health Perspectives. https://globalhealthperspectives.com/article/young-coconut-water-for-use-as-intravenous-and-oral-rehydration-fluid (read in full except Table 1, which is an image. Source of the Pradera 1942 and Eiseman 1954 case counts)
29. Seibert FB. 1923. Fever Producing Substance Found in Some Distilled Waters. American Journal of Physiology 67:90 to 104. https://en.wikipedia.org/wiki/Florence_B._Seibert (the 1923 paper was not read. Account taken from biographical and pharmaceutical-history secondary sources, one of which carries an unreliable-source flag) [VERIFY]
30. Li L, Wilbur CL, Mintz KL. 2011. Kinetics of Hydrothermal Inactivation of Endotoxins. Applied and Environmental Microbiology 77(8):2640 to 2647. https://pmc.ncbi.nlm.nih.gov/articles/PMC3126380/
31. Maki DG and colleagues. 1976. Nationwide epidemic of septicemia caused by contaminated intravenous products. American Journal of Medicine. https://pubmed.ncbi.nlm.nih.gov/1206107/ (abstract and search summaries only)
32. CDC. 1971. Nosocomial Bacteremias Associated with Intravenous Fluid Therapy, USA. MMWR landmark report. https://www.cdc.gov/mmwr/preview/mmwrhtml/lmrk045.htm (search summary only)
33. Pyrogenic Reactions and Hemorrhage Associated With Intrinsic Exposure to Endotoxin-Contaminated Intravenous Solutions. Infection Control and Hospital Epidemiology. https://www.cambridge.org/core/journals/infection-control-and-hospital-epidemiology/article/abs/pyrogenic-reactions-and-hemorrhage-associated-with-intrinsic-exposure-to-endotoxincontaminated-intravenous-solutions/8D6C528524D0A42ADE07724FC12419BF (search summary only, the source of the Brazil 2002 figures, authors and year not recorded) [VERIFY]
34. Quality of intravenous infusion fluids manufactured in Kenya. 1995. https://pubmed.ncbi.nlm.nih.gov/8689981 (PubMed record and search summary only, authors and journal not recorded) [VERIFY]
35. Reliability of pH measurement and the auscultatory method to confirm the position of a nasogastric tube. 2014. International Journal of Nursing Studies. https://www.sciencedirect.com/science/article/abs/pii/S0020748914000728 (abstract and search summaries only, authors not recorded) [VERIFY]
36. The accuracy of methods for determining the internal length of a nasogastric tube in adult patients: a systematic review. 2022. American Journal of Clinical Nutrition. https://ajcn.nutrition.org/article/S0002-9165(22)00094-6/fulltext (search summary only, the full text returned HTTP 403, authors not recorded) [VERIFY]
37. Nasogastric tube insertion length measurement and tip verification in adults: a narrative review. 2023. Critical Care 27. https://link.springer.com/article/10.1186/s13054-023-04611-6 (search summary only, the publisher redirected to a login)
38. Large variations between NICU nurses in predicting nasogastric tube insertion length in a mannequin study. 2021. https://www.sciencedirect.com/science/article/pii/S2666142X21000370 (search summary only, authors not recorded) [VERIFY]
39. Enteral versus intravenous rehydration therapy for children with gastroenteritis: a meta-analysis of randomized controlled trials. 2004. Archives of Pediatrics and Adolescent Medicine. https://pubmed.ncbi.nlm.nih.gov/15184213/ (search summary only, authors not recorded) [VERIFY]
40. Arieff AI, Ayus JC, Fraser CL. 1992. Hyponatraemia and death or permanent brain damage in healthy children. BMJ 304(6836):1218 to 1222. https://pubmed.ncbi.nlm.nih.gov/1515791 (not read. Figures taken from citing papers and a trial registry page and should be treated as approximate) [VERIFY]
41. Hypotonic versus isotonic maintenance fluids in hospitalised children, a meta-analysis. 2014. Journal of Pediatrics. (search summary only, authors and page numbers not recorded) [VERIFY]
42. StatPearls. Pediatric Dehydration. NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/sites/books/NBK436022/

(read for the hypodermoclysis and dehydration-grading sections, figures and tables are images and were not read)
43. Brekke G and colleagues. 2022. Nutrition and preparation of blenderized tube feeding in children and adolescents with neurological impairment: a scoping review. Nutrition in Clinical Practice. https://aspenjournals.onlinelibrary.wiley.com/doi/10.1002/ncp.10853 (search summary only)
44. Blenderized tube feeding for children: a systematic review of health outcomes and impact on upper gastrointestinal symptoms. 2024. https://pubmed.ncbi.nlm.nih.gov/41144871/ (search summary only, authors not recorded) [VERIFY]
45. A guide for selecting the appropriate nasogastric tube. 2022. Compat educational resource. https://www.compat.com/wp-content/uploads/2022/02/compat-web-educational-page-types-nasogastric-tubes-31jan2022-en.pdf (search summary only, used for French sizes alongside the Scottish guideline below)
46. NHS Greater Glasgow and Clyde. Paediatric nasogastric feeding guideline for healthcare professionals (1189). https://www.clinicalguidelines.scot.nhs.uk/ggc-paediatric-guidelines/ggc-paediatric-guidelines/gastroenterology/paediatric-nasogastric-feeding-guideline-for-healthcare-professionals-1189/ (search summary only, used for paediatric French sizes)
47. Complications and long-term outcomes of paediatric intraosseous access, systematic reviews and national cohorts, 2024 to 2026. https://pubmed.ncbi.nlm.nih.gov/39675228/ and https://www.resuscitationjournal.com/article/S0300-9572(24)00829-3/fulltext (search summaries only, several studies pooled, authors not individually recorded) [VERIFY]
48. Self-administered alcohol enema causing chemical proctocolitis. https://www.tandfonline.com/doi/full/10.2147/OAEM.S20 (search summary only, authors and year not recorded. Cites Mian et al. 2005, Gastrointestinal Endoscopy, which was not read) [VERIFY]
49. WHO. 2005a. The Treatment of Diarrhoea: a manual for physicians and other senior health workers. (cited throughout via THRIVING library, HY-03, which read it)
50. THRIVING library, NU-01. Nursing as the main medicine. Library document.
51. THRIVING library, HY-03. Oral rehydration. Library document.
52. THRIVING library, IN-04. Sepsis. Library document.
53. THRIVING library, IN-07. Antiseptics. Library document.
54. THRIVING library, IN-11. Cholera, typhoid and dysentery. Library document.
55. THRIVING library, WO-12. Sterile enough. Library document.
56. THRIVING library, HY-09. Feeding the sick and the starving. Library document.