OR-06 Stockpile, storage and the dispensary's shelf: what a village should hold and how to keep it

HEALING after the FALL, research library, OR-06

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

Scope and how to read this

This report treats the stockpile as one thing. It asks what a village of 300 should hold in medicines, dressings, instruments, plant stock and chemicals, in what quantity for a year, and how that stock is kept, counted and rotated when nothing will ever be resupplied. It builds on four library reports and does not repeat them. ME-09 ranks what to salvage and how long each item keeps (THRIVING library, ME-09). FO-11 sets out the emergency kits and scales the IEHK basic module to a village shelf (THRIVING library, FO-11). IN-05 covers antibiotic stewardship (THRIVING library, IN-05). ME-04 covers drying and storing plant material (THRIVING library, ME-04). The register of what is held belongs to OR-05, the order of building belongs to SY-09, the historical cases to OR-03, the poisons cupboard to OR-08, theft and hoarding as a matter of village law to GOVERNING, and sterile dressings to WO-12. Where this report touches those subjects it points to them by ID.

Quantities computed here from published kit lists are my own arithmetic and are marked [VERIFY]. Rules that the village must choose are marked [OWNER].

Findings by section

1. The template: what the emergency kit assumes

The Interagency Emergency Health Kit is the only published, costed, widely used list of what a population of known size uses in a known time. The 2017 edition supplies "medicines and medical devices for 10 000 people for approximately three months" in ten basic modules, each for 1,000 people, and one supplementary module for the whole 10,000 (WHO 2019). It weighs about 1,150 kg in 63 boxes of 25 kg or less and fills 6.5 cubic metres. One basic module weighs 38 kg and fills 0.22 cubic metres (WHO 2019).

The kit carries five assumptions that a village after the Fall does not share.

First, it is for the first three months of an emergency and is "not intended as re-supply kits". The manual says reordering should follow measured consumption once the kit is open (WHO 2019). UNICEF's note on the 2024 edition repeats this and adds that anyone stockpiling the kit must track expiry dates (UNICEF 2025).

Second, it treats life-threatening and common acute illness only. The manual excludes immunisation, nutrition, reproductive health, HIV, tuberculosis, chronic noncommunicable disease and major surgery (WHO 2019). A settled village has all of these.

Third, it assumes a health worker trained to the kit's treatment guidelines at the basic level and a doctor or clinical officer for the supplementary module (WHO 2019).

Fourth, its quantities rest on burden of disease and expert opinion, not on a published morbidity table. FO-11 found the same gap and cites Cullen, Taithe and Winters on how the kit was built from supply-chain practice rather than measured need (THRIVING library, FO-11). UNHCR's planning figure of one to four consultations per person per year is the closest working number, which for 300 people means one to four patients a day (UNHCR 2024, via THRIVING library, FO-11).

Fifth, it assumes a cold chain for two items, insulin and most brands of oxytocin, and storage at 15 to 30°C for the rest (UNICEF 2025).

The 2024 edition is heavier. Its basic medicine and renewable unit weighs 64.3 kg and fills 0.291 cubic metres, against 38 kg for the 2017 basic module, and the complete kit is nearly 2,000 kg and 9.5 cubic metres (UNICEF 2025). The next revision is due by 2029. FO-11 worked from the 2017 lists, and so does this report, because the 2017 booklet gives the item-by-item quantities and the 2024 note does not [VERIFY whether 2024 quantities differ materially].

The basic module for 1,000 people for three months holds, among other items, 3,000 dispersible amoxicillin 250 mg tablets, 2,000 paracetamol 500 mg and 1,000 paracetamol 100 mg tablets, 4,000 ibuprofen 200 mg, 200 ORS sachets, 1,000 zinc 20 mg, 2,000 ferrous sulfate with folic acid, 200 albendazole 400 mg, 50 tubes of tetracycline eye ointment, a litre each of benzyl benzoate lotion and chlorhexidine 5%, and twelve 200 ml bottles of povidone-iodine. Its renewables include 200 gauze bandages, 20 elastic bandages, 500 non-sterile compresses, two 500 g rolls of cotton wool, 100 examination gloves, ten bars of soap and 30 rolls of zinc oxide tape (WHO 2019).

2. Scaling to 300 people for a year with no resupply

The simplest scaling is linear. A village of 300 for twelve months is 0.3 of a basic module's population for four times its period, a factor of 1.2. The supplementary module serves 10,000 for three months, so the factor for 300 for a year is 0.12. FO-11 used the same factor for the basic module (THRIVING library, FO-11). I extend it to the supplementary module and to dressings, and then correct it where the village's demography or the lack of resupply changes the answer.

Table 1. One year's working stock for 300 people, scaled from IEHK 2017 [VERIFY, my arithmetic]

Item	IEHK quantity and basis	Scaled for 300 for a year	Correction
Amoxicillin 250 mg dispersible	3,000 per 1,000 for 3 months	3,600	Probably two to three times need (see below)
Paracetamol 500 mg	2,000 per 1,000	2,400	Keep
Paracetamol 100 mg dispersible	1,000 per 1,000	1,200	Keep
Ibuprofen 200 mg	4,000 per 1,000	4,800	Keep
ORS sachets	200 per 1,000	240	Replace with home recipe after year one
Zinc 20 mg	1,000 per 1,000	1,200	Keep
Ferrous sulfate with folic acid	2,000 per 1,000	2,400	Lock it (child poisoning)
Albendazole 400 mg	200 per 1,000	240	Keep
Tetracycline 1% eye ointment, 5 g	50 per 1,000	60	Keep
Povidone-iodine 10%, 200 ml	12 per 1,000	15	Keep dark
Ceftriaxone 1 g	800 per 10,000	96	Keep
Doxycycline 100 mg	3,000 per 10,000	360	Keep

Item	IEHK quantity and basis	Scaled for 300 for a year	Correction
Metronidazole 250 mg	2,000 per 10,000	240	Keep
Oxytocin 10 IU	200 per 10,000	24	Coolest place, see section 5
Misoprostol 200 µg	60 per 10,000	7	Raise to about 40 (FO-11, on births)
Magnesium sulfate	30 per 10,000	4	Raise to a fixed floor [OWNER]
Ketamine 50 mg/ml, 10 ml	25 per 10,000	3	Controlled, stock only
Morphine injection	50 per 10,000	6	Controlled, stock only
Morphine tablets	200 per 10,000	24	Controlled, stock only
Diazepam injection	200 per 10,000	24	Controlled, stock only
Naloxone	10 per 10,000	1	Raise to a fixed floor of 2 to 4 [OWNER]
Epinephrine 1 mg	50 per 10,000	6	Fixed floor of 10 (ships' rule)
Ringer's lactate 500 ml	200 per 10,000	24	Bulky, see section 3
Water for injection	2,000 per 10,000	240	Keep
Syringes 5 ml, 10 ml, 2 ml	2,000, 600, 700 per 10,000	240, 72, 84	Keep, reuse plan in WO-12
Needles 21G	1,500 per 10,000	180	Keep
Gauze bandage 8 cm x 4 m	200 per 1,000	240	Washable cloth after year one
Compresses, non-sterile 10 x 10 cm	500 per 1,000	600	Keep
Compresses, sterile	1,500 per 10,000	180	Sterility rules in WO-12
Examination gloves	100 per 1,000 plus 300 per 10,000	156	Too few, see below
Sterile surgical gloves, pairs	250 per 10,000	30	Keep
Sutures, absorbable and non-absorbable	144 each per 10,000	17 each	Keep
Soap bars	10 per 1,000	12	Village makes soap after year one
NaDCC 1.67 g tablets	1,200 per 10,000	144	Water treatment needs far more (HY reports)

Three corrections matter most.

The first is that the kit is generous with antibiotics for a settled village. At 20 to 30 tablets of amoxicillin 250 mg a course, 3,600 tablets is 120 to 180 courses a year. IN-05 estimated 40 to 80 antibiotic courses a year for a village of this size from population consumption data (THRIVING library, IN-05). An emergency population is sicker than a settled one, so the kit's figure is not wrong for its purpose. For a village with no resupply the surplus is not waste. It is the second and third year's stock, provided it is held sealed and cool.

The second is that the kit is mean with obstetric drugs for a village counted by births. IARH assumptions give about 12 births a year for 300 people and the library's own estimate is about 9 (THRIVING library, FO-11 and ME-09). Scaling the supplementary module gives seven misoprostol tablets, enough for two haemorrhages. FO-11's figure of

about 40 tablets a year is the better basis, and I agree with it.

The third is that a fixed floor beats a per-head figure for rare, lethal events. The ships' list shows how. In the UK's merchant ship stores, items marked with an asterisk are carried in the same quantity whatever the crew, for example ten 1 mg adrenaline ampoules, ten 1 g ceftriaxone vials, ten 1% lidocaine ampoules and five tranexamic acid injections in Category A (MCA, MSN 1905 Amendment 5). Anaphylaxis, sepsis and haemorrhage do not shrink with the population. I propose that the village list carry a floor for adrenaline, ceftriaxone, naloxone, magnesium sulfate and tranexamic acid, set at the ship's Category A figure where one exists [OWNER].

Gloves are the commonest under-provision. At one to four consultations a day, 156 examination gloves last weeks, not a year. Gloves are not a substitute for handwashing, but for wounds, births and the dead they matter. A stock of 2,000 to 5,000 examination gloves a year would be closer to need [VERIFY, my estimate, no source counts gloves per consultation].

Weight and volume give the size of the task. A year's basic-module stock for 300 people at the 1.2 factor weighs about 46 kg from the 2017 list. The supplementary module, without the ten basic modules, weighs about 770 kg, so its 0.12 share is about 92 kg. A year's working stock for the village is therefore about 140 kg and under one cubic metre [VERIFY, my arithmetic from WHO 2019]. A decade's stock fits in a small room. Storage, not bulk, is the limit.

3. The first-year list and the forever list

The brief asks for a first-year list against a forever list. I use three tiers, because "forever" means two different things.

The first-year shelf is what the dispensary opens and uses in year one. It is Table 1, corrected. Its rule is FEFO: first expiry, first out. The shortest-dated salvaged stock goes onto the shelf first, whatever its quality on paper, because ME-09 shows most tablets keep potency well past their date if dry and cool, while a few items die fast (THRIVING library, ME-09).

The sealed reserve is all salvaged stock beyond year one. It is never on the open shelf. It sits in the coolest, driest, darkest place the village has, in sealed containers with desiccant, and is drawn down once a quarter into the shelf. ME-09 gives the decade quantities to aim for (THRIVING library, ME-09). The shelf-life evidence supports holding most solid oral drugs for years: in the US Shelf Life Extension Program, 88% of 3,005 lots of 122 products were extended by at least a year, with an average extension of 66 months (Lyon 2006). The same paper warns that variation between lots was high and that only testing of each lot assured stability, which a village cannot do.

The forever list is what the village can make, grow or renew without salvage. It includes soap (lye from wood ash and fat), oral rehydration fluid from salt, sugar and boiled water with a measured spoon, boiled and sun-dried cotton cloth for dressings (WO-12), distilled ethanol for skin and instruments, honey, vinegar, salt for saline, charcoal, clay pots, and an annual harvest of dried plant material kept to ME-04's rules (THRIVING library, ME-04). Instruments belong here too. A pair of stainless scissors, forceps or a scalpel handle lasts decades if kept dry and clean. They do not scale with time, so the village needs a set per worker plus spares, not a yearly quantity.

The point of the three tiers is that the forever list must be running before the reserve runs out. ORS sachets and soap should be replaced by home production in year one, deliberately, so that the habit and the recipe are proven while sachets still exist as a fallback [OWNER].

4. What the record of chests, ships and missions shows

The UK's medical stores for merchant ships are the closest modern analogue to an isolated stock with no shop. The MCA sets three categories: Category A for ships at sea with no limit on distance, Category B within 150 nautical miles of a port with medical facilities (175 with helicopter cover), and Category C for harbour and near-shore craft (MCA, MSN 1905 Amendment 5). Quantities are per ten workers, with asterisked items fixed. The notice, which

replaced MSN 1768 and reflects the 24th edition of the Ship Captain's Medical Guide of December 2024, is newer than the 23rd edition of 2019 named in the brief.

Per head, the ship carries far more than the emergency kit. Category A gives 100 paracetamol 500 mg per ten workers, against 2,000 per thousand people for three months in the IEHK basic module. That is 50 g per ten workers against 10 g [VERIFY, my arithmetic]. For amoxicillin it is 42 capsules of 500 mg per ten workers (21 g) against 3,000 tablets of 250 mg per thousand (7.5 g per ten). The ship stocks for adults at risk of injury, for a voyage in which nothing can be bought, and with a captain who is not a clinician. The village after the Fall is more like the ship than like the refugee camp in one respect: no reorder.

The ship's controls are also instructive. Stores must be checked at least once a year by a competent person, preferably not the officer responsible for them. Controlled drugs sit in an inner locked cupboard inside the medical cabinet, whose key does not open the inner lock, and only the master or a person he authorises may open it. A bound controlled-drugs register records every receipt and issue, and every treatment goes into the official log (MCA, MSN 1905 Amendment 5). Sealed life-raft kits are replaced whole at expiry rather than opened. FO-06 and FO-09 cover the ship's guide and its user studies (THRIVING library, FO-06 and FO-09).

The historical chest shows what travelled. The Science Museum holds a Burroughs Wellcome "Tabloid" medicine chest supplied to Scott's British Antarctic Expedition of 1910, with 38 gutta-percha bottles of compressed tablets, dressings, boric wool and ointment. It was left at the foot of the Beardmore Glacier and recovered in November 1912, buried in snow at a cairn (Science Museum Group, Scott chest record, search summary only). The firm's selling point was the compressed tablet in a sealed bottle, which travelled where tinctures spilled and spoiled [VERIFY]. The firm also gave chests free to famous expeditions for publicity, so the chests' fame is not evidence that their contents were well chosen (Science Museum Group record, search summary).

The record of field losses is sobering in three ways.

Losses to heat are real but concentrated. In rural Zimbabwe, 789 samples of 13 essential drugs were followed from central store to remote, hot health centres over two years. Benzylpenicillin injection, aspirin, amoxicillin, ampicillin, doxycycline, ferrous sulfate, phenoxymethylpenicillin and tetracycline tablets were all satisfactory. Ergometrine injection was the only serious failure: 17 of 26 central samples already failed, and paired samples lost a further 17% in under five months (Nazerali 1998). In Burkina Faso, 27 drugs stored for two years at a rural and an urban site lost more than 10% in seven cases: ampicillin, erythromycin, sulfaguanidine, injectable furosemide, penicillin G, trimethoprim and chloroquine. The authors advised against holding these for more than a year in the tropics (Ballereau 1997, abstract only). Of 100 ergometrine samples from five countries, only 32 held 90 to 110% of the label and 34 held less than 60% (Hogerzeil 1996, abstract only). The two sources differ on the rate of loss. Zimbabwe's paired samples lost 17% in about five months, roughly 3 to 4% a month, while the overview gives up to 20% a month when unrefrigerated and exposed to light. The difference probably reflects light, brand and storage, and both agree that ergometrine cannot be held warm.

Losses to bad donation are larger than losses to heat. Between 1992 and 1996, an estimated 27,800 to 34,800 tonnes of drugs and supplies were donated to Bosnia and Herzegovina, of which 50 to 60% were judged inappropriate (Berckmans 1997, read via a secondary summary). Salvage after the Fall will look like a donation: unsorted, mislabelled, foreign-language, half expired. Sorting is a skill, and ME-09's ranking is the tool for it (THRIVING library, ME-09).

Losses to theft are larger still. In Malawi, about 35% of medicines left the system between central stores and clinics, and most of that loss occurred after delivery to the facility, most likely by staff. A government estimate had put the loss at about 30%. The same research found supply-chain error more common than theft (Jablonski, GIACE project page). A village store holding the only antibiotics for 300 people within reach is a far more valuable target than a Malawian clinic shelf. Section 9 returns to this.

5. What dies first in heat and humidity

Most solid oral medicines are robust. The fragile items are few, and they are among the most important. In order of how fast they die in a warm cupboard:

Ergometrine and methylergometrine injection. Unrefrigerated and in light, ergometrine may lose up to 20% a month. Any discolouration means less than 90% remains. Methylergometrine is no better (Hogerzeil 1996). A village should not rely on it. Where it is salvaged it belongs in the coldest store and is used first.

Insulin. Unopened human insulin keeps about six months at 25°C and about two months at 37°C with little loss, and opened vials are good for 10 to 45 days depending on the label (Richter 2023, via THRIVING library, ME-09). The most useful field result for a village is from a home in the Dagahaley refugee camp in Kenya, where the indoor temperature cycled between 25 and 37°C each day. Under that cycle, insulin kept 96.4 to 101.9% of its potency over 12 weeks. At a constant 37°C, by contrast, suspensions and solutions fell out of specification in one to two weeks (Kaufmann 2021). A daily cycle that dips at night is gentler than its peak suggests. The authors proposed an extended controlled temperature condition but tested a single home, and the insulin was cold until delivery. Prevalence of type 1 diabetes is about 9.5 per 10,000 (THRIVING library, ME-09), so a village of 300 will usually have no one who needs insulin and a district of 3,000 about three. Insulin belongs at district level.

Oxytocin. Across low- and middle-income countries, 45.6% of oxytocin samples failed assay. No loss was seen at 4 to 8°C over 12 months. At 21 to 25°C, losses were 3 to 7% a year, and at 30°C, 9 to 19% (Torloni 2016, via THRIVING library, ME-09). A WHO study of 1993 is titled for the stability of injectable oxytocics in tropical climates and is widely cited as showing oxytocin more stable than ergometrine (Hogerzeil 1993, not read). In practice oxytocin kept at 25°C is usable for two to three years at falling strength, and at 30°C for about one [VERIFY, my inference from the loss rates]. I disagree with FO-11's reading that a cellar gives oxytocin two to four years without qualification. A cellar gives the local mean annual air temperature (section 6), so in a warm country a cellar at 25°C holds oxytocin no better than a cool cupboard.

Misoprostol. It keeps well only in an intact aluminium blister. Tablets from damaged blisters lost 48.2% (Hagen 2020, via THRIVING library, MA-02). The rule is never to cut, pop or decant misoprostol until the moment of use.

Tetanus toxoid and other vaccines. Toxoids tolerate heat better than cold. Freezing ruins them (Milstien 2006, via THRIVING library, ME-09). A cellar that freezes in winter is the wrong place.

Tablets in damp. Humidity kills more slowly but more widely. The tropical stability test condition for climatic zone IVb is 30°C and 75% relative humidity (European Pharmaceutical Review, search summary). When tablets are taken out of their original packs and stored at that condition, some fail within weeks. Repackaged atenolol, sodium valproate and warfarin tablets failed dissolution tests after 14 to 56 days at 40°C and 75% humidity, and telmisartan brands differed in how well they survived 28 days at 30°C and 75% (James Cook University study, Pharmaceutics 2022, search summary). Co-amoxiclav from damaged packaging failed in 10 of 12 Cambodian samples (Khan 2013, via THRIVING library, IN-05). Ampicillin, erythromycin and chloroquine were among the Burkina Faso losses (Ballereau 1997). The lesson is the same as for misoprostol: the original sealed pack is part of the medicine.

Creams, suppositories and ointments. Suppositories and creams that melt above about 30°C should not be used once they have separated or re-set (MSH 2012).

Plant material and tinctures. Dried herbs lose active matter fastest when powdered, warm and humid. Artemisia lost about 30% of its artemisinin in a year at 40°C but kept well at 20°C even when humid (Simonnet 2009, via THRIVING library, ME-04). Tinctures keep longest. A widely repeated rule says at least 20% ethanol preserves a tincture, and one patent test found 20% passed the USP challenge for bacteria while only inhibiting mould (US patent 6361758, search summary). ME-04 used about 25% as the safe line, and I agree with keeping that margin (THRIVING library, ME-04).

6. Cold without electricity: what pots, cellars and springs can do

Every passive method has a ceiling, set by physics, and the village must know which ceiling applies before choosing.

The evaporative pot (zeer, pot-in-pot, clay cooler). Water evaporating from a wet outer pot cools the inner one. Mohammed Bah Abba popularised the pot-in-pot in northern Nigeria from 1995 for food (Wikipedia, Pot-in-pot refrigerator, search summary). The best field data are from Mali. With outside air below 40% relative humidity and 29 to 37°C, average temperature falls were 6.7°C for the pot-in-pot, about 5°C for pot-in-dish designs and 5.8°C for a brick evaporative chamber. Above 70% humidity the pot-in-pot cooled by only 1.8°C (Verploegen 2018). Earlier studies cited in the same report found clay pots cooling 5 to 10°C, and brick chambers 10 to 15°C, but only above 35 to 40°C and below 30 to 40% humidity.

Insulin researchers tested 13 devices in Khartoum and Bamako, including ten clay pots, a goat skin, a gourd and a wet-sand bucket. Mean cooling ranged from 2.7 to 8.3°C, between 20.5 and 71.3% of the theoretical maximum. A goat skin and Ethiopian and Sudanese pots did best. The devices could hold insulin at 20 to 25°C even in a hot climate, and worked better the drier the air (Ogle 2016, abstract).

Two practical facts limit the pot. Inside, the air is at 80 to 100% relative humidity, near saturation when the outside air is above 50% (Verploegen 2018). That is fatal to tablets, paper labels, cardboard and dressings. Only sealed glass vials, or medicines inside a sealed jar, belong in a cooling pot. And the pot must be watered every day. In the Mali study, only just over half the users kept watering regularly (Verploegen 2018). A pot that dries out is a warm, damp box.

So the evaporative pot suits a dry hot season and fails in a humid one. In a humid tropical village it buys at most two degrees.

The cellar and the soil. The ground damps the year's temperature swing with depth. The damping depth is where the swing has fallen to 37% of its surface value. A 27-year record from a Dutch grassland gave an annual damping depth of 1.80 m (WUR record, search summary). The annual wave penetrates about 19 times deeper than the daily one, which is why a few centimetres of soil remove the day-night swing but a cellar must be about two metres deep to cut the seasonal swing to a third (Oklahoma State University open textbook, search summary). At three to four metres the swing is down to about a tenth [VERIFY, my arithmetic from the exponential decay].

The deep soil's temperature is close to the mean annual air temperature of the place [VERIFY, standard soil physics, not checked in a primary source]. That is the cellar's ceiling. A cellar in a temperate country with a mean of 10°C will hold about 6 to 14°C at two metres. University handouts give 4 to 10°C and builders' guidance 10 to 13°C for root cellars (THRIVING library, HY-10). A cellar in a tropical country with a mean of 27°C cannot get below about 26°C. A farm trial in Thailand found a root cellar at 28.9°C at midday against 31.0°C in the farmhouse, with smaller swings (ECHO Community, Charis Teaching Farm trial, search summary). The cellar's value in the tropics is in cutting the peaks, not in reaching refrigerator temperature. Cellars are also damp, so the same sealed-jar rule applies as for the pot.

The spring house. Spring water emerges near the deep ground temperature and holds it year-round. Accounts give 45 to 55°F, about 7 to 13°C, in the eastern United States (Wikipedia, Spring house, and historicbldgs.com, search summaries). I found no measured series. A spring house is a cellar with running water and the same ceiling. Its advantage is that the water pulls heat out of a sealed jar standing in it faster than still air in a cellar can.

Ice. Only ice breaks the ceiling. A passive vaccine store such as the Arktek holds 0 to 10°C for about five weeks on one charge of ice even at 43°C outside (THRIVING library, HY-10, vendor figures). A district with an ice house in a cold winter, or such a device, can keep oxytocin and insulin cold. A village in the tropics cannot.

What this means for each fragile item. Oxytocin and insulin need the coolest place the village has: in a dry climate, a sealed jar in a watered pot in shade, and in a humid or temperate climate, a sealed jar in a cellar or spring

box. Ergometrine needs ice or should not be held. Tablets need dry, dark and cool, but never the inside of a pot.

7. Damp, light, pests and packaging

Damp. The MSF storage standard is 0 to 30°C, aiming below 25°C, with relative humidity at 65% or less, shelves clear of the walls and floor, and the temperature logged twice a day (MSF 2008, via THRIVING library, ME-09). MSH sets the normal store at 15 to 25°C, or up to 30°C by climate, dry and well ventilated (MSH 2012). A store that cannot be kept dry should keep everything in sealed tins or glass with a desiccant. Silica gel can be regenerated in a low oven, and dry rice or quicklime are rough substitutes [VERIFY whether rice is adequate].

Light. Ergometrine and oxytocin are light-sensitive, as are povidone-iodine and some tinctures. ME-04 found no trial supporting amber glass for herbs and only short-term benefit from light protection (THRIVING library, ME-04). A closed box or cupboard gives the same protection as amber glass and costs nothing.

Pests. Rodents eat cotton wool, gauze, cardboard and labels. The drugstore beetle and the cigarette beetle infest dried herbs and develop in about two months at 25°C and 65 to 70% humidity (THRIVING library, ME-04). Metal and glass are the only reliable barriers. Dressings belong in tins.

Packaging as a medicine. The original blister or sealed bottle protects against water, oxygen and light. Decanting into a jar is the most common way a village will destroy good stock, as the misoprostol and co-amoxiclav results show. The rule is to issue from the original pack and to count tablets out at the moment of issue.

Temperature monitoring without a logger. A min-max thermometer read twice daily is the MSF standard. Where none is available, the household thermometer read at the hottest hour, written in the ledger, is the substitute [OWNER].

8. Counting and rotating

The supply-chain textbook method is a stock card for each item, kept with the item, with each receipt and issue entered and a running balance. A stock book duplicates the cards. The longest-dated stock goes to the back and issue is from the front (MSH 2012). The IEHK manual includes a sample stock card with columns for date, origin, in, out, stock and remarks, and a daily consumption form (WHO 2019).

The method's central idea is the maximum stock: average monthly consumption times a factor, so that the shelf never holds more than it will use before the next delivery. With monthly orders and four weeks' lead time the factor is three. The quantity to order is the maximum minus the stock in hand. A top-up or imprest system replaces exactly what was used (MSH 2012).

Without resupply, "order" becomes "draw from the sealed reserve". The same logic serves two purposes the textbook did not intend. It keeps the open shelf small, so less stock is exposed to heat, damp, children and theft. And it makes the reserve's draw-down visible: if the shelf needs topping up twice as often as last year, something has changed, whether an epidemic, a new prescriber or a leak. MSH notes that medicines usually expire because they were over-ordered or FEFO was not observed (MSH 2012). In the village the equivalent failure is a reserve opened too early or a shelf stocked for a year instead of a quarter.

The count has three rhythms. The keeper updates the card at each issue. A second person counts the shelf against the cards each month. Once a year, someone who is not the keeper counts everything, shelf and reserve, as the ship's rule requires (MCA, MSN 1905 Amendment 5). OR-05 owns the form of the register (THRIVING library, OR-05). This report sets only the rhythm and who does it.

Rotation without resupply has one extra rule. When an item passes its printed expiry date it does not go into the rubbish. It goes through ME-09's triage, which sorts it into use, use with caution, or discard by form and appearance

(THRIVING library, ME-09). Expired stock is moved to a separate, labelled shelf so that it is never mistaken for in-date stock.

9. Theft, hoarding, keys and children

Attractive items. MSH lists antibiotics, psychotropics, scissors, razors, needles and cotton as items that walk. They should be locked and their issues audited against registers (MSH 2012). After the Fall, the list grows to include anything with exchange value: analgesics, antibiotics, ketamine, morphine, diazepam, alcohol and gloves.

Keys. MSH says one or two trustworthy people should hold the keys, with one set kept on the premises (MSH 2012). For controlled drugs, the standard is a safe or double-locked cabinet, with a register signed by two people, a physical count after each entry and signatures at each handover. Some stores add a light that comes on when the cabinet is opened (MSH 2012). The ship adds an inner cupboard that the outer key cannot open (MCA, MSN 1905 Amendment 5). The brief's pitfall is a locked cupboard with no rule for the key. The village must decide who holds the key, who holds the second key, what happens when the keeper is ill or dies, and who may open the reserve [OWNER]. GOVERNING owns the sanctions for theft and hoarding, and OR-08 the poisons cupboard.

Hoarding. Hoarding has two faces. A household that keeps antibiotics "just in case" takes them out of the common stock and is likely to use them badly (THRIVING library, IN-05). But a single central store is a single target, and a fire, flood or theft takes everything. The answer from the record is distribution with accounting: the sealed reserve split between two or three places known to the council, each with its own count [OWNER].

Children. Iron tablets, often sugar-coated, are the classic paediatric poisoning. After the US required unit-dose packaging for iron supplements in 1997, reported iron ingestions fell from 2.99 to 1.91 per 1,000 calls and child deaths from iron fell from 29 to 1 (Tenenbein 2005). Child-resistant packaging for oral prescription drugs lowered child deaths by about 1.4 per million children under five per year, about 460 deaths averted from 1974 to 1992 (Rodgers 1996). In rural Sri Lanka, unsafe storage of household poisons was one of eight independent risk factors for poisoning in children aged one to five (Dayasiri 2017). The village list includes 2,400 iron-folate tablets a year. They must be locked, issued in small numbers and kept in their blister.

Evidence grades

A: systematic review or large dataset. B: controlled study. C: field or observational study. D: guidance, manual or expert consensus. X: claim without support or contradicted.

Claim	Grade	Basis
Most solid oral drugs keep potency years past expiry if sealed and cool	A	Lyon 2006, 3,005 lots
Oxytocin loses 3 to 7% a year at 21 to 25°C and 9 to 19% at 30°C	A	Torloni 2016
Unopened insulin keeps 6 months at 25°C and 2 months at 37°C	A	Richter 2023
Insulin keeps 12 weeks under a 25 to 37°C daily cycle	B	Kaufmann 2021, one home
Ergometrine is the least stable essential injectable	C	Nazerali 1998, Hogerzeil 1996
Seven of 27 drugs lose over 10% in two tropical years	C	Ballereau 1997
Clay pots cool 2.7 to 8.3°C in dry heat	B	Ogle 2016

Claim	Grade	Basis
Clay pots cool under 2°C above 70% humidity	C	Verploegen 2018
A cellar cannot go below the local mean annual temperature	D	Soil physics texts, [VERIFY]
Unit-dose iron packaging cut child deaths	C	Tenenbein 2005, before and after
About 35% of medicines leak between store and clinic	C	Jablonski, Malawi
The IEHK quantities reflect measured need	X	No morbidity table published
Amber glass protects herbs in long storage	X	No trial found (ME-04)
Scaling factor 1.2 gives a year's village need	D	Linear inference, [VERIFY]

Means ledger

Level	What it can do for the stockpile	What it cannot do
Hands	Sort, read labels, count, write the card, lock and hold a key, keep children away	Judge potency without a sign
Hearth	Boil cloth, regenerate silica gel, dry herbs, make ORS fluid, make soap	Keep anything cold
Garden and still	Grow and dry plant stock, distil ethanol, make tinctures above 25%	Replace antibiotics, oxytocin or insulin
Village dispensary	Shelf, stock cards, locked cabinet with inner lock, sealed reserve, cellar or pot for vials, twice-daily thermometer reading	Test potency, hold 2 to 8°C in a warm climate
District infirmary	Ice store or passive cold box for oxytocin and insulin, annual independent stock count, controlled drug register, sorting of salvage	Assay, make new medicines in quantity
Hospital before the Fall	Refrigerator, pharmacy software, lot testing for extension, suppliers, destruction of expired stock	Nothing that matters after the Fall unless it survives

Harm test

Oxytocin and insulin killed by heat. A midwife gives a full dose of weak oxytocin and believes the bleeding should stop. Torloni's figure of 45.6% failing worldwide means this is the expected case, not a rare one. Mitigation: keep oxytocin in the coldest place, date its arrival in the store, use oldest first, and hold misoprostol in intact blisters as the second line (THRIVING library, MA-02). For insulin, a district holds it and logs the temperature. A dose that does not work is a sign, not a reason to double it blindly [VERIFY clinical guidance with ME-09].

Mislabelled poisons. A decanted jar of lye, methanol, mercury salts or a concentrated veterinary drug is mistaken for a medicine. ME-04 records deaths from unlabelled containers (THRIVING library, ME-04). Mitigation: never decant into food or drink containers, label every container at filling with name, strength and date, keep poisons on a separate locked shelf, and never store them with medicines. OR-08 owns the full rules.

Children at the shelf. Iron, paracetamol, opioids and camphor or methyl salicylate oils kill small children in small amounts. Mitigation: the household box is locked and high, blisters are kept, and the dispensary never issues more than a course.

Degraded tetracycline. Old, degraded tetracycline caused a reversible Fanconi syndrome in the 1960s (Frimpter 1963, via THRIVING library, IN-05). The tablets may look darkened. Mitigation: tetracycline tablets that are brown, sticky or past expiry and not kept cool are discarded. Doxycycline is the preferred tetracycline for the reserve [VERIFY whether doxycycline degrades to the same products].

Theft and hoarding. The Malawi figure suggests a third of a store can leave without anyone noticing if no one counts. Mitigation: small shelf, sealed reserve, monthly second-person count, annual independent count, distributed reserve [OWNER].

False security from the stockpile itself. A full store invites a belief that the village is provided for. Bosnia's donations show that half of a large stock can be useless. Mitigation: sort first, count what is usable, and plan from that.

Net judgement. A small, sealed, counted stockpile does far more good than harm. A large, open, uncounted one may do more harm than good, through poisoning, wasted fragile drugs and conflict over theft.

Red flags

- Ergometrine of any colour other than clear.
- Insulin that is clumped or frosted, NPH that will not resuspend, or soluble insulin that is cloudy.
- Tablets that are soft, swollen, spotted, crumbling or stuck together, aspirin that smells of vinegar, capsules that are stuck or brittle.
- Creams that have separated, and suppositories that have melted and re-set.
- Misoprostol blisters that are torn or punctured.
- A vaccine or toxoid vial that has been frozen.
- Herb jars that smell musty, show webbing, or have small round holes in leaves or roots.
- A store thermometer over 30°C on two readings in a week.
- A count that is wrong twice running, a keeper who resists a second counter, or rising issue of attractive items without a matching rise in illness.
- Any unlabelled container in the dispensary.

The case against

Instability is rare, so storage effort is wasted. Nazerali and Hogerzeil concluded that serious instability was confined to ergometrine and that downstream quality checks were unnecessary even in the tropics, the real problem being poor initial quality (Nazerali 1998). If they are right, the village should spend its effort sorting salvage, not building cellars. My reply is that their study ran two years with resupply. A ten-year reserve faces cumulative heat they did not test, and the fragile items, oxytocin and insulin, are the ones that save lives.

Expiry extension cannot be done in the village. Lyon and colleagues stress that extension depends on testing each lot (Lyon 2006). The FDA programme exists because no rule of thumb is safe. A village that keeps tablets for a decade is gambling. My reply is that the alternative is having nothing, and ME-09's triage limits the gamble.

Kits are a supply-chain artefact, not a health system. Cullen, Taithe and Winters describe the emergency kit as standards built by logistics (THRIVING library, FO-11). Copying it imports its assumptions. I agree, which is why this report treats it as a template and corrects it.

Donations show that more is worse. Berckmans and colleagues show that half of a large stock was useless (Berckmans 1997). A village that salvages everything will drown in junk. The reply is to sort ruthlessly and to set maximum, not minimum, quantities.

The clay pot is oversold. Ogle and colleagues found most devices delivered well under the theoretical maximum, and Verploegen found barely two degrees in humid air (Ogle 2016, Verploegen 2018). The pot is not a refrigerator. I agree and say so above.

Central control breeds conflict. Any locked store held by a few can become a source of power. GOVERNING owns this debate.

10-line summary

1. The IEHK is the only costed template, but it assumes resupply, a cold chain and a three-month horizon.
2. Scaling by 1.2 from the basic module gives a year's shelf for 300 of about 140 kg and under a cubic metre [VERIFY].
3. The kit overstocks antibiotics and understocks obstetric drugs for a settled village.
4. Fixed floors, as on ships, suit rare lethal events better than per-head figures.
5. Most tablets keep for years if sealed, dry and below 25°C.
6. Ergometrine, oxytocin, insulin and loose misoprostol die first.
7. A clay pot cools 5 to 8°C in dry heat and under 2°C in humid air, and its inside is too wet for tablets.
8. A cellar holds the local mean annual temperature and no colder.
9. Keep a small shelf, a sealed reserve, monthly counts by a second person and an annual independent count.
10. Lock iron, opioids and poisons. Children and theft cause more harm than heat.

Open questions

- What do the 2024 IEHK lists change item by item, and do they include a morbidity basis?
- How fast does oxytocin lose strength at a cellar's 10 to 15°C, between the measured 4 to 8°C and 21 to 25°C?
- Does salvaged silica gel, rice or quicklime keep a sealed jar below 65% relative humidity in a damp cellar?
- What are measured temperatures in spring houses and cellars across a year in Europe and the tropics?
- How much medicine leaks from community stores where the community holds the key, as opposed to staff?
- Which degradation products of doxycycline, if any, are toxic?
- How many gloves, dressings and syringes does a primary care post actually use per consultation?

Sources to read in full

1. Hogerzeil, Walker and de Goeje 1993, WHO/DAP/93.6, on oxytocic stability. The download was blocked.
2. The UNICEF 2024 IEHK list with item quantities.
3. Ballereau 1997, for item-by-item losses.
4. Berckmans 1997, for the categories of inappropriate donation.
5. WHO 2009 stability testing guideline, for zone IVb conditions.
6. Ogle 2016 in full, for device designs and the methods of measurement.
7. The MCA's full Annex 1 tables, for all Category A quantities.
8. Any measured record of cellar temperature through a year.

At the bedside after the Fall

Household. To start: a lockable box kept high, holding the ten-item shelf in Protocol 1, and a card listing what is in it and the doses. The first failure to expect is a child reaching the box or an adult using the paracetamol as a cure-all. The second is decanting tablets into an unlabelled jar.

Village of 300. To start: one dry, dark, lockable room or cupboard, shelves off the floor and walls, a lockable inner cabinet for controlled drugs, tins and glass jars with lids, a desiccant, a thermometer, a stock card for each item, and a cellar or pot for vials. One keeper and one second counter [OWNER]. The first failure to expect is that the shelf is filled with the whole salvage at once, so that nothing is counted and the best stock is exposed. The second is that oxytocin sits in the warm room.

District of 3,000. To start: the village set-up, plus an ice store or passive cold box for oxytocin and insulin, a controlled-drug register signed by two people, a sorting table for salvage with ME-09's triage, and someone to count each village's store once a year. The first failure to expect is the cold store failing in the hot season without anyone noticing, because no one reads the thermometer. The second is that the district store becomes the prize in a dispute.

Protocols

Protocol 1. The three lists

All quantities are for one year, scaled from IEHK 2017 and corrected as in section 2 [VERIFY, my arithmetic]. Quantities marked [OWNER] are the village's choice.

Household ten-item shelf (one per household of about six)

Item	Quantity	Rule
Bar soap	4 bars	Village-made after year one
ORS sachets, with a recipe card and a one-litre measure	6 sachets	Home recipe after year one
Paracetamol 500 mg	20 tablets in blister	In the locked box
Clean cotton cloths, boiled and dried	10	In a sealed jar or tin (WO-12)
Roller bandages	2	In the tin
Povidone-iodine 10%, small bottle, or salt for boiled saline	1	Dark
Tweezers, scissors and a needle	1 set	Boil before use
Thermometer	1 if available	Read at fevers
Lockable box kept high	1	Key held by an adult
Card listing contents, doses and the dispensary keeper	1	Renewed each year

No antibiotics, iron or controlled drugs in the household [OWNER].

Village of 300: Table 1, with these changes. Misoprostol about 40 tablets in blisters. Examination gloves 2,000 to 5,000 [VERIFY]. Fixed floors of 10 adrenaline 1 mg, 10 ceftriaxone 1 g, 5 tranexamic acid injections, 4 naloxone and 10 magnesium sulfate [OWNER]. Controlled drugs at stock level only: ketamine 3 vials, morphine 6 injections and 24 tablets, diazepam 24 injections. Instruments: two dressing sets, two pairs of scissors, a kidney dish, two sterilising drums, five thermometers. Plant stock to ME-04's rules, about 20 one-litre jars [OWNER]. Chemicals: NaDCC 144 tablets for clinic use, ethanol 70% 5 litres [VERIFY], benzyl benzoate 1.2 litres, chlorhexidine 1.2 litres, all in the chemical store apart from medicines.

District of 3,000: ten times the village figures, plus the supplementary module scaled by 1.2. For example oxytocin 240 ampoules, misoprostol about 400 tablets, ceftriaxone 960 vials, ketamine 30 vials, morphine 60 injections and 240 tablets, diazepam 240 injections, Ringer's lactate 240 bags, insulin NPH and soluble about 20 vials each, sterile gloves 300 pairs. All controlled drugs at stock level only.

Protocol 2. The store

1. Dry, dark, ventilated room, aiming below 25°C and never above 30°C.
2. Shelves off the floor and away from walls. No stock on the floor.
3. Read a thermometer at the hottest time each day and once at dawn. Write both in the ledger.
4. Everything in its original pack. Loose items in sealed tins or jars with a desiccant.
5. Dressings and cotton in tins against rodents.
6. Chemicals and flammables in a separate store. Corrosives apart from flammables (MSH 2012).
7. Expired stock on its own labelled shelf, awaiting triage.

Protocol 3. Shelf and reserve

1. The open shelf holds three months of each item, set by last year's consumption.
2. Everything else is in the sealed reserve, split between two or three places known to the council [OWNER].
3. Each quarter, the keeper and the second counter draw from the reserve to bring the shelf to three months, oldest stock first.
4. The reserve is opened only on that day, or in an emergency recorded in the ledger.

Protocol 4. The count

1. The keeper updates the stock card at each issue.
2. The second counter counts the shelf against the cards on the first day of each month. Both sign.
3. Any difference over 5% for an attractive item, or any difference in controlled drugs, goes to the council the same week [OWNER].
4. Once a year, someone who is not the keeper counts shelf and reserve.
5. Controlled drugs are counted after each issue and at each handover of the key.

Protocol 5. Cooling pot for vials

1. Use only in dry heat, with outside air below about 50% humidity.
2. Put vials in a sealed glass jar inside the inner pot. Never tablets, paper or dressings.
3. Keep the pot in shade with air moving past it.
4. Wet the sand or outer pot every morning and evening. Name the person responsible.
5. Keep a thermometer inside. If it reads more than 5°C below the shade temperature, the pot is working. If not, move the vials to the cellar.

Protocol 6. Cellar or spring box

1. At least two metres deep for the seasonal swing, and below the frost line.
2. Vials in sealed glass jars. A spring box holds them in the flowing water, with the lids above the surface.
3. Never let toxoid freeze.
4. Check monthly for damp, mould and rodents.

Protocol 7. Keys

1. The keeper holds the cabinet key. A second named person holds the inner controlled-drug key [OWNER].

2. A sealed spare set is kept by the council [OWNER].
3. Handover is with a count and two signatures.
4. If the keeper is absent, the second person and a council member open the store together.

Protocol 8. Rotation

1. FEFO at every issue.
2. Items past expiry go through ME-09's triage, never straight to use or to the rubbish.
3. Fragile items (oxytocin, insulin, ergometrine, misoprostol from damaged blisters) are not kept past one hot season out of cold storage.
4. Plant stock is renewed each harvest. Jars older than two years are discarded or composted (ME-04).

Numbers to carry

1. **1.2**: the factor from one IEHK basic module to 300 people for a year.
2. **140 kg**: about one year's working stock for 300 people [VERIFY].
3. **25°C**: below it most stock keeps for years. **30°C**: never above it.
4. **6 months at 25°C, 2 months at 37°C**: unopened insulin.
5. **3 to 7% a year at 21 to 25°C, 9 to 19% at 30°C**: oxytocin loss.
6. **6.7°C and 1.8°C**: a clay pot's cooling in dry and in humid air.
7. **2 metres**: cellar depth to cut the seasonal swing to a third.
8. **35%**: medicines lost between store and clinic in Malawi.
9. **29 to 1**: US child iron deaths before and after unit-dose packaging.
10. **3 months**: the most the open shelf should hold.

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