# HY-01 Clean hands: Semmelweis, Nightingale and the quantified effect of handwashing and soap

HEALING after the FALL, research library, HY-01

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

## Scope and method

This report gathers the evidence for cleaning the hands at the right moments: the historical record (Gordon, Holmes, Semmelweis, Nightingale, Lister), the community trials and reviews, the hospital literature, and the laboratory and field data on soap, water, ash, soil, sand, alcohol rub and chlorine. Every figure comes from a source in the References, read online on 10 October 2026, most modern trials as abstracts only. Figures that are my own arithmetic, or that I could not confirm, carry [VERIFY]. Three cautions run through it. Trial effects are smaller than observational claims. Trials measured the promotion of handwashing, not washing itself. And compliance, not knowledge, limits the benefit everywhere.

## 1. The historical record

### 1.1 Alexander Gordon, Aberdeen, 1789 to 1792

The first clear argument that childbed fever is carried from woman to woman by the birth attendant came from Alexander Gordon, a naval surgeon practising in Aberdeen, Scotland. His Treatise on the Epidemic Puerperal Fever of Aberdeen (London, 1795) described an epidemic from December 1789 to March 1792. Secondary summaries report that he treated 77 women and lost 28, though one later account gives 25 deaths, a discrepancy I could not resolve (Wikipedia, Alexander Gordon, secondary summary only) [VERIFY]. Gordon traced each case to the attending midwife or doctor, himself included, and recommended fumigating clothing, burning bed linen and cleanliness of the attendants. His treatment, heavy bleeding and purging, was wrong, and his prevention was right. He was largely ignored.

### 1.2 Oliver Wendell Holmes, Boston, 1843

Oliver Wendell Holmes read The Contagiousness of Puerperal Fever to the Boston Society for Medical Improvement and published it in 1843 (Holmes 1843). He collected clusters of cases tied to single practitioners. Dr Peirson of Salem had five consecutive cases in the first nineteen days of January 1829, three of the first cases fatal. Dr Rutter of Philadelphia had about seventy cases within a year. One correspondent washed his hands in chloride of lime after each visit.

Holmes ended with eight conclusions that remain usable almost as written. A man who delivers babies should take no active part in post-mortems on women dead of puerperal fever. If he does, he should wash thoroughly, change every article of clothing and let twenty-four hours or more pass before attending a birth. The same applies after erysipelas, the spreading skin infection. After one case in his practice he should treat the next labouring woman as at risk from

him. After two close cases he should give up obstetrics for at least a month. Three or more closely connected cases are prima facie evidence that he is the carrier. A private pestilence in one physician's practice should be regarded "not as a misfortune, but a crime" (Holmes 1843). The essay changed little in its day, and Holmes reissued it in 1855.

### 1.3 Ignaz Semmelweis, Vienna, 1846 to 1849

The Vienna General Hospital had two obstetric clinics. Medical students and doctors, who also performed autopsies, worked in the First Clinic, and pupil midwives, who did not, in the Second. Women were admitted on alternate days, which made the comparison close to a natural experiment. From 1840 to 1846 maternal mortality was 98.4 per 1,000 births in the First Clinic and 36.2 per 1,000 in the Second (Loudon 2013). In 1846 the First Clinic recorded 459 deaths in 4,010 births (11.4 per cent) and the Second 105 in 3,754 (2.8 per cent) (Wikipedia, Historical mortality rates, from Carter's 1983 translation of Semmelweis 1861).

In 1847 Semmelweis's colleague Jakob Kolletschka died of a fever resembling childbed fever after he was cut by a student's scalpel during a post-mortem examination (Wikipedia, Ignaz Semmelweis). Semmelweis concluded that "cadaverous particles" carried on the students' hands caused the disease, and in mid-May 1847 he required everyone entering the First Clinic to wash in a chlorine solution, described as chlorinated lime or chloride of lime (Loudon 2013). He chose chlorine because it removed the smell of the dissecting room. I could not confirm the strength of the solution, nor the claim that he first used liquid chlorine and then switched to cheaper chlorinated lime [VERIFY].

The First Clinic's monthly figures show the turn (Wikipedia, Historical mortality rates).

| Month | Births | Deaths | Mortality |
|---|---|---|---|
| April 1847 | 312 | 57 | 18.3% |
| May 1847 (washing from mid-month) | 294 | 36 | 12.2% |
| June 1847 | 268 | 6 | 2.2% |
| July 1847 | 250 | 3 | 1.2% |
| August 1847 | 264 | 5 | 1.9% |
| September 1847 | 262 | 12 | 4.6% |
| October 1847 | 278 | 11 | 4.0% |
| November 1847 | 246 | 11 | 4.5% |
| December 1847 | 273 | 8 | 2.9% |
| January 1848 (stricter control of students) | 283 | 10 | 3.5% |
| March 1848 | 276 | 0 | 0.0% |
| August 1848 | 261 | 0 | 0.0% |
| March 1849 (Semmelweis's post ends) | 406 | 20 | 4.9% |

For 1848 as a whole the First Clinic lost 45 women in 3,556 births (1.27 per cent), against 43 in 3,319 (1.3 per cent) in the midwives' clinic. The often-quoted "18 per cent to under 2 per cent" sets a monthly figure (April 1847) against an annual one (1848). A 2024 review in Cureus wrongly gives 18.27 per cent as the annual rate for 1847 (Paul and others 2024), which was in fact 5.0 per cent (176 deaths in 3,490 births), because washing began in May. The fair comparison is 11.4 per cent in 1846 against 1.27 per cent in 1848, a relative fall of about 89 per cent, or roughly one mother saved for every ten deliveries [VERIFY: my arithmetic, assuming the whole fall was due to washing].

Three features matter for the book. The fall came within weeks, the signature of an intervention rather than a trend. The rate crept back to 4 to 4.6 per cent from September to November 1847 as discipline slipped, until Semmelweis tightened control of students in January 1848. And the gain did not last: the First Clinic averaged 35.7 per 1,000 over 1848 to 1859 (Loudon 2013). A rule that depends on one zealous man fails when he goes. The record also holds

an awkward fact. January to March 1847, before any washing, show rates of 3.2, 1.9 and 3.6 per cent. Childbed fever came in waves, and none of my sources explain that trough.

Why was he rejected? His theory implied that doctors killed their patients. His chief, Johann Klein, credited a new ventilation system, in line with miasma theory, and did not renew his post in 1849 (Wikipedia, Ignaz Semmelweis). Rudolf Virchow and Friedrich Scanzoni rejected the doctrine, and Carl Levy of Copenhagen thought a single cadaveric cause implausible. Semmelweis waited thirteen years to publish, and his 1861 book was long, muddled and abusive in places. Loudon (2013) describes him as complex, difficult and dogmatic. He died on 13 August 1865 in an asylum at Döbling, of a septic wound of the hand. Loudon also warns against the myth. Gordon and Holmes preceded him, he did not abolish the disease, and antisepsis entered obstetrics in the 1880s through Lister and bacteriology, not through him. His numbers nonetheless remain the clearest early demonstration that clean hands save mothers.

### 1.4 Florence Nightingale, Scutari and the lying-in wards

The claim that Nightingale cut the Scutari death rate from 42 to 2 per cent by hygiene is a later legend. The 42.7 per cent figure is the death rate among cases treated in February 1855, the worst month (McDonald 2016). Nightingale had arrived in November 1854. The fall followed the Sanitary Commission under Dr John Sutherland, which began work in March 1855, flushed the sewers, improved ventilation and removed 202 cartloads of filth in its first week. Over June 1854 to June 1856 the Scutari hospitals together recorded 11.9 per cent deaths over admissions, Koulali 25.9 per cent and Brunel's prefabricated hospital at Renkioi 3.8 per cent (McDonald 2016). Hugh Small (1998) argued that Nightingale did not grasp sanitation until after the war. McDonald disputes much of his case but accepts that she was not a sanitarian before Crimea (McDonald 2016, New York Review of Books exchange 2001). Some commentators say she strengthened handwashing at Scutari (Martini and Lippi 2021), but McDonald's statistical history does not mention it. The book should credit drains, crowding, water and filth, not hands, for the Scutari figures.

Her direct contribution is in her writing. Notes on Nursing tells every nurse to wash her hands very frequently during the day (Nightingale 1860). Her Introductory Notes on Lying-in Institutions (1871), rarely cited, matters more here. She collected returns for 888,312 institutional deliveries across Europe, with 30,394 deaths, 34 per 1,000, against the Registrar-General's 5.1 per 1,000 for English women delivered at home. The midwifery ward her own Fund set up at King's College Hospital in 1862 lost 26 of 780 women before it was closed. She reproduced the Vienna figures and saw a bad influence on the students' side, but did not name the hands or Semmelweis (Nightingale 1871). Her prescription was small wards, short stays, lime-washing and the separation of midwifery from general hospitals.

The lesson for a district of 3,000 is exact. A nineteenth-century lying-in ward killed women at six to seven times the rate of home births [VERIFY: my ratio from 34 and 5.1 per 1,000]. An infirmary that offers births must earn its safety through hand discipline or it will repeat that record.

### 1.5 Lister, Glasgow, 1867

Joseph Lister's carbolic acid system for wounds, dressings, instruments and hands is usually reported as cutting amputation deaths in his Glasgow wards from 16 of 35 (about 46 per cent) in 1864 to 1866 to 6 of 40 (15 per cent) in 1867 to 1870 (Royal College of Surgeons of England library blog, secondary summary only) [VERIFY against Lister 1870]. This is wound antisepsis as a package, treated in HY-05 and WO-12, but it shows the size of effect cleanliness had on wound fever before antibiotics.

### 1.6 What the old record shows

Western maternal death rates stayed on a high plateau from the mid-nineteenth century until about 1937, then fell within decades to between one-fortieth and one-fiftieth of earlier levels, after sulphonamides, penicillin, transfusion and better obstetric care (Loudon 2000, abstract). Loudon argued that the main determinant before then was the

standard of care given by the birth attendant. Clean hands were part of that standard but never removed puerperal sepsis. After the Fall the reader returns to the plateau, and clean hands are the main lever left.

## 2. The modern trials: diarrhoea and pneumonia in children

### 2.1 Karachi, 2002 to 2003

Stephen Luby and colleagues randomised 36 neighbourhoods in squatter settlements of Karachi, Pakistan: 25 to handwashing promotion and 11 (306 households) to control. In promotion areas 300 households received plain soap and 300 antibacterial soap with 1.2 per cent triclocarban (Luby and others 2004, 2005). Fieldworkers visited weekly for a year. They taught people to wet the hands, lather and rub for 45 seconds, and to wash after defecation and after cleaning an infant, and before preparing food, eating and feeding an infant. Households used a mean 3.3 bars of 90 grams a week, which the authors convert to 4.4 grams of soap per person per day (Luby and others 2004).

Diarrhoea in children under 15 fell from 4.06 to 1.91 episodes per 100 person-weeks, a 53 per cent reduction (95 per cent confidence interval 41 to 65 per cent), and healer visits for diarrhoea by 56 per cent. The difference appeared only after the first 8 weeks (Luby and others 2004). Pneumonia in children under 5 fell by 50 per cent (34 to 65 per cent) and impetigo by 34 per cent (Luby and others 2005, abstract). A secondary summary gives pneumonia as 4.40 per 100 person-weeks in controls against 2.20 with plain soap (Scientific American) [VERIFY]. Antibacterial soap added nothing. Seven children died, three with diarrhoea, far too few to measure an effect on deaths. Five years later 97 per cent of intervention households had soap at the washing place, against 28 per cent of controls (Bowen and others 2013).

Weaknesses: mothers who knew their group reported the outcomes, the soap maker (Procter and Gamble) funded the trial and employed one author, and weekly visits for a year cannot be reproduced at scale (Luby and others 2004).

### 2.2 The systematic reviews

| Review | Scope | Result |
|---|---|---|
| Curtis and Cairncross 2003 | 17 studies | Not washing hands RR 1.88, implying 42 to 47 per cent less diarrhoea with washing. Shigellosis 59 per cent less. Authors warn of poor quality and publication bias. |
| Aiello and others 2008 | 30 community studies | Gastrointestinal illness down 31 per cent (19 to 42), respiratory illness down 21 per cent (5 to 34). Antibacterial soap no better than plain. |
| Rabie and Curtis 2006 | 8 intervention studies, none in poorer countries | Respiratory infection down 16 per cent (11 to 21). |
| Freeman and others 2014 | Meta-regression | Diarrhoea RR 0.60, but 0.77 (0.32 to 1.86) after adjusting for unblinded studies. |

| Review | Scope | Result |
|---|---|---|
| Ejemot-Nwadiaro and others 2021 (Cochrane) | 29 RCTs | Day-care and schools in rich countries IRR 0.70 (0.58 to 0.85), high certainty. Communities in poorer countries IRR 0.71 (0.62 to 0.81), moderate certainty. Soap provided RR 0.66 (0.58 to 0.75), education alone RR 0.84 (0.67 to 1.05). No trial measured deaths. |
| Wolf and others 2022 | Meta-analysis | Handwashing promotion RR 0.70 (0.64 to 0.76) for child diarrhoea. |

The convergent figure is about 30 per cent less diarrhoea from promoting handwashing with soap, and 16 to 21 per cent less respiratory infection. Karachi sits at the top of the range. The Cochrane finding that education alone did not reach significance, while education with free soap did, matters after the Fall: telling people is not enough, they must have soap in their hands.

### 2.3 The disappointing trials: WASH Benefits and SHINE

Three large trials published in 2018 and 2019 tested water treatment, sanitation and handwashing, alone and together, against diarrhoea and stunting.

WASH Benefits Bangladesh enrolled 5,551 pregnant women in 720 clusters (Luby and others 2018). Seven-day diarrhoea prevalence was 5.7 per cent in controls, and handwashing alone reduced it (prevalence ratio 0.60, 0.45 to 0.80). Sanitation and nutrition did about as well, combining water, sanitation and handwashing added nothing (0.69), and water chlorination alone failed (0.89). Adherence was high. WASH Benefits Kenya enrolled 8,246 women (Null and others 2018). No intervention reduced diarrhoea, and handwashing adherence fell from above 70 per cent in year one to below 25 per cent in year two. SHINE in Zimbabwe randomised 211 clusters and gave households a ventilated improved pit latrine, two handwashing stations, liquid soap, chlorine and a play space (Humphrey and others 2019). The hygiene package reduced neither diarrhoea nor stunting.

An expert panel judged the trials internally valid, concluded that these basic interventions had no effect on growth and mixed effects on diarrhoea, and called for more transformative hygiene (Cumming and others 2019). The likely reasons are decaying adherence, exposure to animal and neighbours' faeces that one household's hands cannot block, and noisy caregiver-reported outcomes. In the Kenya trial, goat or sheep ownership went with more E. coli in stored drinking water, a reminder that animals are a route hands do not block (Swarthout and others 2024).

The book's reading: where adherence held, handwashing alone cut diarrhoea by 40 per cent. Where it collapsed, nothing worked. The trials show that a programme which does not sustain the habit fails, and that hands are one route among several.

### 2.4 Water alone and the timing of washes

In rural Bangladesh, Luby and colleagues observed 347 households and followed diarrhoea in children under 5 for two years (Luby and others 2011, observational). Compared with households where the food preparer did not wash, washing both hands with water alone was associated with less child diarrhoea (odds ratio 0.67, 0.51 to 0.89) and washing at least one hand with soap with much less (0.30, 0.19 to 0.47). Washing with soap after defecation was also protective (0.45). Washing before feeding a child or eating showed no significant association in that study. The authors concluded that washing before preparing food is a particularly important moment and that water alone is better than nothing.

## 3. Childbed fever, the newborn and wounds

### 3.1 Birth attendants and newborn deaths

In Sarlahi District, Nepal, 23,662 newborns enrolled in a chlorhexidine trial were followed for 28 days (Rhee and others 2008, observational). Birth attendant handwashing with soap before delivery was associated with 19 per cent lower neonatal mortality (adjusted RR 0.81, 0.66 to 0.99), maternal handwashing before handling the baby with 44 per cent lower (0.56, 0.38 to 0.82), and both with 41 per cent lower (0.59, 0.37 to 0.94). A review for the Lives Saved Tool found low-quality evidence that birth attendant handwashing reduces all-cause neonatal mortality by 19 per cent, cord infection by 30 per cent and neonatal tetanus by 49 per cent (Blencowe and others 2011). Thirty experts estimated that clean birth practices at home cut neonatal sepsis deaths by 15 per cent and clean postnatal care by 40 per cent.

Sepsis causes 10.7 per cent of maternal deaths worldwide (Say and others 2014). I found no randomised trial of handwashing against maternal sepsis, and none would be ethical now. The evidence for childbed fever is the Vienna record, the clusters of Gordon and Holmes, Nightingale's institutional figures, and the plausibility that microbiology now provides.

### 3.2 Hospitals and wound infection

The Geneva programme led by Didier Pittet is the landmark (Pittet and others 2000). From 1994 to 1997, across more than 20,000 observed opportunities, compliance rose from 48 to 66 per cent, driven by bedside alcohol rub containing chlorhexidine and emollients, whose use rose from 3.5 to 15.4 litres per 1,000 patient-days. Hospital-acquired infection fell from 16.9 to 9.9 per cent and MRSA transmission from 2.16 to 0.93 per 10,000 patient-days. Doctors improved least. It was an uncontrolled before-and-after study in one hospital.

Wider evidence is weaker. Across 96 studies, median compliance was 40 per cent, 32 per cent among doctors and 48 among nurses, and only 21 per cent before patient contact against 47 after (Erasmus and others 2010). Dispensers within sight of an auditor were used about three times as often as those out of sight (Srigley and others 2014). The Cochrane review of 26 studies found only low-certainty evidence that multimodal programmes improve compliance or infection (Gould and others 2017). In poorer countries, hospital-acquired infection affected 15.5 per 100 patients and surgical site infection 5.6 per 100 operations (Allegranzi and others 2011).

For surgery, no method of hand antisepsis beat another: soap and water against alcohol rub with hydrogen peroxide gave a risk ratio of 0.97 (0.77 to 1.23) for wound infection in 3,317 patients (Tanner and others 2016). No one has tested no preparation. For the village, the surgeon's hands should be scrubbed with soap and water every time, and the choice of antiseptic matters much less.

## 4. Soap, water, ash, soil, sand, alcohol and chlorine compared

### 4.1 The benchmark

WHO's 2025 community guidelines define effective hand hygiene as a reduction of more than 2 log, or 99 per cent, in organisms on the hands (WHO and UNICEF 2025). The review commissioned for those guidelines pooled 177 studies (Hilton and others 2025).

| Method | Bacteria (log reduction) | Viruses (log reduction) | Notes |
|---|---|---|---|
| Soap and water, all | 2.48 (32 studies) | 2.03 | Plain soap 2.34 for bacteria |
| Soap and water, 10 to 20 seconds | 2.19 | not pooled | |

| Method | Bacteria (log reduction) | Viruses (log reduction) | Notes |
|---|---|---|---|
| Soap and water, 30 seconds or more | 2.49 | not pooled | Duration made little difference |
| Water alone | 1.54 (lab, 8 studies) | 1.55 | WHO quotes 1.16 |
| Alcohol handrub | 3.13 | 1.86 | Only 1.10 for non-enveloped viruses |
| Non-alcohol antiseptics | 2.54 | 1.91 | Chlorhexidine, chlorine, iodine |
| Field studies of soap | 0.44 | | Real-world washing is far less thorough |

The last row matters most. In the laboratory people wash as instructed. In the field, washes are brief, partial and dried on clothing.

### 4.2 Soap against plain water

Twenty volunteers who contaminated their hands on door handles and railings in public spaces carried bacteria of potential faecal origin on 44 per cent of samples after no washing, 23 per cent after washing with water and 8 per cent after plain soap (Burton and others 2011). Antibacterial soap adds nothing in trials (Luby and others 2004, Aiello and others 2008), and WHO advises against it because triclosan and triclocarban may harm health and the environment (WHO and UNICEF 2025). Soap works mainly by lifting dirt, fat and organisms off the skin to be rinsed away.

### 4.3 Ash, soil and sand

The traditional substitutes have a good laboratory record and a poor evidence base for health outcomes.

- In a Dhaka slum, 20 women washed with ash, soap, mud and plain water in turn. Mud and ash removed faecal coliforms as well as soap (Hoque and Briend 1991).
- In Bangladesh, traditional washing after defecation left geometric means of 1,995 faecal coliforms on the left hand and 1,318 on the right. Seventy-five per cent of the women said they could not afford soap. Under the same washing conditions, left-hand counts were 195 with soap, 98 with ash and 129 with soil (Hoque and others 1995b). Most women rubbed their hands on the ground or used soil, and the authors concluded that washing both hands, rubbing, and the amount and quality of rinse water mattered more than the agent (Hoque and others 1995a, Hoque 2003).
- Among 440 caregivers in East Dembiya, northwest Ethiopia, a closed palmful of wood ash reduced E. coli on hands by 1.65 log more than water alone, though two-thirds of hands still grew E. coli (Gizaw and others 2022).
- With model viruses, 20 seconds of ash, sand, soap or water all exceeded 2 log. At 5 seconds soap (2.7 to 4.8 log) beat ash (2.0 to 2.8) and sand (1.8 to 2.7) (Zambrana and others 2023).
- A Cochrane rapid review found 14 studies, one randomised, and judged the benefits and harms of ash against soap uncertain (Paludan-Müller and others 2020).

Wood ash filtrate is alkaline, pH 10.7 falling to 8.2 on dilution, with pH-dependent antibacterial activity (Shithi and others 2024). The risks are contamination (soil carries helminth eggs, and stored ash becomes dirty), ash from dung, coal or rubbish, and possible metals and pesticides (Bloomfield and Nath 2009, summary only). WHO does not recommend ash, soil or sand except as a last resort in emergencies (WHO and UNICEF 2025). After the Fall that last resort may be daily. The book should teach clean wood ash, fresh from the hearth, as the second-best agent, and should not teach soil or mud.

### 4.4 Alcohol handrub

Alcohol rub at 60 per cent or more kills most bacteria and enveloped viruses faster than soap removes them, and in hospitals it raised compliance because it is quick and at the bedside (Pittet and others 2000, WHO 2009). It has three gaps. It does not remove dirt or blood. It does not kill spores: alcohol rubs removed only 0.11 to 0.37 log more Clostridioides difficile spores than water, chlorhexidine soap 0.89 log, and a handshake afterwards passed on 30 per cent of the remaining spores (Jabbar and others 2010). It is weak against norovirus: on finger pads alcohol rub reduced Norwalk virus by only 0.14 to 0.34 log, less than a water rinse (Liu and others 2010). For a village whose main killers are diarrhoeal, soap and water come first.

WHO publishes two formulations for local production. Formulation I is ethanol 80 per cent by volume, glycerol 1.45 per cent and hydrogen peroxide 0.125 per cent. For one litre: 833.3 millilitres of 96 per cent ethanol, 41.7 millilitres of 3 per cent hydrogen peroxide and 14.5 millilitres of 98 per cent glycerol, topped up with distilled or boiled and cooled water (WHO 2010, read through secondary reproductions, and Production report form 2015). Formulation II uses isopropyl alcohol at 75 per cent. The production form specifies boiling the water for 15 to 20 minutes if no distilled water is available, topping up after the alcohol-water contraction, and quarantining the batch for at least 72 hours (Production report form 2015). The peroxide is there to kill spores in the ingredients and the glycerol protects the skin [VERIFY: rationale not read in the original guide].

### 4.5 Chlorine solution

In Ebola treatment units 0.05 per cent chlorine is a standard hand rinse. In a laboratory comparison on 18 volunteers of soap, alcohol rub and four 0.05 per cent chlorine products, all six reduced E. coli by about 1.9 to 3.3 log and the virus surrogate Phi6 by about 2.4 to 3.7 log, with no consistent winner. Chlorine also killed organisms in the rinse water (Wolfe and others 2017). In a 28-day trial in which 91 people washed ten times a day, neutral-pH chlorine irritated the skin most, soap less and alcohol rub least, and 4 people developed dermatitis (Wolfe and others 2016). WHO does not recommend chlorine for routine community hand hygiene because it irritates skin and degrades in sunlight and heat (WHO and UNICEF 2025). Semmelweis's chlorinated lime was a chlorine hand wash, and it worked. For the book, chlorine is an outbreak and childbirth tool, not a daily one.

### 4.6 Plant saponins

Saponin-rich plants such as soapwort (Saponaria officinalis, root and leaf) and soapnut (Sapindus mukorossi and related species, fruit pericarp) were used for washing in Europe and South Asia. I found no controlled study of either for hand hygiene. Moringa (Moringa oleifera, seed or leaf powder) was largely ineffective in the 2 studies pooled by Hilton and others (2025). I did not research their toxicity or lookalikes [VERIFY]. Grade D for all three until tested.

### 4.7 Drying, water quality and quantities

Drying on one's own clothes recontaminates hands. WHO recommends a clean single-use towel or shaking the hands dry, poured or running water, and never rinsing in a shared standing basin (WHO and UNICEF 2025). Water of doubtful quality should still be used with soap: a risk model found that washing with non-potable water generally reduces faecal contamination on hands, though it may not make hand-to-mouth contact safe (Verbyla and others 2019). WHO lists the quantities that have reduced faecal contamination: 0.5 to 2.0 litres of water per wash, 1 to 3 millilitres of liquid soap, 0.5 to 1 gram of bar soap, or 200 millilitres of soapy water made with about 5 grams of powdered soap or 5 millilitres of liquid soap per litre (WHO and UNICEF 2025).

### 4.8 How long

WHO's health-care technique takes 40 to 60 seconds for a handwash and 20 to 30 seconds for an alcohol rub (WHO 2009). Karachi taught 45 seconds of lathering (Luby and others 2004). The 2025 community guideline found the

evidence on duration inconclusive and recommends washing long enough to cover both hands with soap, rub and rinse (WHO and UNICEF 2025). Pooled laboratory data show only a small gain beyond 10 to 20 seconds (2.19 against 2.49 log) (Hilton and others 2025). The book should teach a counted routine that reaches every surface: 20 to 40 seconds in the household, 40 to 60 seconds before a wound or a birth.

## 5. When to wash

WHO's five key times for communities are before preparing food, before eating or feeding or breastfeeding, after the toilet or handling faeces (a child's included), after coughing, sneezing or blowing the nose, and whenever hands are visibly dirty (WHO and UNICEF 2025). The evidence for the times is of low certainty, though the Bangladesh data single out washing before food preparation and after defecation (Luby and others 2011). WHO's five moments for health care are before touching a patient, before a clean or aseptic procedure, after risk of exposure to body fluids, after touching a patient, and after touching the patient's surroundings, with gloves or without (WHO 2009).

For the village dispensary these make one rule: wash before and after every patient, before any clean task (a wound, a birth, a cord, an injection, feeding a sick child), after any body fluid, and after the latrine. For the birth attendant, Holmes's rules apply as well. The one page the book should teach is this rule, Protocols 1 and 2 below, and the four lessons of section 6.

## 6. Why people do not wash

People know they should wash and do not. Only about 19 per cent of people worldwide wash with soap after contact with excreta (Freeman and others 2014). Across eleven countries an average of 17 per cent of child caretakers washed with soap after the toilet, though soap and water were in almost every home (Curtis and others 2009). Washing was driven by disgust, nurture, comfort and affiliation (wanting to be seen as clean and proper), not by fear of disease, except briefly in cholera epidemics. In Ghana the strongest motivators were nurturing children, social acceptance and disgust (Scott and others 2007). Because washing is habit, people's reports of it are unreliable.

The SuperAmma trial in Andhra Pradesh, India, built on disgust, nurture and status rather than health knowledge, raised observed washing with soap at key events from 1 to 2 per cent to 37 per cent, against 6 per cent in controls, at six months (Biran and others 2014). In hospitals, compliance followed handrub at the point of care and feedback, and fell when staff were busiest (Erasmus and others 2010). Semmelweis's monthly series shows the same decay and recovery under supervision.

Four lessons follow. Put soap and water where the act happens (the latrine exit, the cooking place, the birth room), because the cue must be in sight. Tie washing to fixed moments so that it becomes habit. Appeal to disgust, care for children and standing, not lectures on germs. Check and give feedback, because compliance collapses without it.

## Evidence grades

| Practice | What tradition says | What the record shows | What modern science infers | Grade |
|---|---|---|---|---|
| Plain soap and water at key times | Cleanliness prevents illness, with ritual hand washing in many faiths [VERIFY] | Karachi: 53 per cent less diarrhoea, 50 per cent less pneumonia | About 30 per cent less child diarrhoea, 16 to 21 per cent less respiratory illness | A |

| Practice | What tradition says | What the record shows | What modern science infers | Grade |
|---|---|---|---|---|
| Birth attendant and mother washing before birth and handling the newborn | Varies by tradition | Nepal cohort: 19 to 44 per cent lower neonatal deaths | Low-quality but consistent evidence | B |
| Chlorine hand wash before obstetric examination | None before Holmes's correspondent and Semmelweis | Vienna: 11.4 to 1.27 per cent maternal deaths, 1846 to 1848 | Chlorine kills bacteria on hands and in rinse water | B |
| Alcohol handrub of 60 per cent or more | None | Geneva: compliance 48 to 66 per cent, infections 16.9 to 9.9 per cent | Strongest killing of bacteria, weak on spores and norovirus | A for hand contamination, B for infection |
| Water alone with rubbing | Common practice where soap is scarce | Bangladesh food preparers: odds ratio 0.67 | About 1.2 to 1.5 log, below the 2 log standard | B, better than nothing |
| Clean wood ash | Used in Bangladesh and Ethiopia | Better than water, near soap in tests | Alkaline and abrasive, contamination risk | B for hand contamination, C for disease |
| Soil, mud or sand | Soil common in Bangladesh | Lab removal similar to soap, sand near ash for viruses | Contamination with helminth eggs, possibly tetanus spores [VERIFY] and metals | D, teach against |
| Antibacterial soap | Marketing claim | No added benefit in Karachi or meta-analysis | WHO: possible harm to health and environment | X |
| Drying on clothes, shared standing basin | Universal habits | Recontaminate hands (WHO) | | X |
| Soapwort, soapnut, moringa | Washing agents in Europe and South Asia | No hand trials found, moringa largely ineffective | Saponins are surfactants | D |
| Holmes's rules (wash, change clothes, wait 24 hours, stop after clusters) | | Consistent with the Vienna and Aberdeen clusters | Plausible | B for the principle, D for the exact intervals |

## Means ledger

The ledger applies to the core practice, cleaning hands at key moments.

| Rung | What can be done | What it changes |
|---|---|---|
| Hands and knowledge alone | Poured water, vigorous rubbing of both hands for 20 seconds, air drying, short nails, the five times. | About 1.2 to 1.5 log. Food preparers washing both hands with water went with less child diarrhoea (odds ratio 0.67). |
| The hearth | Fresh wood ash in a covered pot. Soap from fat and ash lye (HY-02). A poured-water station at the latrine and the cooking place. Clean cloth or air drying. Boiled water for births. | Ash adds about 1.6 log over water. Soap reaches the WHO standard and the level that halved diarrhoea and pneumonia in Karachi. |
| Garden and still | Ethanol made up to 80 per cent with glycerol from soap making, and peroxide if salvaged, as handrub. Soap made in weighed batches. Beeswax and fat balm for hands. | Hand hygiene at the bedside without water. Does not replace soap for dirty hands or diarrhoea. |
| Village dispensary (300) | Wash station with soap and covered water, handrub at the bed, a healer who washes before and after each patient, birth kits with nail brush, a register of births and of fevers after birth by attendant. | Stops the healer becoming the carrier. Supports the 19 to 44 per cent lower newborn mortality seen with clean birth hands. Records allow Holmes's three-case rule. |
| District infirmary (3,000) | Soap and handrub at every bed, 0.05 per cent chlorine for outbreaks, a nurse who observes compliance and reports monthly, a separate birth room, short stays. | Geneva's gains (infections 16.9 to 9.9 per cent) needed handrub, feedback and supervision. Without them an infirmary repeats the lying-in record of 34 deaths per 1,000 births. |
| Hospital before the Fall (reference) | Commercial handrub, gloves, surgical scrub, infection control team, surveillance, antibiotics. | Hand hygiene is the main barrier, but antibiotics rescue its failures. After the Fall they are not rescued. |

Today soap is on every market stall. After the Fall it must be made, and the fat it costs is also food. At Karachi's 4.4 grams per person per day a village of 300 would need about 1.3 kilograms a day, close to half a tonne a year [VERIFY: my arithmetic, and Karachi included daily bathing]. The realistic plan is soap for the key moments and ash or soapy water between.

## Harm test

Handwashing is among the safest acts in this book. The harms lie in the substitutes, in making soap and handrub, and in false confidence.

**Soap making.** Lye burns skin and blinds. Uncured soap with excess lye burns hands with repeated use, and the signs are stinging, red, cracked palms. Stop that batch and rinse with plenty of water (see HY-02).

**Ash.** Ash from dung, coal, plastics, painted wood or rubbish may carry pathogens or toxic metals, and stored ash becomes contaminated (WHO and UNICEF 2025, Bloomfield and Nath 2009). Alkaline ash used many times a day can crack skin, and cracked skin harbours more bacteria [VERIFY]. Use fresh, clean wood ash only and rinse well.

**Soil, mud and sand.** These can carry helminth eggs and other pathogens (Bloomfield and Nath 2009), and tetanus spores [VERIFY]. Never use them before touching food for others, a wound, a birth or a newborn's cord.

**Alcohol handrub.** It is flammable. One secondary source gives the flash point of the 80 per cent ethanol formulation as about 17.5 degrees Celsius (Bettercare, summary only) [VERIFY]. Make and store it away from flame, and let hands dry before going near a fire. It is poisonous if drunk, and methanol-contaminated sanitiser killed five people in Arizona in 2020 (Holzman and others 2021). Every still run yields methanol in its first fraction, so handrub must come only from tested ethanol with the heads discarded, kept from children and from anyone who might drink it. It gives false confidence on dirty hands and against spores and norovirus (Jabbar and others 2010, Liu and others 2010).

**Chlorine.** Neutral-pH chlorine irritated skin more than soap with repeated use (Wolfe and others 2016). Stronger solutions burn, and chlorine mixed with acids such as vinegar releases chlorine gas [VERIFY]. Make 0.05 per cent fresh daily, label it, keep it from sunlight, and do not use it routinely.

**Over-washing.** Washing ten times a day for a month raised hand irritation in every group, though only 4 of 91 people developed dermatitis (Wolfe and others 2016). WHO advises daily hand cream, no hot water, and not washing with soap straight before or after handrub (WHO 2009).

**Contaminated stations.** A shared standing basin, a shared towel, a bar sitting in water, or a water jar dipped with hands spreads organisms (WHO and UNICEF 2025). Diarrhoea clustering around one station is the sign.

**Who must not.** No one is too young or ill to benefit from clean hands around them. Do not put ash or alcohol rub on an infant's own hands [VERIFY: a precaution, no source read]. People with cuts on the hands should not handle wounds or births until healed, or must cover them.

**Historical harm.** In April 1847 unwashed hands killed 57 of 312 women in one Vienna month. Nightingale's King's College ward lost 26 of 780 women before it was closed (Nightingale 1871). Semmelweis himself died of an infected wound of the hand.

## Red flags

Clean hands prevent infection. They do not treat it. These signs mean infection has taken hold and the patient may die or be disabled without what the village cannot give (see MA-04, WO-12, NU-01 and SY-05).

- **After a birth:** fever of 38 degrees Celsius or more, shivering, lower abdominal pain, a tender womb, foul-smelling discharge, a fast pulse or confusion, up to six weeks after the birth (thresholds from secondary summaries of WHO guidance) [VERIFY]. In Gordon's Aberdeen epidemic more than a third of cases died [VERIFY: 28 of 77 from secondary sources].
- **In a newborn:** poor feeding, fever or a cold body, fast breathing, redness spreading from the cord, stiffness or spasms.
- **In a child with diarrhoea:** sunken eyes, unable to drink, very sleepy, no urine.
- **In a child with cough:** fast breathing (50 a minute or more from 2 to 12 months, 40 or more from 1 to 5 years, from secondary summaries of WHO guidance [VERIFY]), the lower chest pulling in, unable to drink.
- **In a wound:** spreading redness, red streaks up the limb, foul smell, crackling under the skin, fever.

What to do anyway: fluids, warmth, rest and the measures in the related chapters. Keep the case away from births and wounds, and make the carer wash before touching anyone else. If a mother with childbed fever was attended by the village birth attendant, the attendant follows Holmes's rules before the next birth. Count the cases. Tell the family plainly that this is a serious infection the village cannot be sure to cure, that she will be kept clean, warm, watered and never alone, and that her care will not put others at risk.

## The case against

**The trial effect is smaller than the legend.** Curtis and Cairncross (2003) estimated 42 to 47 per cent less diarrhoea but warned of poor studies and publication bias. Freeman and others (2014) showed that adjusting for unblinded reporting shrinks the pooled effect from 40 to 23 per cent, with a confidence interval that crosses no effect. Every community trial relied on caregivers' reports, and no trial measured child deaths.

**The big trials disappointed.** Null and others (2018) and Humphrey and others (2019) found no reduction in diarrhoea from handwashing packages, and the consensus panel accepts mixed effects on diarrhoea and none on growth (Cumming and others 2019). A sceptic can argue that Karachi's 53 per cent came from an intensive, industry-funded programme with self-reported outcomes.

**Field washing is poor washing.** Soap washing in field studies achieved only 0.44 log (Hilton and others 2025). Five key times mean more than ten washes a day for a poor mother (Luby and others 2011), and few manage it.

**The hospital evidence is weak.** Geneva was one hospital, before and after. The Cochrane review rates compliance programmes at low or very low certainty (Gould and others 2017). Dispenser use roughly triples within sight of an auditor (Srigley and others 2014). No trial shows one surgical hand antisepsis beating another (Tanner and others 2016).

**The heroes are partly myth.** Loudon (2013) calls much of the popular Semmelweis story nonsense. Small (1998) argued that Nightingale did not understand sanitation at Scutari, and McDonald (2016) agrees she was not a sanitarian before the war. The Vienna series holds an unexplained dip before washing began.

**WHO rejects the traditional substitutes.** The 2025 guideline does not recommend ash, soil or sand, on grounds of contamination and skin damage (WHO and UNICEF 2025).

**The romance of the hospital.** Nightingale's 1871 figures show that gathering women to give birth in one place killed them at several times the home rate. A district infirmary could do the same.

**Answer.** None of this reverses the direction of the effect. Every randomised review finds less diarrhoea with handwashing promotion, the laboratory data agree, the historical natural experiments are large and sudden, and the mechanism is understood. The criticisms set the expectation. A well-run village programme should hope for about a third less diarrhoea, perhaps a fifth less respiratory infection, and a clear fall in childbed fever and newborn sepsis where birth attendants are disciplined, and it should expect compliance to decay unless supervised. Today these figures are modest. After the Fall a third fewer infections is worth far more, because the infections not prevented are no longer cured.

## 10-line summary

1. Handwashing with soap at key times cuts child diarrhoea by about 30 per cent across 29 randomised trials, and by 53 per cent in Karachi.
2. Respiratory infections fall by 16 to 21 per cent, and pneumonia in children under 5 halved in Karachi.
3. In Vienna, chlorine hand washing cut First Clinic maternal deaths from 11.4 per cent (1846) to 1.27 per cent (1848).
4. Birth attendant and maternal handwashing go with 19 to 44 per cent lower newborn mortality.
5. Soap removes about 2.3 to 2.5 log of bacteria, water alone about 1.2 to 1.5, alcohol rub about 3.1.
6. Clean wood ash beats water and approaches soap in tests, but has no outcome trials and carries contamination risk.
7. Antibacterial soap adds nothing. Alcohol rub fails on dirty hands, spores and norovirus.
8. Free soap matters: education without soap did not significantly reduce diarrhoea.
9. Compliance decays everywhere (Kenya below 25 per cent by year two, Vienna after Semmelweis left) and must be supervised.

10. People wash from disgust, care for children and standing, not fear of disease, so the station must be in sight.

## Open questions

- What is the effect on child and maternal deaths? No trial measured it.
- How much of Karachi's effect came from the weekly visits rather than the soap?
- Why did Kenya and Zimbabwe fail where Bangladesh succeeded: adherence, animal faeces, community contamination or measurement?
- What strength of chlorinated lime did Semmelweis use, and why were January to March 1847 already low?
- Does clean wood ash prevent disease, and how often can skin bear it?
- Do soapwort or soapnut clean hands to the 2 log standard?
- What is the smallest soap ration that keeps most of the benefit?
- How long should a birth attendant wait after a case of childbed fever? Holmes's 24 hours and one month were judgement, not measurement.

## Sources to read in full

1. Semmelweis 1861, in Carter's 1983 translation, for the monthly tables and the technique.
2. Holmes 1843, short, free, and a ready-made protocol.
3. Nightingale 1871, free on Project Gutenberg, for the case that institutions kill.
4. Luby and others 2004 and 2005, the Karachi trial.
5. Ejemot-Nwadiaro and others 2021, the Cochrane review.
6. WHO and UNICEF 2025, for quantities, times and the reasoning on ash.
7. Hilton and others 2025, for the comparison of agents.
8. Cumming and others 2019 with Null and others 2018, on why the big trials disappointed.
9. Curtis and others 2009 and Biran and others 2014, on why people do not wash.
10. Loudon 2000 and 2013, for maternal mortality without the myths.

## At the bedside after the Fall

**Household.** Minimum: a poured-water station outside the latrine and one by the cooking place, soap on a draining rack or a bottle of soapy water, a covered pot of fresh wood ash for when soap runs out, and the rule of the five times. Air drying and short nails. To start: fat and ash for soap or a soap ration, a jar, cord and a stick, and a parent who washes in front of the children. First failure to expect: the soap runs out or melts in a puddle, the jar sits dry, and within a month nobody washes. Answer: a soap rack, a rota for filling the jar, and ash as the fallback.

**Village of 300.** Minimum: every household as above, a seasonal soap-making day, a dispensary wash station with soap and handrub, and a healer and birth attendants who wash before and after every patient and before every birth. A birth kit: nail brush, soap, boiled water, clean cloth, clean blade, cord ties. A register of births, attendants, fevers within six weeks and newborn deaths, so that Holmes's rules can be applied. To start: fat, ash or salvaged lye, a scale, the still if handrub is wanted, and someone who checks the stations weekly. First failure to expect: the healer washes after dirty patients but not before clean tasks, the pattern seen in hospitals (21 per cent compliance before patient contact). Answer: washing before is the rule that saves lives, and someone watches and counts.

**District of 3,000.** Minimum: soap and handrub at every bed, a separate birth room with a strict entry wash, chlorine for outbreaks, a nurse responsible for hand hygiene who observes and reports monthly, short stays after birth, and Semmelweis's monthly mortality ledger. To start: a reliable fat supply, a still with a hydrometer, glycerol, and a habit of feedback. First failure to expect: the infirmary becomes a lying-in hospital in Nightingale's sense, crowded, with shared basins and towels and rising fever after birth. Answer: count deaths per 1,000 births each month against home births, and if the infirmary is worse, send women home to deliver with a clean attendant.

## Protocols

### Protocol 1. Household handwash with soap

- ☐ Use poured or running water, never a shared basin.
- ☐ Wet both hands. Turn the water off or put the jug down.
- ☐ Apply soap: a bar rubbed to lather (about 0.5 to 1 gram used), or 1 to 3 millilitres of liquid soap, or about 200 millilitres of soapy water.
- ☐ Rub palm to palm, back of each hand, between the fingers, backs of the fingers, each thumb, fingertips in the opposite palm, and wrists. Count to 20 at least (target 20 to 40 seconds).
- ☐ Rinse under poured water until no soap remains (about 0.5 to 2 litres in total).
- ☐ Shake dry in the air or use a clean cloth used for nothing else that day. Never dry on clothes.
- ☐ Return the bar to a draining rack.
- When: before preparing food, before eating, before feeding a child or breastfeeding, after the latrine, after cleaning a child's bottom or handling faeces, after coughing, sneezing or blowing the nose, and whenever hands look dirty.

### Protocol 2. When there is no soap

- ☐ First choice: soapy water from any soap scraps (5 grams of soap per litre).
- ☐ Second choice: fresh white or grey wood ash from today's or yesterday's hearth, from clean wood only. Never ash from dung, coal, plastic, painted or treated wood, or rubbish.
- ☐ Take one closed palmful of ash. Wet hands, rub the ash over all surfaces as in Protocol 1 for at least 20 seconds. Rinse with at least 1 litre of poured water.
- ☐ Third choice: water alone, both hands, vigorous rubbing for 20 seconds, poured water. Better than nothing.
- ☐ Never use soil, mud or sand before handling food for others, a wound, a birth or a newborn.
- ☐ Rub fat or balm into the hands at night if ash causes dryness or cracks.

### Protocol 3. Building a hand-washing station

- ☐ Place one at the latrine exit and one at the cooking place, in sight of the act.
- ☐ Use a covered container of at least 10 litres with a tap, a tilting jug on a cord (tippy-tap), or a jug kept for this use only.
- ☐ Soak-away under it: a pit of stones so waste water does not make mud.
- ☐ Soap on a rack or in a hanging net so it dries between uses. Or a bottle of soapy water.
- ☐ Assign one person each day to fill the water and check the soap. Check every evening.
- ☐ Budget water at about 1 litre per wash. A family of six washing six times a day needs about 36 litres a day [VERIFY: my arithmetic from WHO's 0.5 to 2 litres].

### Protocol 4. Dispensary hand hygiene

- ☐ Nails short, no rings or bracelets, sleeves above the elbow.
- ☐ Before touching each patient, wash with soap (40 to 60 seconds) or rub with handrub (3 to 5 millilitres, 20 to 30 seconds until dry).
- ☐ Wash with soap, not handrub, when hands are visibly dirty, after the latrine, after any patient with diarrhoea, and after body fluids.
- ☐ Before any clean task (dressing a wound, examining a woman in labour, cutting a cord, giving an injection), wash with soap again even if you just washed, then touch nothing else before the task.
- ☐ After touching the patient or the bed, wash or rub before the next task.
- ☐ Gloves, if any, do not replace washing. Wash before putting them on and after taking them off.
- ☐ One clean cloth per patient for drying, then to the boil wash. Or air dry.

☐ Moisturise hands with balm at the end of each day.

**Protocol 5. The birth attendant**

☐ Before attending a birth: wash hands and forearms to the elbow with soap and a nail brush for at least 60 seconds, rinse in poured boiled-and-cooled water, air dry.
☐ Wash again before every internal examination, before cutting the cord, and before touching the newborn's cord stump.
☐ The mother washes her hands with soap before handling the baby and before every feed in the first weeks.
☐ After attending a woman with fever after childbirth, a death from childbed fever, or a spreading skin or wound infection: full wash, change every garment, and wait at least 24 hours before attending another birth (Holmes's rule).
☐ If two women in one attendant's care develop childbed fever close together, she stops attending births for one month. If three, she is presumed the carrier until proven otherwise (Holmes's rule).
☐ In an outbreak of childbed fever, rinse hands in 0.05 per cent chlorine solution after soap washing before each examination.
☐ Record every birth, the attendant, and every fever in the mother within six weeks.

**Protocol 6. Making alcohol handrub (still and district only)**

☐ Only ethanol tested with a hydrometer or alcoholmeter, from a run where the heads were discarded. Never methanol or unknown spirit.
☐ For 1 litre: 833 millilitres of 96 per cent ethanol, 42 millilitres of 3 per cent hydrogen peroxide, 14.5 millilitres of 98 per cent glycerol, boiled-and-cooled water to 1,000 millilitres (WHO Formulation I).
☐ If the ethanol is weaker, use more of it to reach 80 per cent final strength. Do not go below 60 per cent [VERIFY: adjustment by calculation].
☐ If there is no peroxide, the rub still works but must be made with clean equipment and boiled water [VERIFY].
☐ No flame within the room. Mix in a closed container, shake 5 minutes, top up to volume, bottle at once, label.
☐ Quarantine every bottle for at least 72 hours before use.
☐ Check strength with the alcoholmeter: 75 to 85 per cent for Formulation I (Bettercare, summary only) [VERIFY: tolerance from a secondary source].
☐ Store cool, out of sun and away from children and from anyone who might drink it.

**Protocol 7. Chlorine hand rinse for outbreaks**

☐ Use only for cholera, an epidemic of diarrhoea, an outbreak of childbed fever, or a dangerous unknown fever.
☐ Target 0.05 per cent available chlorine. From 5 per cent bleach: 1 part bleach to 99 parts water (10 millilitres in 1 litre) [VERIFY: arithmetic, and check the bleach strength on the label].
☐ Make fresh each day, in a labelled container, out of sunlight.
☐ Wash off visible dirt with soap first. Then pour about 200 millilitres of the solution over the hands over about 8 seconds, rubbing all surfaces (the method tested by Wolfe and others 2017), and air dry.
☐ Never mix with vinegar, acids or urine. Stop and use soap instead if hands crack.

## Numbers to carry

1. **30 per cent.** Less child diarrhoea from handwashing with soap across 29 trials, up to 53 per cent in Karachi.
2. **Half.** Pneumonia in children under 5 in Karachi with soap and weekly encouragement.
3. **11.4 to 1.3.** Per cent of mothers dying in Semmelweis's clinic, 1846 against 1848.
4. **34 against 5.** Deaths per 1,000 births in nineteenth-century lying-in institutions against home births.

5. **Five times.** Before food, before eating or feeding, after the latrine or faeces, after coughing or sneezing, when dirty. In the dispensary, before and after every patient and before every clean task.
6. **20 to 60 seconds.** At least 20 at home, 40 to 60 before a wound or a birth, 20 to 30 for handrub.
7. **2 log.** The standard for clean hands, 99 per cent removed. Soap reaches it, water alone does not.
8. **60 per cent.** The minimum alcohol strength for a handrub. Aim for 80.
9. **4.4 grams.** Soap per person per day in Karachi.
10. **One in five.** People who wash with soap after the latrine without a programme. The habit fades unless checked.

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