Costs of healthcare acquired infections due to inadequate water, sanitation and hygiene (WASH) in healthcare facilities in Malawi

Summary

The number of healthcare associated infections (HAI) in Malawi (population: 13.2 million) is conservatively estimated at 250,000 cases in 2022, with 25,800 excess deaths in a year. The increasing rate of antimicrobial resistance causes worse health outcomes and higher costs of treating HAIs. Monetary estimates were aggregated from the healthcare costs, the productivity losses and the premature deaths associated with HAIs, including antimicrobial resistance. The total economic costs of HAI in Malawi in 2022 is US$ 246 million. This equates with 2.92% of Gross Domestic Product in 2022. The financial costs of providing healthcare to treat HAIs is US$ 79 million in 2022, or 11% of total health expenditure. When comparing the medical costs per capita in Malawi of US$ 6.00 per year with the cost per capita needed to provide basic water, sanitation and hygiene (WASH), waste management and environmental cleaning in healthcare facilities in low-income countries (US$ 0.3 per capita for capital cost and starting at US$ 0.7 recurrent cost) it is highly likely that the spending will be more than covered by the savings in medical costs.

In addition to HAIs, cleanliness, availability of drinking water and a clean toilet are key determinants of patient satisfaction. These aspects are particularly important to people when they are at their most vulnerable, such as during surgery, during labour and delivery, and neonates in the first moments of their lives. Experiences of poor quality of care and inconvenience can impact future treatment-seeking behaviour and they also impact healthcare worker job satisfaction and absenteeism. WASH and infection prevention and control (IPC) should be essential interventions implemented by the health sector in Malawi to reduce HAIs and improve the quality of healthcare and patient satisfaction across the country.

Key messages

- The total economic costs of healthcare associated infections (HAI) in Malawi in 2022 was US$ 246 million.
- This equates with 2.92% of Gross Domestic Product.
- The financial costs of providing healthcare to treat HAIs is US$ 79 million in 2022, or 11% of total health expenditure.
- It is feasible that the spending to provide basic WASH, waste management and environmental cleaning in healthcare facilities in Malawi (less than US$ 1 per capita) will be more than covered by the savings in medical costs of US$ 3.00 per year, if the HAI rate can be halved.

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Introduction

The lack of adequate water, sanitation and hygiene (WASH), waste management and environmental cleanliness in healthcare facilities poses a significant health risk to patients and healthcare workers in Malawi, and it seriously impacts quality of care and satisfaction with health services.

In Malawi there are hundreds of thousands of healthcare associated infections (HAI)[1] each year, and tens of thousands of resulting deaths. These infections impact patients, their families and healthcare facilities by causing illness, prolonged hospital stays, potential disability, excess costs and sometimes death. Furthermore, HAIs affect people when they are at their most vulnerable – during surgery, women during pregnancy, labor and delivery, and neonates in the first moments of their lives.

This problem was recognised more than two decades ago, when the Ministry of Health in Malawi started implementing Performance and Quality Improvement (PQI) in Infection Prevention and Control (IPC) practices in 2002 (Rawlins et al 2004;). Jhpiego's Standards Based Management and Recognition (SBMR) were adopted. The process was introduced in a phased approach. To date, 40 hospitals across the country are implementing IPC practices and 18 hospitals have been recognised as centres of excellence in infection prevention.

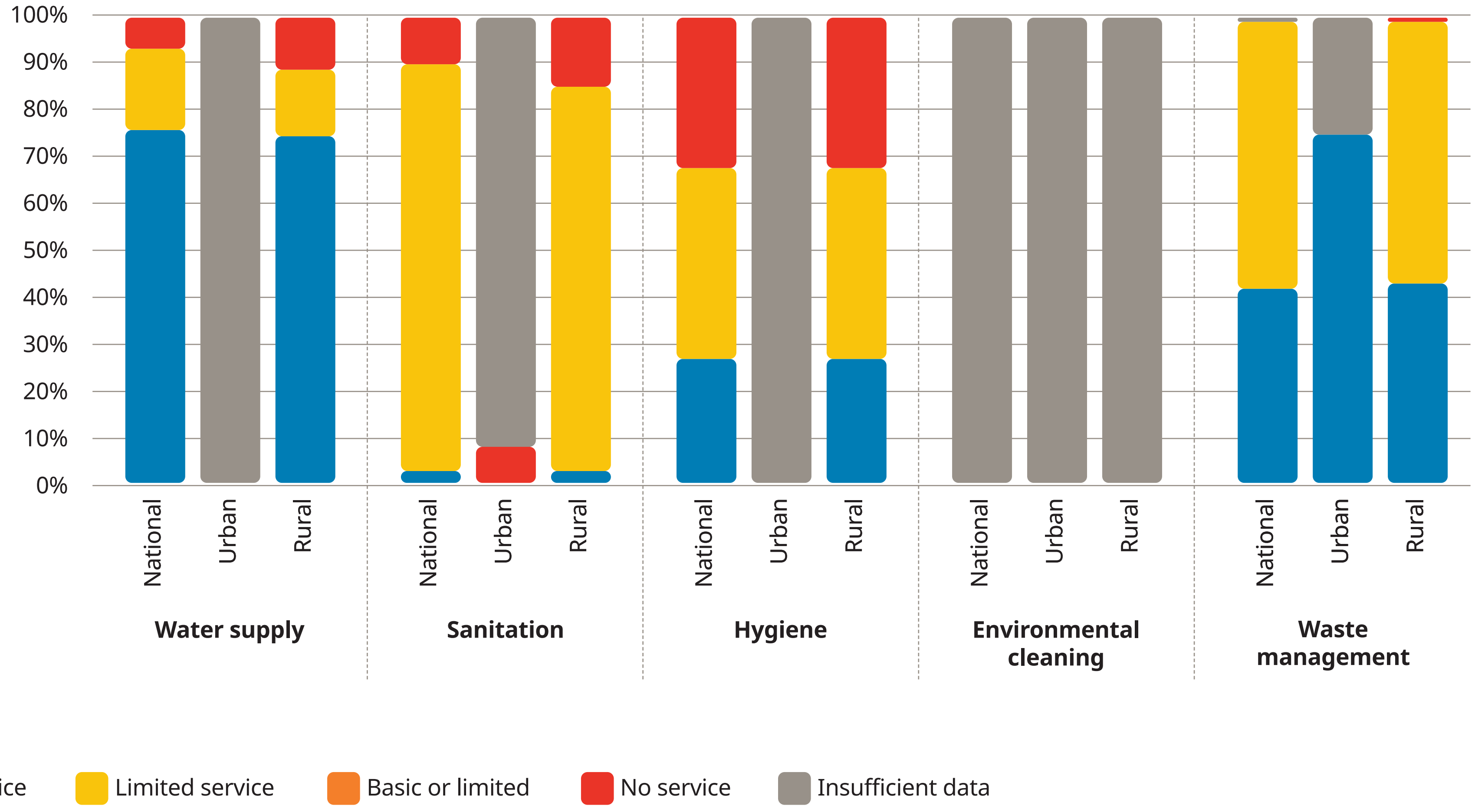
A growing proportion of HAIs are resistant to antimicrobials, leading to a worse health outcome for the patient and making them more costly to treat and requiring longer to recover and restart normal life, including productive activities. Antimicrobial resistance (AMR) rates vary across drugs and across settings within Malawi, but available estimates suggest that the majority of HAIs will be resistant to first-line drugs. As a response, the Malawi AMR National Action Plan (NAP), published as the National AMR Strategy, runs from 2017 to 2022 and provides the operational detail for implementation through the HSSPIII strategy (2023-2030), and is also a response to the global WHO efforts to reduce the impact of AMR (Ministry of Health, n.d; WHO, 2022). The NAP incorporates a One Health approach for addressing AMR, defines specific roles for relevant government ministries and implementation partners, and includes a detailed operational plan, cost analysis, and monitoring and evaluation (M&E) framework (WHO, 2022). One of ten recommendations of the NAP is to "Prioritise investments and capacity building in IPC and water, sanitation and hygiene (WASH) to achieve the objectives of the NAP on AMR and broader health systems strengthening".

The major transmission pathway for HAIs is a lack of cleanliness and hygiene measures provided during medical care and recovery time. The most common HAIs are surgical site infections, bloodstream infections, and respiratory tract infections, including pneumonia. The highest rates are found in intensive care units (ICUs), neonatal wards or ICUs, and pediatric medical wards. Some HAIs originate in the endogenous native microflora of the patients themselves, and hence cause infection following surgery or catheter-associated urinary tract infections.

Figure 1 shows data compiled by the WHO/UNICEF Joint Monitoring Programme (JMP) for WASH in healthcare facilities in Malawi. Compared to rural areas, coverage for urban areas is limited. Nationally and in rural areas three quarters of healthcare facilities have a basic water supply. Only 3% of rural healthcare facilities have basic sanitation services, whilst 82% have limited. Basic hygiene services, where handwashing materials are available at points of care and in toilets, are present in less than 30% of rural facilities.

1. An HAI is a condition resulting from an adverse reaction to an infectious agent or its toxins acquired from healthcare settings that was not incubating or symptomatic at the time of admission.

Figure 1. Coverage of WASH, waste management and environmental cleaning in healthcare facilities in Malawi in 2021



Source: WHO/UNICEF Joint Monitoring Programme (2021): https://washdata.org

Methods

This study uses a cost-of-illness methodology developed for a recent World Bank study on the costs of healthcare associated infections in nine countries of Eastern and Southern Africa. See Hutton et al, (2023) where full methods and data sources are available. A quantitative model was constructed to estimate (1) healthcare costs, (2) patients' productivity losses, and (3) mortality costs due to HAIs in Malawi, including additional costs of treating antimicrobial resistant infections. Variables and data inputs are summarised in Table 1. The calculations are as follows:

- **Healthcare costs:** the number of HAIs across three health facility levels (health centre, district hospital and higher-level hospital such as regional, referral or teaching hospital), multiplied by the average cost per inpatient day at each level, multiplied by the average length of stay, and with the total drug cost per HAI added.
- **Productivity costs:** (a) the number of HAIs multiplied by the proportion of adults working multiplied by the daily opportunity cost of time (proxied by the agricultural wage), plus (b) the number of HAIs multiplied by the proportion of patients not working (including children) multiplied by the daily opportunity cost of time for non-working people (30% of the daily GDP per capita). All calculations are made separately for male and female.
- **Mortality costs:** the number of deaths due to HAIs (= the number of HAIs multiplied by the excess case fatality rate due to HAIs) multiplied by the value of life.

Table 1. Variables, data needs and sources for damage cost estimation of HAIs

Cost variable	Data needs	Malawi data value (in brackets range used in sensitivity analysis)	Data source
Healthcare cost			
Annual healthcare associated infections (HAIs)	Average % of admissions infected with HAI	12.76% (10.3% to 15.2%) [a]	Abubakar et al (2022), Bunduki et al (2021)
	Proportion of anti-microbial resistance in HAIs	50% (25% to 75%) [b]	Kariuki et al (2022), Murray et al (2022)
	No. of annual hospital admissions	5.6 admissions per 100 population	Ministry of Health (2014)
Additional cost of treating a patient with an HAI [c]	Average hospital cost per day ('hotel' cost)	US$ 17.6 health centre, US$ 37.6 district hospital, US$ 72.8 higher hospital [d]	IHME (2015)
	Cost of drugs and laboratory tests per HAI	US$ 29.8 health centre, US$ 71.4 district hospital, US$ 327.8 higher hospital[e]. Double for AMR	Aerts et al (2022), Gidey et al (2023), Bocoum et al (2019)
	Additional length of stay	5 days [f] (10 days AMR) [g]	Fenny et al (2020) Otieku et al (2023)

Cost variable	Data needs	Malawi data value (in brackets range used in sensitivity analysis)	Data source
Productivity cost			
Annual HAIs	Same as Healthcare cost		
Additional days for recovery after HAI	Additional recovery time	2 days (2 days AMR)	Assumption
Loss in value-added of workers	Productivity loss (value-added in agriculture)	US$ 18.2 per day (US$ 47 per day in industry)	World Bank statistics
	Proportion of adult HAI patients	60%	Assumption
	Labour force participation rate	69.5% (female) 73.4% (male)	ILOSTAT (2023)
	Proportion of HAIs suffered by women	60%	Assumption
Loss of time spent in non-productive activities (opportunity cost	Average daily value	30% of the agricultural value-added	Hutton (2012)
Mortality cost			
Annual HAIs	Same as Healthcare cost		
Case fatality rate	HAI case fatality rate	6.9% (4% to 15%) [h]	7 studies
Value of a premature death	Value of a statistical life	US$ 43,296 [i]	Calculation based on Banzhaf (2022)

Notes: See Annex 1.

Several impacts were excluded due to lack of data and lack of methods to quantify in monetary values[2]. Hence, the estimates presented in this study will significantly underestimate the true economic and social costs of HAIs in Malawi[3].

2. For example, unoccupied beds due to isolation (loss of capacity and revenue), extended length of stay in an intensive care unit (ICU), non-standard surgical prophylaxis in infected patients, infection prevention and control interventions such as screening at hospital admission or before surgery, long-term consequences of AMR infection, training of healthcare professionals and communication, HAIs of healthcare workers. Out-of-pocket expenditures by patients and their carers were also excluded. Financial burden on the government such as disability benefits were excluded.

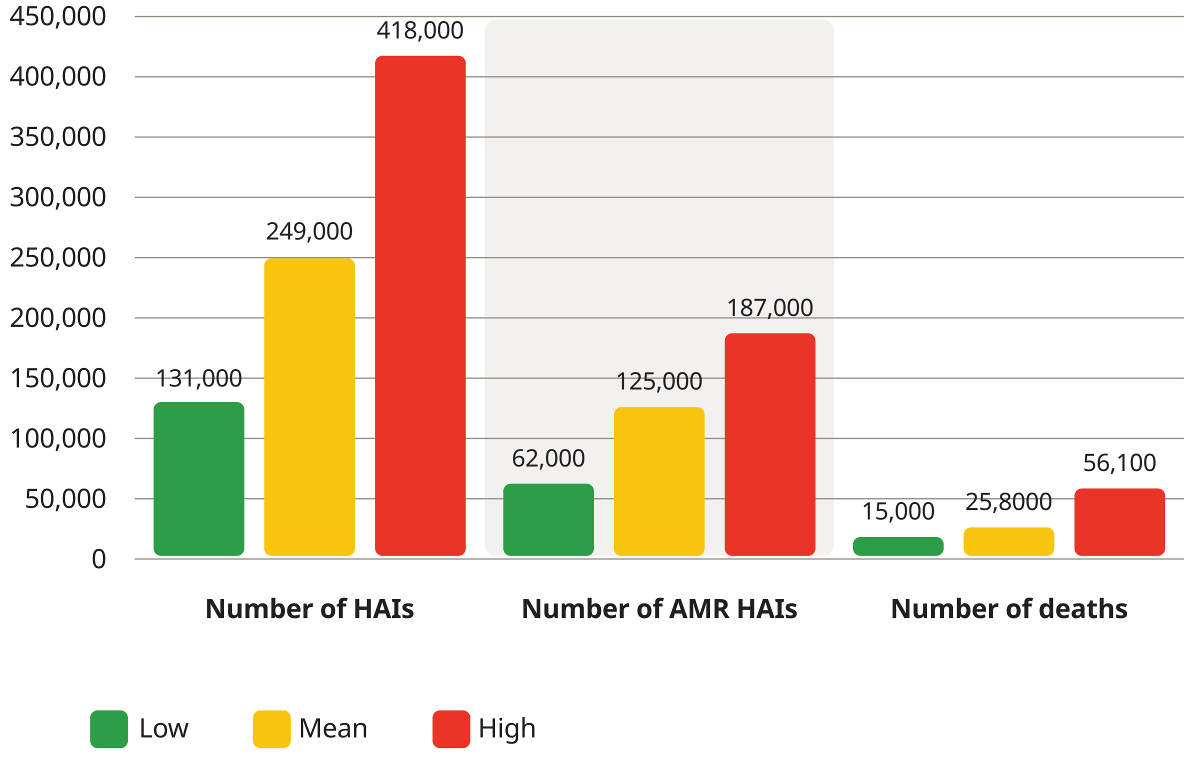
3. No comprehensive study of the economic and financial costs of HAIs has been conducted anywhere in the world, so it is not possible to conclude by how much this current study underestimates the true costs of HAIs.

Results

Disease burden due to healthcare associated infections

In total, the average number of HAIs in Malawi is estimated to be 249,000 in 2022 (Figure 2), of which half are predicted to be antimicrobial resistant (Berhe et al. 2021; Murray et al. 2022). The number of fatalities resulting from these HAIs is estimated to be 25,800 deaths.

Figure 2. Estimated number of healthcare associated infections and related deaths in Malawi

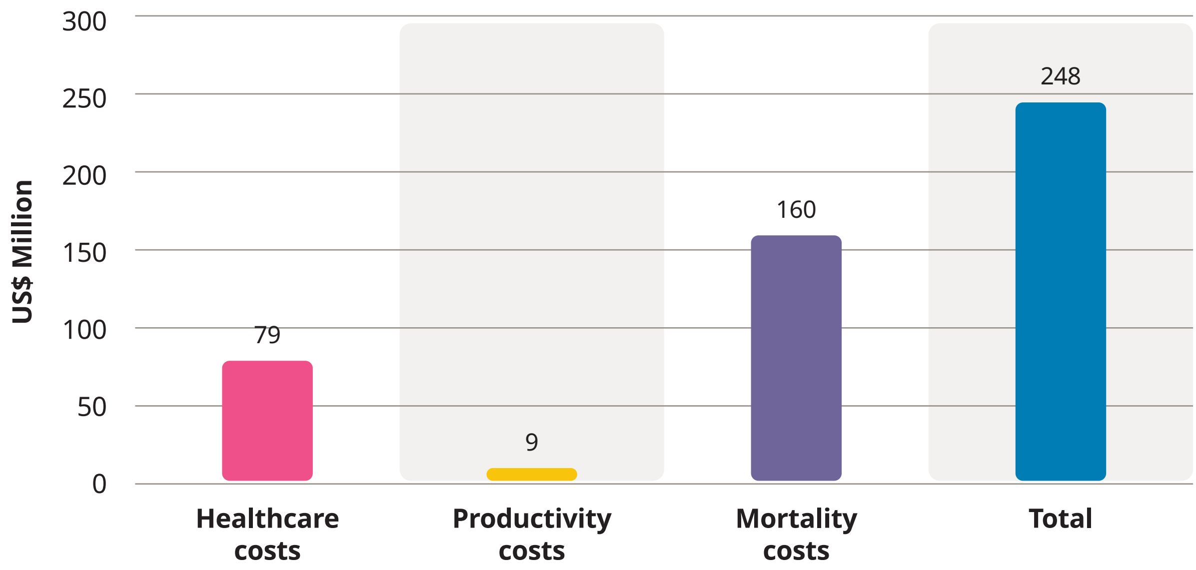


Estimates were made using different data inputs. When varying the baseline HAI rate of 12.76% from 10.3% to 15.2%, the number of HAIs varied from 131,000 to 418,000. When varying the AMR rate (baseline 50%) from 25% to 75%, the number of HAIs that are anti-microbial resistant varies from 62,000 to 187,000. When varying the case fatality rate (baseline 6.9%) from 4% to 15%, the number of deaths varies from 15,000 to 56,100.

Monetary impacts due to HAIs

Costs of HAI are presented in Figure 3. Total costs exceed US$ 246 million per year in Malawi.

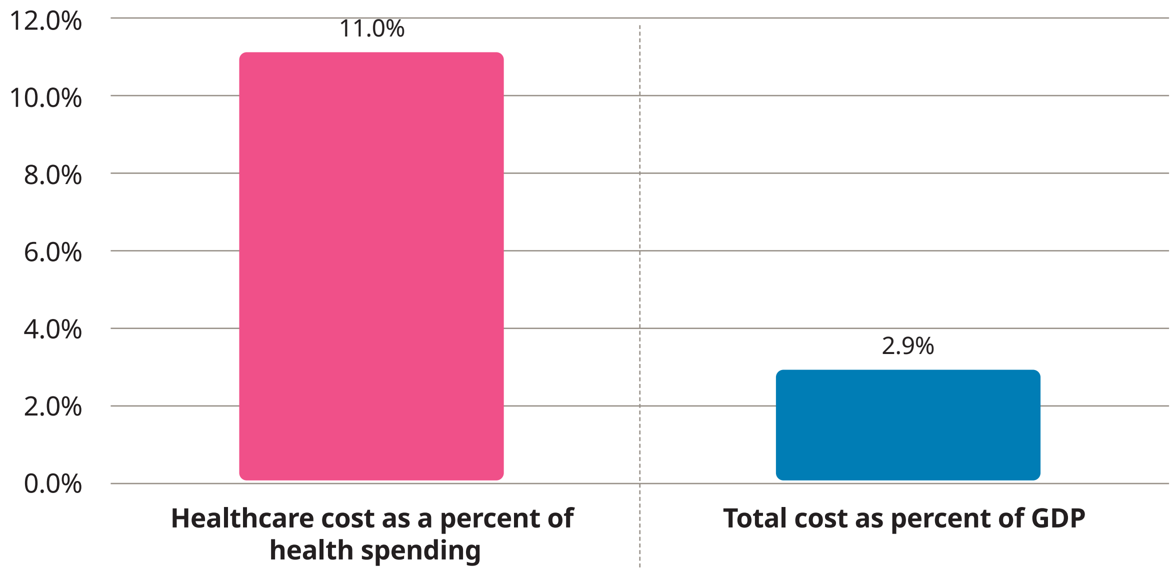
Figure 3. Estimated costs from HAIs in Malawi



Healthcare costs amount to US$ 79 million per year, with US$ 9 million in productivity losses and US$ 160 million in lost lives. The costs of premature death account for 65% of the total costs, due to the relatively high case fatality rate from HAIs. Total cost per HAI is US$ 996. Healthcare costs averaged US$ 316 per HAI episode.

Costs as a proportion of GDP and healthcare spending are shown in Figure 4. In terms of economic cost, HAIs cost an equivalent of 2.92% of GDP. The costs of treating HAIs (US$ 79 million per year) reflect 11.0% of overall healthcare spending from all sources.

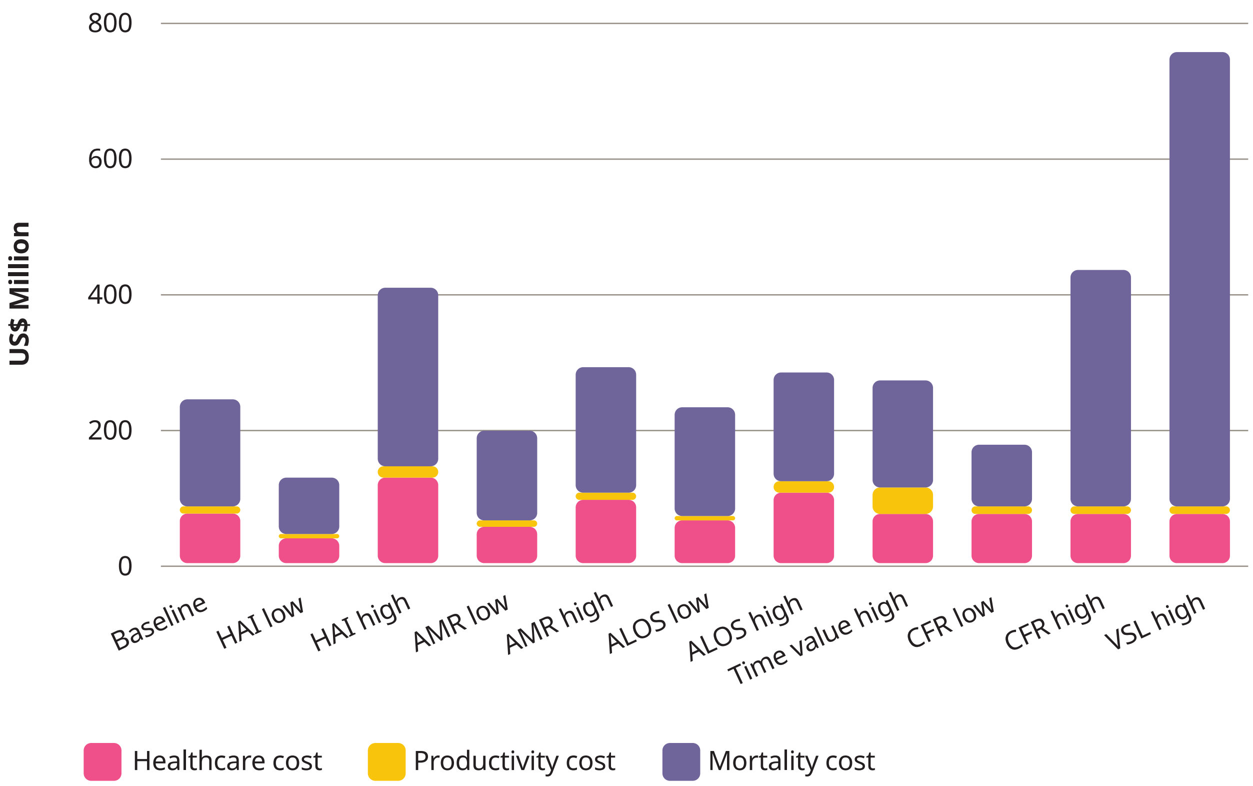
Figure 4. Costs as a proportion of GDP and healthcare spending



Sensitivity analysis

To better understand the impact of uncertain data inputs on the results, the values of selected variables were altered one at a time to assess what impact would be on the overall results in terms of economic impact. The variables selected include the HAI rate, the AMR rate, the average length of hospital stay, the value of time, the value of death, the case fatality rate. The results are shown in Figure 5. The biggest impact is the value of statistical life (VSL) which when a higher value was used led to a total economic cost of US$ 760 billion in 2022. The results were also sensitive to the case fatality rate and the HAI rate. The resulting impact on costs as a percent of GDP were from 1.53% (low data value for HAI rate) to 9% (high value for VSL).

Figure 5. Results of sensitivity analysis



Cost-benefit analysis

The financial cost per capita to the health system due to HAIs across all the Malawian population is at least US$ 6.00 each year. Comparing this conservative figure with the cost per capita needed to provide basic WASH, waste management and environmental cleaning in healthcare facilities in low-income countries (US$ 0.3 per capita for capital cost and starting at US$ 0.7 recurrent cost) it is highly feasible that the spending will be covered by the savings in medical costs (Chaitkin et al, 2022).

Patient satisfaction as a key outcome of healthcare

Beyond the HAIs and additional costs to the health system and patients themselves, there will be several other negative consequences of inadequate WASH in healthcare facilities. Patient satisfaction has many determinants. Cleanliness, good housekeeping services and availability of drinking-water and a clean toilet have been reported in the literature as key determinants of patient satisfaction.

Adequate WASH is particularly important to some population groups. For example, women attending antenatal clinics and choosing to have their child in a healthcare facility will consider the cleanliness of the facility and WASH services as essential, especially when they experience prolonged hospitalisations. Hygienic conditions for newborn health are vital and are therefore an important determinant of maternal and paternal satisfaction. A 2019 survey of over 1 million women and girls in 114 countries found that respectful and dignified maternity care was the most cited demand for quality reproductive and maternal healthcare, and this was closely followed by WASH services and facilities (White Ribbon Alliance, 2019).

Studies that assess the rates of HAI typically do not include infections in healthcare workers, which can seriously impact the health system's ability to provide quality healthcare. Healthcare workers' job satisfaction influences their future career decisions and, if they do not feel safe in their working environment, they may leave their job. Furthermore, studies that measure HAIs focus on patients *admitted* to hospitals, while excluding the impact on outpatients of the lack of WASH facilities, cleaning, and waste management. Hence, there is a hidden burden of disease of ambulatory patients who pick up – and take home – a healthcare associated infection, with implications for the health of other family members. Furthermore, the lack of cleanliness and WASH facilities causes dissatisfaction of ambulatory patients with the quality of care and inconvenience, which might impact future treatment-seeking behaviour.

Conclusions

HAIs and other impacts of inadequate WASH are key challenges that need to be urgently addressed to achieve progress towards universal healthcare. Hospitals and health centres should be seen as safe environments where people can go to overcome illness and heal fully, and not places to get even sicker and stay for longer than necessary. At least 5.5% of healthcare expenditures could be saved if HAIs were minimised.

As has been found in richer nations, it is difficult to eliminate HAIs altogether, but significant reductions can be achieved through targeted interventions as well as improved general training and healthcare practices. Therefore, WASH and IPC measures should be essential interventions implemented by the health sector in Malawi to reduce HAIs and improve the quality of healthcare and patient satisfaction across the country.

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Annex 1: Notes to table 1

[a] Abubakar et al (2022) provides a pooled estimate for HAIs, estimating 12.76% (95% confidence interval 10.30– 15.23), based on 15 eligible Africa studies. It was found that surgical site infection was the most common HAI and accounted for 41.6% of all HAIs, followed by bloodstream infection and respiratory tract infections/ pneumonia. In Malawi, one study was found: Bunduki et al (2021) undertook a survey of HAI and antimicrobial use in the surgery department of Queen Elizabeth Central Hospital (QECH) and found a point prevalence of HAI was 11.4% (12 out of 105 patients). Based on the stronger evidence from the pooled estimates, it is appropriate to use the pooled estimates reported in the meta-analysis by Abubakar et al (2022).

[b] Musicha et al (2017) analysed 194,000 blood cultures that were routinely taken from adult and paediatric patients with fever or suspicion of sepsis admitted to Queen Elizabeth Central Hospital, Blantyre, Malawi from 1998 to 2016. 13 366 (51·1%) of 26 174 bacterial isolates were resistant to the Malawian first-line antibiotics amoxicillin or penicillin, chloramphenicol, and co-trimoxazole.

Murray et al (2022) report a systematic analysis of the global burden of bacterial antimicrobial resistance in 2019 and produce modelled estimates for resistance of several important pathogens to frontline drugs. The following figures are modelled data for Malawi:

- Meticillin-resistant Staphylococcus aureus is 20-30%.
- Isoniazid and rifampicin co-resistant (excluding XDR) Mycobacterium tuberculosis <5%.
- Third-generation cephalosporin-resistant Escherichia coli 50-60%.
- Carbapenem-resistant Acinetobacter baumannii 20-30%.
- Fluoroquinolone-resistant Escherichia coli 50-60%.
- Carbapenem-resistant Klebsiella pneumoniae <5%.
- Third-generation cephalosporin-resistant Klebsiella pneumoniae is 70-80%.

[c] Due to lack of published data available on the total costs of treating HAIs, it is necessary to construct the cost based on the cost per hospital bed day, the additional length of stay due to HAI, and the costs of drugs, procedures and laboratory tests related to the HAI. AMR will also lead to longer length of stay, and additional costs of drugs, procedures and laboratory tests.

[d] The cost per bed day in 2022 is estimated using the 2011 cost in Uganda (IHME, 2014), updating to current prices using the GDP deflator for Uganda for 11 years, and then converting to Malawi Kwacha using the average exchange rate for 2022.

[e] Aerts et al (2022) for Mozambique, Gigey et al (2023) for Ethiopia and Bocoum et al (2019) for Mali, reflecting three ranges for different levels of care. Values in local currency were updated to 2022 costs and converted to Malawi Kwacha using PPP. The upper value is similar to the

[f] Based on data, as follows. Fenny et al (2020) found in a teaching hospital additional average length of stay (ALOS) of 4.6 days for patients with SSI. Otieku et al (2023) found ALOS was 3 days longer between the HAI (non-AMR) group and the control group.

[g] Otieku et al (2023) found patients in the AMR cohort stayed approximately 5 more days compared with HAI patients and 8 more days compared with uninfected cohorts.

[h] An exploratory literature review with a focus on the nine countries of the Hutton et al (2023) study found seven studies. Two studies presented case fatality of only HAI patients, while five compared HAI and non-HAI patients. Differences in case fatality ranged from 4.2% to 14.6%, with two studies from Ethiopia with a difference of 6.9%.

[i] US$ 8 million value of statistical life (VSL) from the USA (Banzhaf, 2022) converted to Malawi based on GDP per capita differential with the USA and using an income elasticity of 1.5.

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