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

Summary

The number of healthcare associated infections (HAI) in Zambia (population: 19.6 million) is conservatively estimated at 242,000 cases in 2022, with 25,100 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 HAIs in Zambia in 2022 is US$ 674 million. This equates with 2.3% of Gross Domestic Product in 2022. The financial costs of providing healthcare to treat HAIs is US$ 115 million in 2022, or 6.9% of total health expenditure. When comparing the medical costs per capita in Zambia of US$ 5.74 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 Zambia 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 Zambia in 2022 was US$ 674 million.
- This equates with 2.3% of Gross Domestic Product.
- The financial costs of providing healthcare to treat HAIs is US$ 115 million in 2022, or 6.9% of total health expenditure.
- It is feasible that the spending to provide basic WASH, waste management and environmental cleaning in healthcare facilities in Zambia (less than US$ 1 per capita) will be more than covered by the savings in medical costs of US$ 2.87 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 Zambia, and it seriously impacts quality of care and satisfaction with health services.

In Zambia 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.

The problem caused by HAIs has been long recognised by the Ministry of Health in Zambia, which – in its quest to improve patient safety and quality of care – has prioritised infection prevention and control (IPC) as a critical component of quality healthcare, with guidelines and minimum standards (Ministry of Health, 2018a, 2018b). A training manual on IPC and WASH in healthcare facilities was also published (Ministry of Health, 2018c).

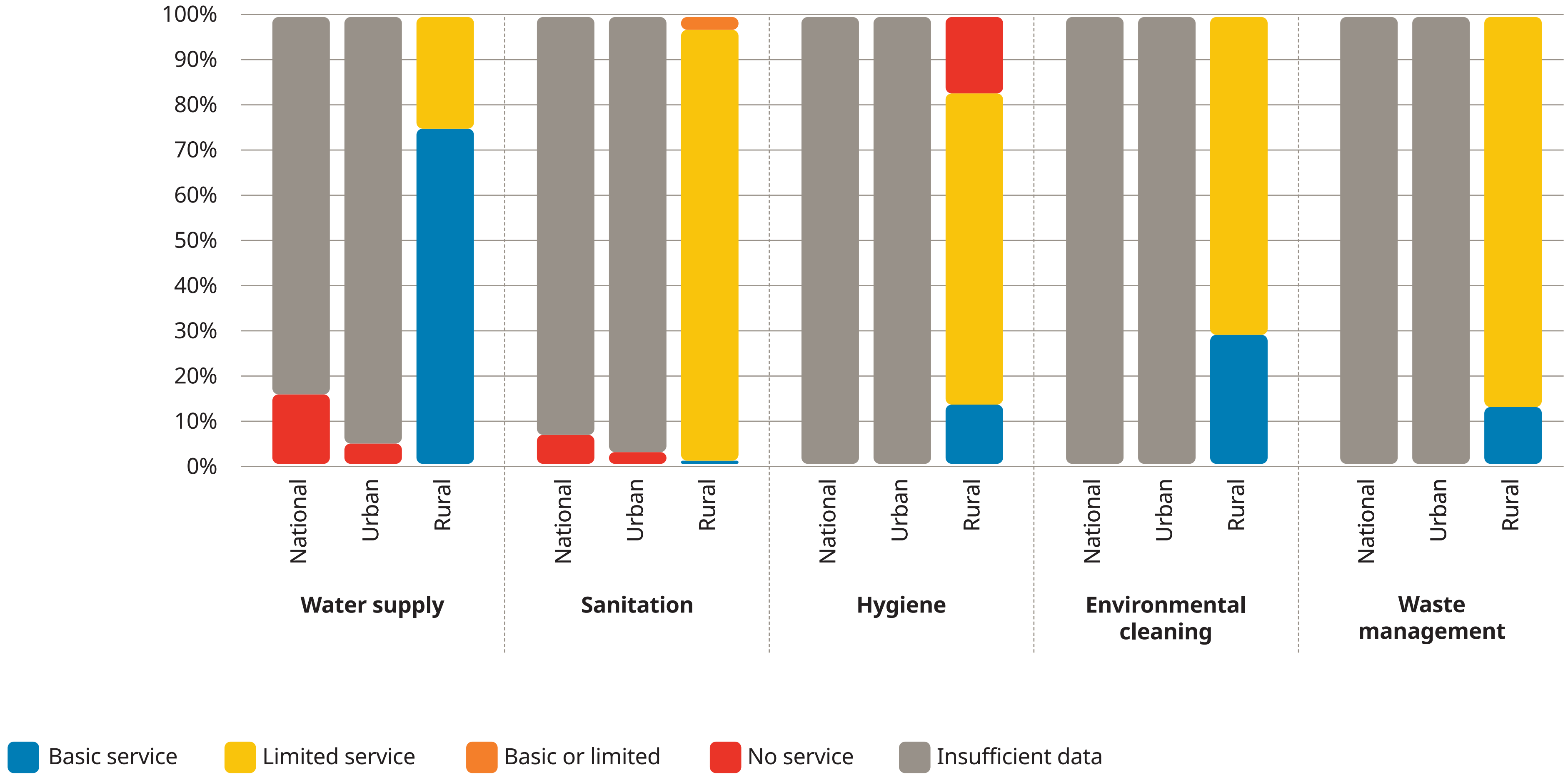
A growing proportion of HAIs are resistant to antimicrobials, leading to a worse health outcome for the patient and making them more costly to treat and requiring longer to recover and restart normal life, including productive activities. Antimicrobial resistance (AMR) rates vary across drugs and across settings within Zambia, but available estimates suggest that the majority of HAIs will be resistant to first-line drugs. As a response, in 2018 the Director General of the Zambia National Public Health Institute (ZNPHI) launched the Zambia Strategic Program for Antimicrobial Stewardship (ZASPARS) (ReAct, 2022). The programme is an adaptation of the Swedish Strategic Programme Against Antibiotic Resistance (STRAMA) which has led to a significant reduction of the inappropriate use of antibiotics in Sweden since its introduction in 1995.

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 Zambia, in all instances there is limited data available However, this is particularly the case in urban compared to rural healthcare facilities. Less than 30% of rural healthcare facilities practice basic environmental cleaning, while almost all rural healthcare facilities meet a limited, but not basic, sanitation standard. On the other hand, three-quarters of rural healthcare facilities have basic water supply. Basic handwashing and solid waste management is below 15% in rural areas.

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 Zambia 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 Zambia, 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	Zambia 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), Loevinsohn et al (2021), Mwananyanda (2019)
	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	9.5 admissions per 100 population	Ministry of Health
Additional cost of treating a patient with an HAI [c]	Average hospital cost per day ('hotel' cost)	US$ 17.9 health centre, US$ 19.9 district hospital, US$ 48.3 higher hospital [d]	IHME (2015), Chola et al (2019)
	Cost of drugs and laboratory tests per HAI	US$ 31.3 health centre, US$ 75.1 district hospital, US$ 344.8 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	Zambia 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$ 1.8 per day (US$ 67 per day in industry)	World Bank statistics
	Proportion of adult HAI patients	60%	Assumption
	Labour force participation rate	54.1% (female) 71.9% (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	Assumption
Mortality cost			
Annual HAIs	Same as Healthcare cost		
Case fatality rate	HAI case fatality rate	6.9% (4% to 15%) [h] 13.8% (AMR)	7 studies
Value of a premature death	Value of a statistical life	US$ 21,635 (high value US$ 70,590) [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 Zambia[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.

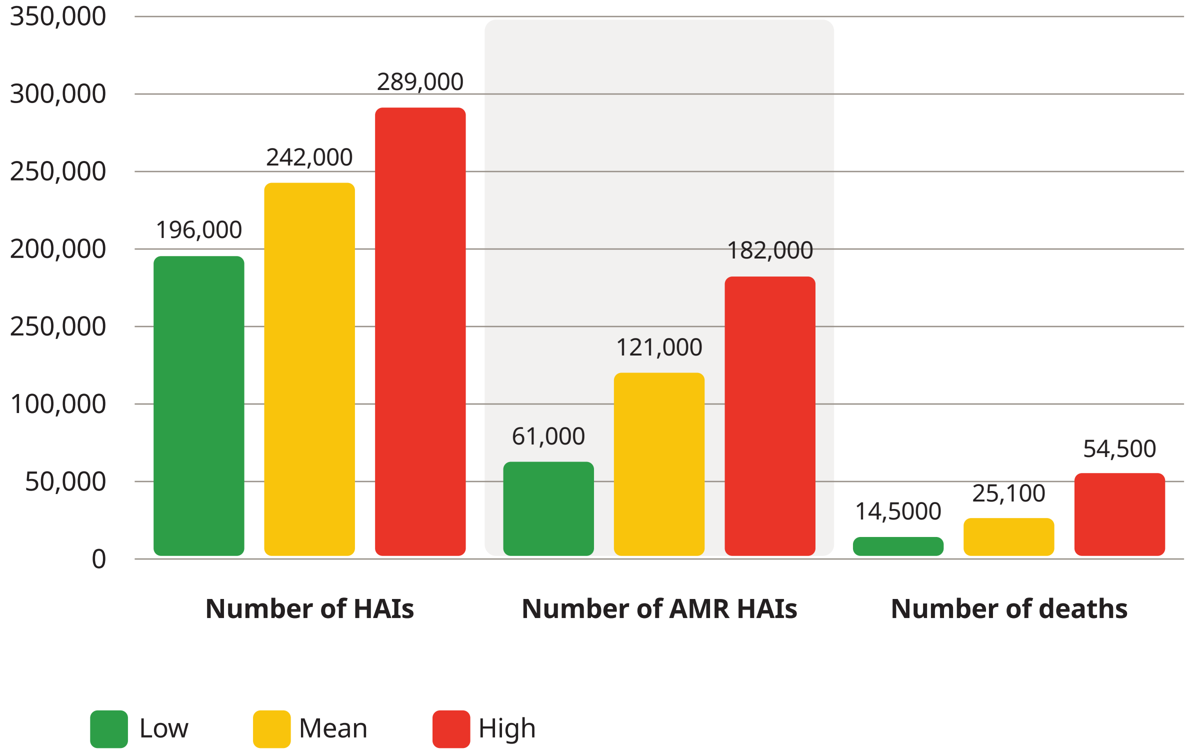
3. No comprehensive study of the economic and financial costs of HAIs has been conducted anywhere in the world, so it is not possible to conclude by how much this current study underestimates the true costs of HAIs.

Results

Disease burden due to healthcare associated infections

In total, the average number of HAIs in Zambia is estimated to be 242,000 in 2022, 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 25,100 deaths.

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

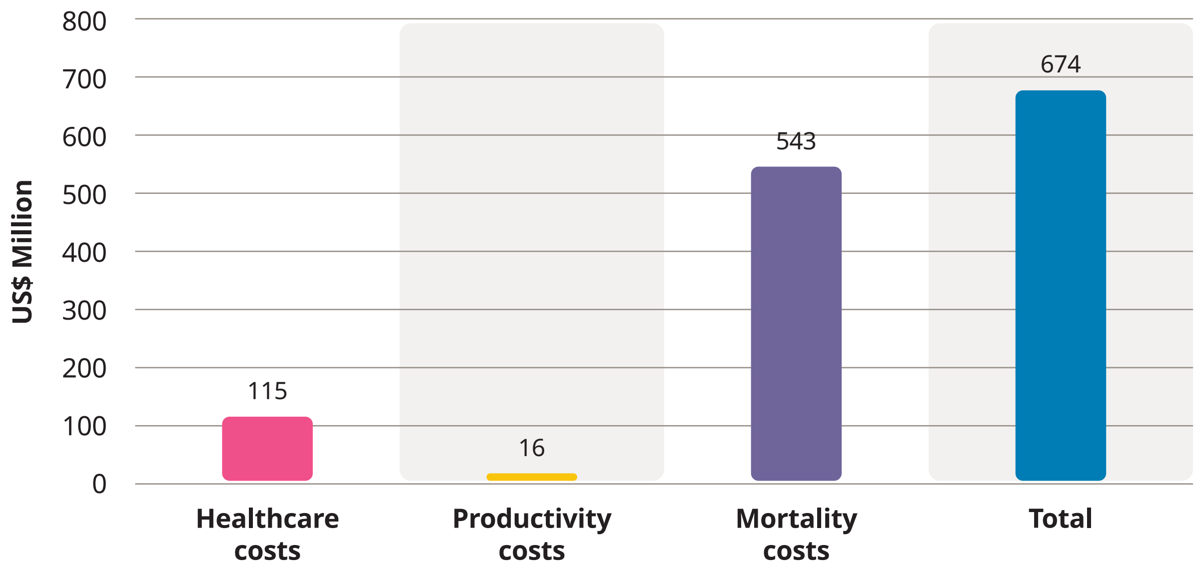


Estimates were made using different data inputs. When varying the baseline HAI rate of 12.76% from 10.3% to 15.2%, the number of HAIs varied from almost 196,000 to 289,000. When varying the AMR rate (baseline 50%) from 25% to 75%, the number of HAIs that are anti-microbial resistant varies from 61,000 to 182,000. When varying the case fatality rate (baseline 6.9%) from 4% to 15%, the number of deaths varies from 14,500 to 54,500.

Monetary impacts due to HAIs

Costs of HAI are presented in Figure 3. Total costs exceed US$ 674 million per year in Zambia.

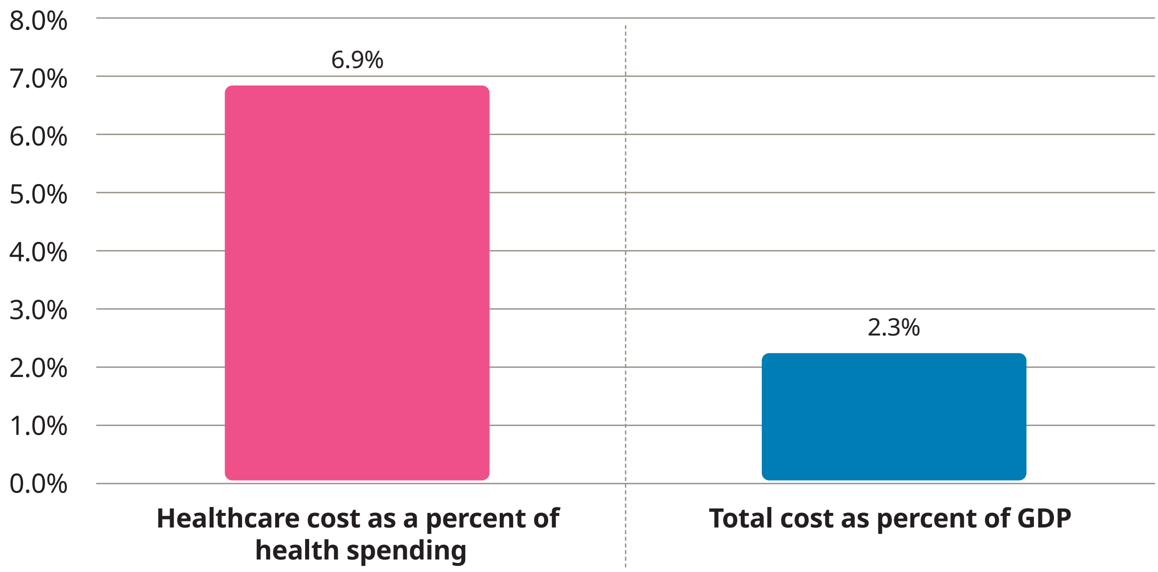
Figure 3. Estimated costs from HAIs in Zambia



Healthcare costs amount to US$ 115 million per year, with US$ 16 million in productivity losses and US$ 543 million in lost lives. The costs of premature death account for 81% of the total costs, due to the relatively high case fatality rate from HAIs. Total cost per HAI is US$ 2,780. Healthcare cost averaged US$ 475 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 2.3% of GDP. The costs of treating HAIs (US$ 115 million per year) reflect 6.9% of overall healthcare spending from all sources.

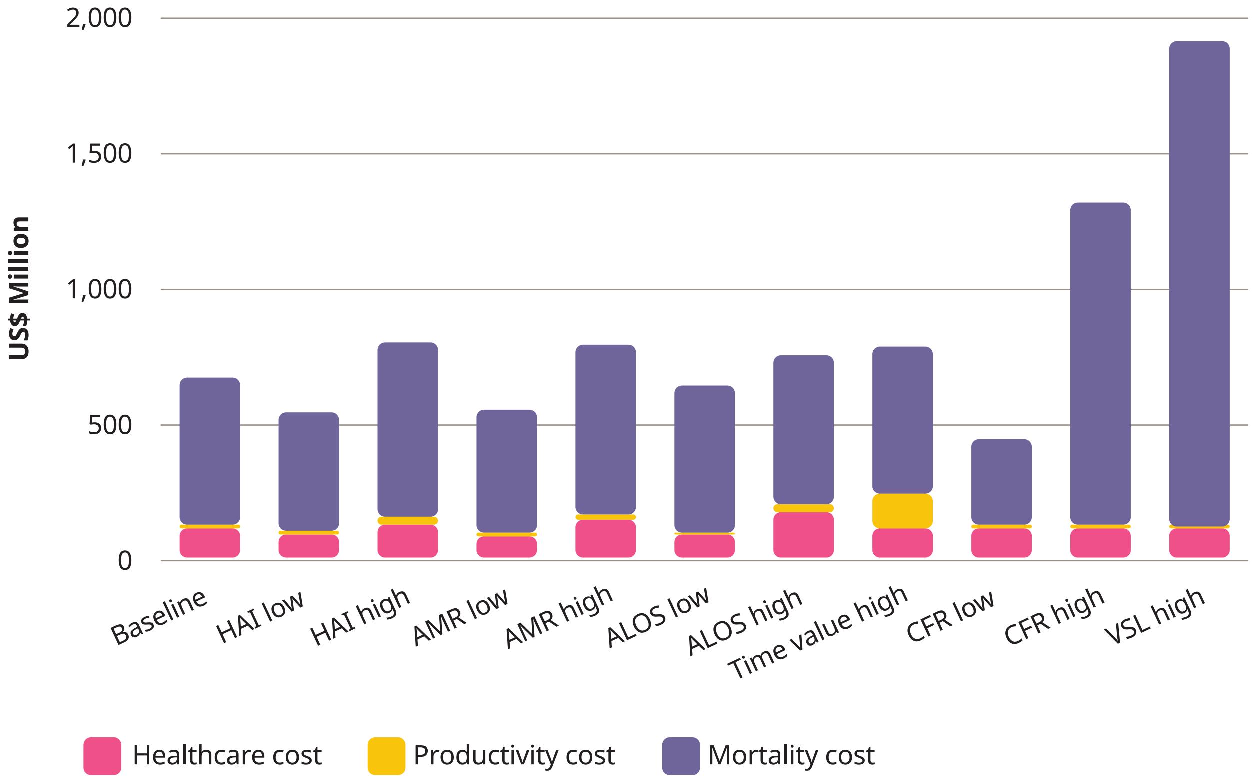
Figure 4. Costs as a proportion of GDP and healthcare spending



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 it led to a total economic cost of US$ 1.9 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 1.5% (low data value for CFR rate) to 6.4% (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 Zambian population is at least US$ 5.74 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 clinic 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 to healthcare workers, which can seriously impact the health system's ability to provide quality healthcare. Healthcare worker 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. Given the healthcare cost estimates have been conservative, at least 3.45% of healthcare expenditures could be saved if HAIs were minimised.

As has been found in more economically developed 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 Zambia 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 Zambia, Loevinsohn et al (2021) conducted 1 year surveillance and found that 1.7% of admissions developed an infection more than 48 hours after admission. A parallel study on healthcare workers found that 43% experienced at least one infection episode during the year. The cumulative incidence of influenza infection among HCWs over 1 year was 9%. Mwananyanda (2019) found that half of the neonates enrolled in the study (1344 out of 2669 – 50.4%) experienced 1 or more episodes of suspected sepsis.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] 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. From Murray et al (2022), rates of resistance are the following for Zambia:

- Meticillin-resistant Staphylococcus aureus is 10-20%.
- Isoniazid and rifampicin co-resistant (excluding XDR) Mycobacterium tuberculosis is <5%.
- Third-generation cephalosporin-resistant Escherichia coli is 30-40%.
- Carbapenem-resistant Acinetobacter baumannii is 30-40%.
- Fluoroquinolone-resistant Escherichia coli is 20-30%.
- Carbapenem-resistant Klebsiella pneumoniae is <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 Kwacha (IHME, 2014), updating to current prices using the GDP deflator for Zambia for 11 years, and then applying the average exchange rate for 2022. The health centre unit cost is similar to US$18 per inpatient bed day found in Chola et al (2019).

[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 Zambian Kwacha using PPP.

[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 Zambia based on GDP per capita differential with the USA and using an income elasticity of 1.5. The high value is estimated using an income elasticity of 1.2.

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