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

Summary

The number of healthcare associated infections (HAI) in Uganda (population: 45.9 million) is conservatively estimated at 422,000 cases in 2022, with 43,600 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 Uganda in 2022 is US$ 580 million. This equates with 1.43% of Gross Domestic Product in 2022. The financial costs of providing healthcare to treat HAIs is US$ 123 million in 2022, or 7.9% of total health expenditure. When comparing the medical costs per capita in Uganda of US$ 2.80 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 Uganda 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 Uganda in 2022 was US$ 580 million.
- This equates with 1.43% of Gross Domestic Product.
- The financial costs of providing healthcare to treat HAIs is US$ 123 million in 2022, or 7.9% of total health expenditure.
- It is feasible that the spending to provide basic WASH, waste management and environmental cleaning in healthcare facilities in Uganda (less than US$ 1 per capita) will be more than covered by the savings in medical costs of US$ 1.40 per capita 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 Uganda, and it seriously impacts quality of care and satisfaction with health services.

Uganda has a total of 6,937 health facilities (public, private and private not for profit). There are four national referral hospitals, five specialised hospitals, 17 Regional referral hospitals, and 62 general or district hospitals (Ministry of Health Uganda, n.d.). 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 recognised by the Ministry of Health (2013) when it produced the Uganda National Infection Prevention and Control Guidelines. The IPC training of trainers manual was produced in 2018. A national IPC unit has been established, as has a national IPC strategic plan, and revision of national IPC guidelines for COVID-19, which included content on healthcare worker monitoring and management, screening and triage, rational use of PPE, waste management, and environmental cleaning and disinfection. In addition, an IPC monitoring and evaluation framework now exists with key performance indicators to strengthen IPC program implementation, monitoring, and evaluation (Gomes et al 2022).

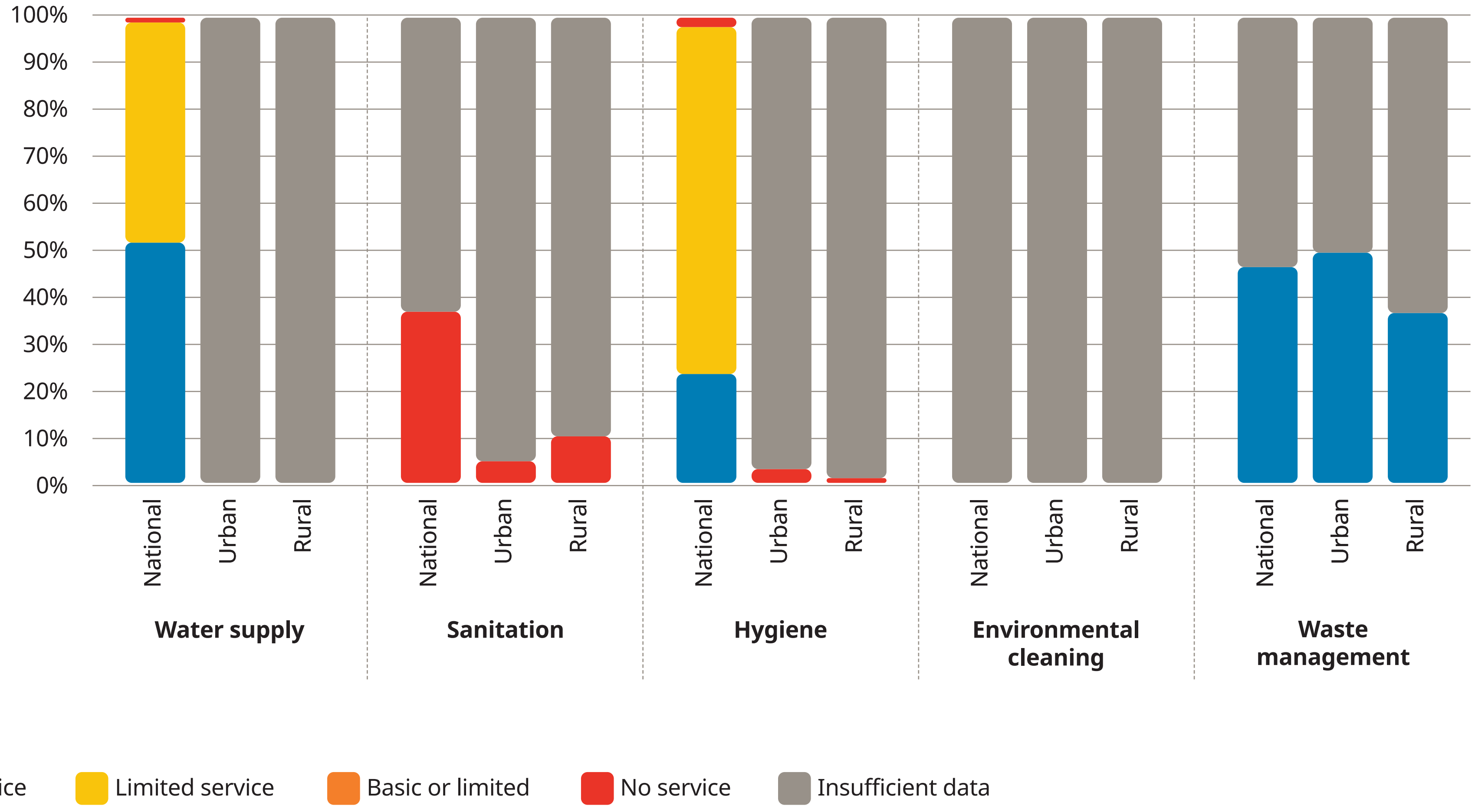
A growing proportion of HAIs are resistant to antimicrobials, leading to a worse health outcome for the patient and making them more costly to treat and requiring longer to recover and restart normal life, including productive activities. Antimicrobial resistance (AMR) rates vary across drugs and across settings within Uganda, but available estimates suggest that a majority of HAIs will be resistant to first-line drugs. As a response, Uganda has issued an Antimicrobial Resistance National Action Plan 2018-2023 (Ministry of Health, 2020). The Plan outlines its 'One Health' approach arguing that 'Prevention is the most effective, affordable way to reduce risk for and severity of resistant infections'. Strategic Objective Two identifies key actions to improve infection prevention and control.

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 Uganda. There is insufficient data for national estimates for sanitation and environmental cleaning. Basic water supply was available in 52% of healthcare facilities nationally. Basic hygiene services, where handwashing materials are available at the point of care and near toilets, are present in less than one-quarter of healthcare facilities nationally. Basic waste management is available in just under 50% of healthcare facilities across the country. A study (Opollo et al, 2021) at the Lira University hospital (LUH) in 2020 highlighted the continuing poor IPC practices where the overall IPC compliance score was 225/800, or 28.5%, thus implying a basic IPC compliance level. At the hospital, there was no IPC committee, no IPC team, and no IPC budgets.

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 Uganda 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 HAIs 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 Uganda, 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	Uganda 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), Greco & Magombe (2010) Seni et al (2013)
	Proportion of anti-microbial resistance in HAIs	50% (25% to 75%) [b]	4 studies for Uganda, Murray et al (2022), East Africa reviews
	No. of annual hospital admissions	7.2 admissions per 100 population	Ministry of Health (2020)
Additional cost of treating a patient with an HAI [c]	Average hospital cost per day ('hotel' cost)	US$ 10.7 health centre, US$ 17.0 district hospital, US$ 31.7 higher hospital [d]	IHME (2014)
	Cost of drugs and laboratory tests per HAI	US$ 26.9 health centre, US$ 64.6 district hospital, US$ 296.7 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	Uganda 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$ 4.3 per day (US$ 60 per day in industry)	World Bank statistics
	Proportion of adult HAI patients	60%	Assumption
	Labour force participation rate	37.4% (female) 57.1% (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] 13.8% (AMR)	7 studies
Value of a premature death	Value of a statistical life	US$ 9,907 (high value US$ 37,789) [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 Uganda[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.

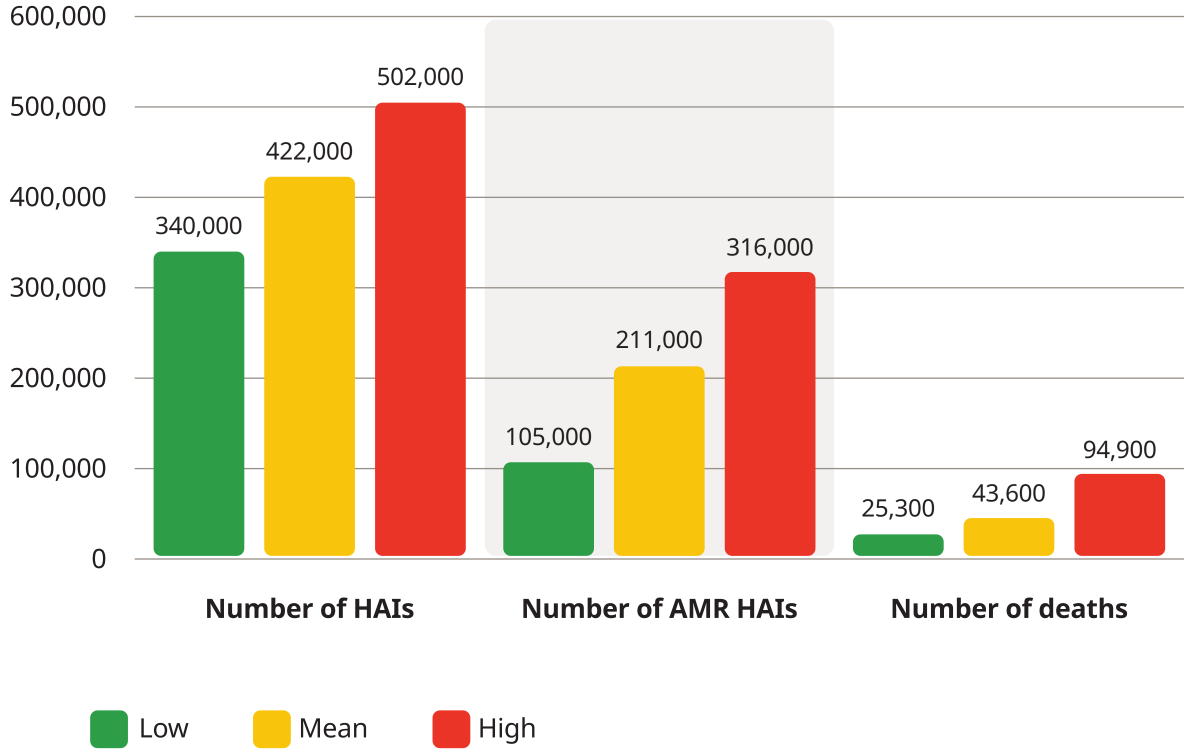
3. No comprehensive study of the economic and financial costs of HAIs has been conducted anywhere in the world, so it is not possible to conclude by how much this current study underestimates the true costs of HAIs.

Results

Disease burden due to healthcare associated infections

In total, the average number of HAIs in Uganda is estimated to be 422,000 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 43,600 deaths.

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

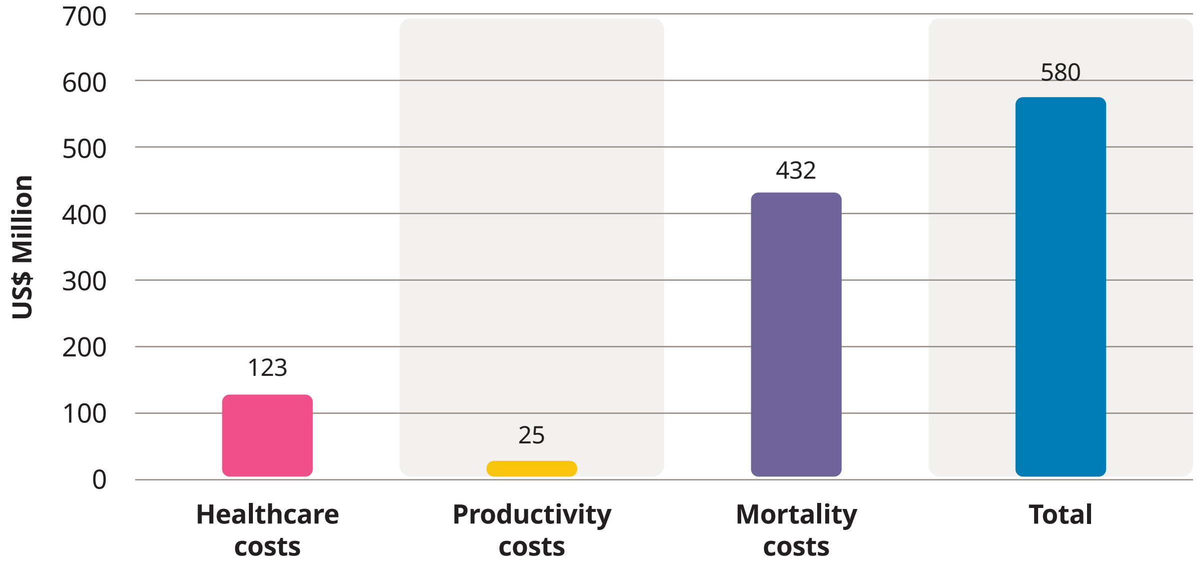


Estimates were made using different data inputs. When varying the baseline HAI rate of 12.8% from 10.3% to 15.2%, the number of HAIs varied from 340,000 to 502,000. When varying the AMR rate (baseline 50%) from 25% to 75%, the number of HAIs that are anti-microbial resistant varies from approximately 105,000 to 316,000. When varying the case fatality rate (baseline 6.9%) from 4% to 15%, the number of deaths varies from 25,300 to 94,900.

Monetary impacts due to HAIs

Costs of HAI are presented in Figure 3. Total costs exceed US$ 580 million per year in Uganda.

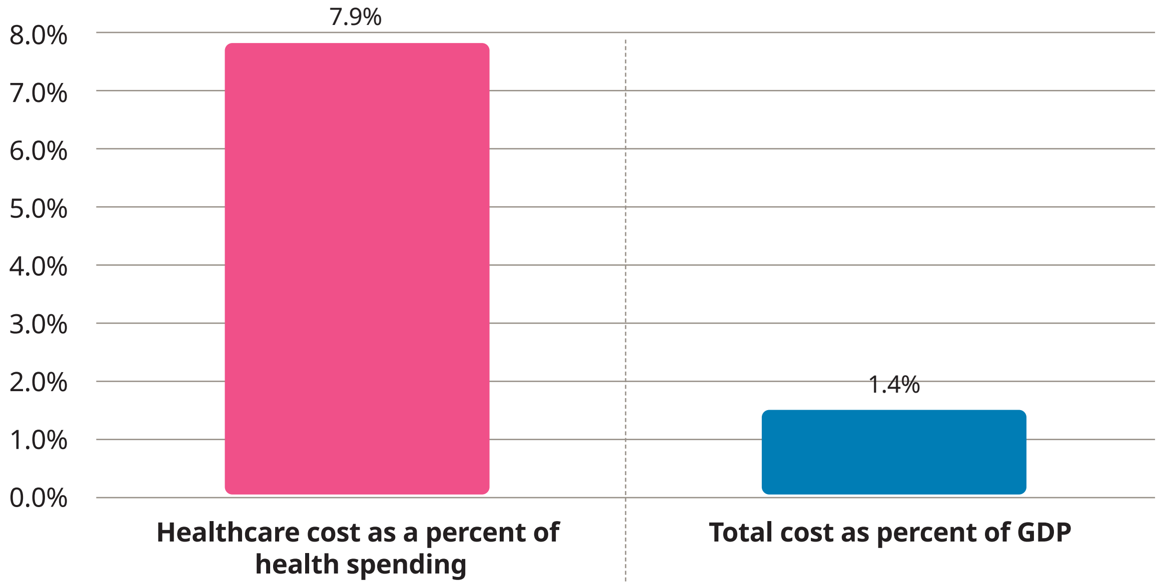
Figure 3. Estimated costs from HAIs in Uganda



Healthcare costs amount to US$ 123 million per year, with US$ 25 million in productivity losses and US$ 432 million in lost lives. The costs of premature death account for 75% of the total costs, due to the relatively high case fatality rate from HAIs. Total cost per HAI is US$ 1,375. Healthcare cost averaged US$ 291 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 1.4% of GDP. The costs of treating HAIs (US$ 115 million per year) reflect 7.9% of overall healthcare spending from all sources.

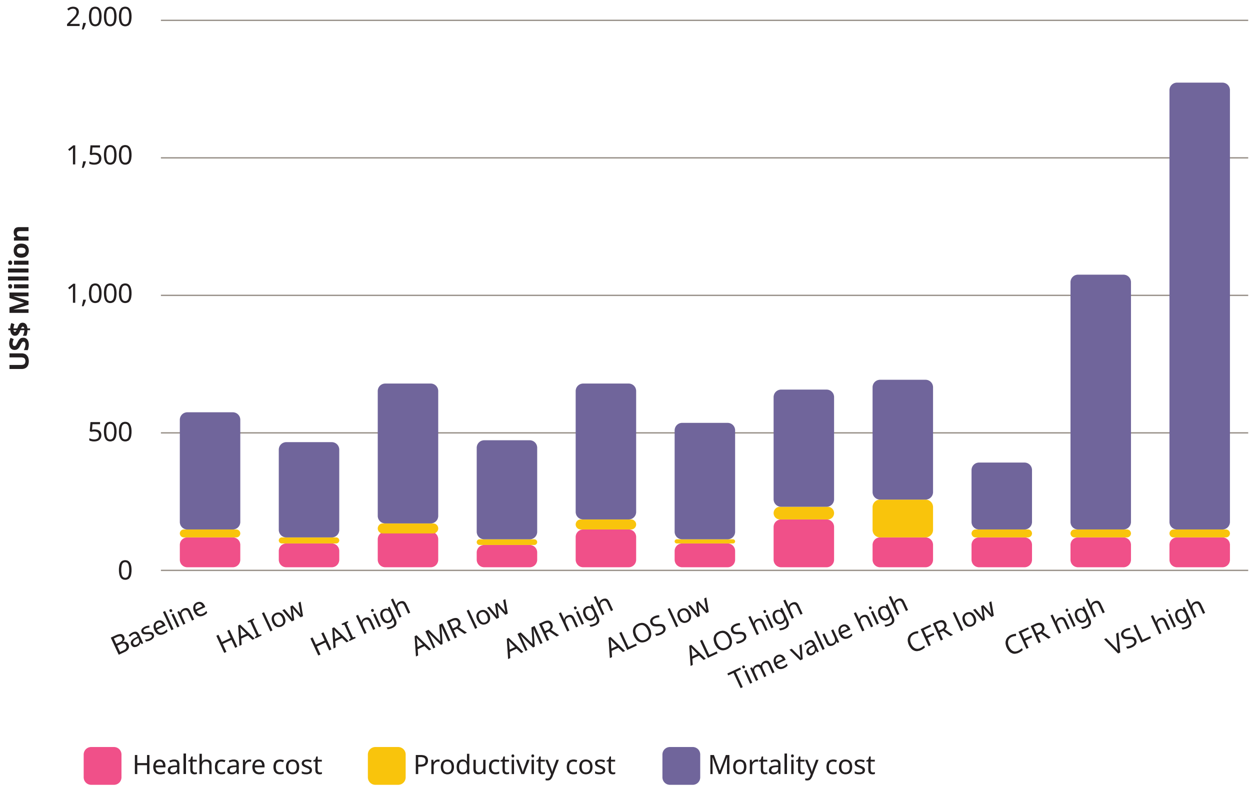
Figure 4. Costs as a proportion of GDP and healthcare spending



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, and 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$ 1.8 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 1.0% (low data value for HAI rate) to 4.4% (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 Ugandan population is at least US$ 2.80 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 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 costs are conservatively estimated, at least 3.95% 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 Uganda 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 Uganda, Greco & Magombe (2010) find HAI rate of 28% in one large hospital and Seni et al (2013) reported a rate of 10% for SSI at the national hospital. 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] Systematic reviews of antimicrobial drug resistance in sub-Saharan Africa show that antimicrobial resistance varies widely for different first- and second-line drugs and across geographies from 0% to over 80% (Leopold et al, 2014; Tadesse et al, 2017; Kariuki et al, 2021). Kariuki et al (2021) report for Uganda AMR of above 80% for tetracycline and chloramphenicol. A study of women with postpartum fever in Uganda found that among 25 blood and urine cultures with Gram-negative isolates, 80% were multi-drug resistant including cefepime-resistant (Bebell et al, 2017). Tadesse et al (2017) conduct a systematic review of AMR in Africa, including a total of 144 publications covering more than half of African countries. Penicillin resistance in Streptococcus pneumoniae averaged 26.7% from 14 studies. 34.0% of Haemophilus influenza isolates were resistant to amoxicillin. Resistance of Escherichia coli to amoxicillin, trimethoprim and gentamicin was 88.1%, 80.7% and 29.8% respectively. Ciprofloxacin resistance in Salmonella Typhi was rare. Carbapenem resistance was common in Acinetobacter spp. and Pseudomonas aeruginosa but uncommon in Enterobacteriaceae. Browne et al (2020) reported during the latest period of data (2010-2014) that the pooled prevalence of multidrug resistant S. Typhi was 59% in Eastern SSA, while fluoroquinolone non-susceptibility (FQNS) was 16% in Eastern SSA

In Uganda, Anguzu et al (2007) found resistance to ampicillin, amoxycillin and chloramphenicol for surgical site infections. Staphylococcus aureus was most resistant to erythromycin (56.2%) and ampicillin (97%), while being less resistant to gentamicin (13%), ciprofloxacin (31%) and methicillin (25%). Most of the gram-negative bacteria isolated (Coliforms, P.aeruginosa, E.coli, Proteus mirabilis, and Klebsiella pneumoniae) were sensitive to Ciprofloxacin, Gentamicin and Ceftazidime but resistant to Ampicillin, Amoxycillin and Chloramphenicol. Methicillin-resistant Staphylococcus aureus (MRSA) strains formed 25% of this species. Pseudomonas aeruginosa was most resistance to ciprofloxacin (57.2%) and less resistant to gentamicin (13%) and ceftazidime (14%).

In Uganda, Seni et al (2013) report that more than 75% of Enterobacteriaceae were found to be resistant and 37.5% of S. aureus were Methicillin resistant S. aureus (MRSA). MDR occurred in 78.3% (238/304) of the isolates. Amikacin and imepenem showed excellent performance except that they remain expensive drugs in Uganda.

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 Uganda:

- Meticillin-resistant Staphylococcus aureus is 5-10%.
- Isoniazid and rifampicin co-resistant (excluding XDR) Mycobacterium tuberculosis is <5% for all of Africa.
- Third-generation cephalosporin-resistant Escherichia coli is 40-50%.

- Carbapenem-resistant Acinetobacter baumannii is <5%.
- Fluoroquinolone-resistant Escherichia coli is 40-50%.
- Carbapenem-resistant Klebsiella pneumoniae is <5%.
- Third-generation cephalosporin-resistant Klebsiella pneumoniae is 60-70%.

[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 Kwachas (IHME, 2015), updating to current prices using the GDP deflator for Uganda for 11 years, and then applying the average Kwacha:dollar 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 Uganda 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 Uganda 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.

WaterAid is an international not-for-profit, determined to make clean water, decent toilets and good hygiene normal for everyone, everywhere within a generation. Only by tackling these three essentials in ways that last can people change their lives for good.

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