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Water availability at hospitals in low- and middle-income countries: implications for improving access to safe surgical care



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ABSTRACT

Introduction: Although two billion people now have access to clean water, many hospitals in low- and middle-income countries (LMICs) do not. Lack of water availability at hospitals hinders safe surgical care. We aimed to review the surgical capacity literature and document the availability of water at health facilities and develop a predictive model of water availability at health facilities globally to inform targeted capacity improvements.

Methods: Using Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, a systematic search for surgical capacity assessments in LMICs in MEDLINE, PubMed, and World Health Organization Global Health Library was performed. Data regarding water availability were extracted. Data from these assessments and national indicator data from the World Bank (e.g., gross domestic product, total health expenditure, and percent of population with improved access to water) were used to create a predictive model for water availability in LMICs globally.

Results: Of the 72 records identified, 19 reported water availability representing 430 hospitals. A total of 66% of hospitals assessed had water availability (283 of 430 hospitals). Using these data, estimated percent of water availability in LMICs more broadly ranged from under 20% (Liberia) to over 90% (Bangladesh, Ghana).

Conclusions: Less than two-thirds of hospitals providing surgical care in 19 LMICs had a reliable water source. Governments and nongovernmental organizations should increase efforts to improve water infrastructure at hospitals, which might aid in the provision of

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safe essential surgical care. Future research is needed to measure the effect of water availability on surgical care and patient outcomes.

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Background

Since 1990, nearly two billion people have gained access to improved sources of water, one of the success of the United Nations Millennium Development Goals.¹ Despite this success, 700 million people still live without access to water; half of those without water live in sub-Saharan Africa.² Lack of access to water, sanitation, and hygiene (WASH) infrastructure has a significant and negative impact on both health and healthcare provision, including surgical care.^{1,3,4}

Much of the increased access to water has been achieved by providing piped water on-site (i.e., running water), building public taps, drilling boreholes, and supporting rainwater capture methods.¹ However, public taps, boreholes, and rainwater capture are poorly suited for providing a constant supply of large volumes of water.² Furthermore, water availability at hospitals has not been systematically addressed.² In low- and middle-income countries (LMICs) with a funded institutional framework for achieving improved WASH targets, water coverage in hospitals is 85% or greater. To date, few LMICs have assessed or reported the availability of water in hospitals.

The World Health Assembly 68.15 underlined the importance of strengthening emergency and essential surgical care as a component of universal health coverage; in particular, it specifies the concern that inadequate investment in infrastructure, such as water availability, limits progress in improving delivery of surgical care.³ The need to better defining the critical aspects of providing essential surgical care lead to the launch of the WHO Global Initiative for Emergency and Essential Surgical Care in 2005, an alliance of international organizations, civil and professional societies, nongovernmental organizations, and those representing disciplines of surgery, orthopedics, anesthesia, emergency medicine, and obstetrics.⁴ Recognizing the availability of water at hospitals providing surgery as a limiting factor is important for this mission and surgeons operating in LMICs. Reliable water availability is essential for providing safe surgical care.^{1,5,6} Water is required for washing instruments, steam sterilization, wound irrigation, and surgical hand scrub (SHS). SHS is an essential surgical safety measure⁴; it is also the most water-intensive part of surgical care, ranging from 15 to 20 L per SHS.⁵⁻⁷ In 1 y, a tertiary hospital in Nigeria used 200,283 L of water for SHS alone.⁶ Lack of reliable water availability can lead to delays in treatment and poor surgical outcomes.^{6,8-14}

Surgery is an indivisible and indispensable part of healthcare.¹⁵ However, surgical care is under funded, which has led to critical capacity deficiencies and a significant burden of avertable death and disability.¹⁶⁻¹⁸ Although a number of surgical capacity assessments have reported a lack of equipment and supplies, water availability at hospitals remains poorly characterized.^{1,19,20} These assessments provide a unique opportunity to examine the water

availability at hospitals in LMICs. Thus, we aimed to systematically review the surgical capacity literature and describe the availability of water at hospitals in LMICs where they were performed. In addition, we used data from these assessments to model water availability at hospitals in LMICs more broadly. By doing so, the findings might identify fundamental limitations in surgical capacity and inform targeted capacity development strategies.

Material and methods

Systematic review

We designed a systematic search strategy to identify all published surgical capacity assessments that reported the water availability at hospitals in LMICs (see [Supplementary material](#)). The search strategy included terms for each of the following surgical care capacity assessments:

- (i) WHO's Tool for Situational Analysis to Assess Emergency and Essential Surgical Care²¹;
- (ii) Personnel, Infrastructure, Procedures, Equipment, and Supplies survey²²; and
- (iii) the Harvard Humanitarian Initiative's survey tool.²³

Other terms were used to identify records that did not use the three tools aforementioned but assessed surgical care capacity, such as "surgical," "surgery," "capacity," "assessment," and "survey" (see [Supplementary material](#)). The World Bank World Development Report was used to define LMICs.²⁴

Low-income countries are those with a gross national income (GNI) per capita of \$1045 or less in 2014; lower-middle-income countries are those with GNI per capita between \$1046 and \$4125; upper-middle-income countries are those with GNI per capita between \$4126 and \$12,735.²⁴

The titles and abstracts of retrieved records were screened for relevance, and the duplicates were removed. Two reviewers (S.S.C. and S.G.) screened all records; a third reviewer (A.L.K.) resolved disagreements. The remaining full-text reports and their reference lists were reviewed. Reports were included if they described the availability of water at one or more hospitals in a LMIC. If multiple reports from one country were found, the report with the most hospitals assessed was included.

Systematic review data analysis

A binary score was assigned to water availability for each hospital (i.e., water reliably available or not reliably available). For studies that did not provide data for each hospital, the countrywide prevalence of water availability was used. Most reports did not provide description of type or quality of the

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