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Monitoring Environmental Health in Maternal and Newborn Health Programs In Health Care Facilities

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Introduction

In health care facilities (HCFs), adherence to infection prevention and control practices are necessary to protect patients, health care workers, visitors, and staff; promote satisfaction with health services; and ensure quality maternal and newborn health (MNH) care. This requires adequate environmental health infrastructure (e.g. water supplies, sanitation facilities, handwashing stations, sterilization equipment), environmental hygiene items for infection prevention and control (IPC) (e.g. soap, gloves), clean surfaces, appropriate hygienic behaviors, and effective facility design in HCF maternity wards^{1,2,3}. However, many HCFs in low- and middle-income countries (LMICs) have substandard water, sanitation, and hygiene (WASH) facilities and lack adequate IPC items, policies, protocols, and behaviors^{4,5}. These inadequate

Key Facts

- Indicators are available to measure policy, interventions, critical environmental conditions (such as water supplies) and health outcomes associated with environmental health in health care settings for maternal and newborn health (MNH)
- Indicators exist to measure the presence of microorganisms in water, on surfaces, and on staff and patients, but these are infrequently used in MNH monitoring
- MNH program monitoring should comprehensively incorporate indicators linked to “critical conditions” of environmental health in the healthcare environment, such as availability of sanitation, waste management, and cleaning practices
- Programs seeking to demonstrate health impact should consider measuring contamination and clinically diagnose health care acquired infections (HCAIs)

¹ Benova, L., Cumming, O., & Campbell, O. M. R. (2014). Systematic review and meta-analysis: association between water and sanitation environment and maternal mortality. *Tropical Medicine & International Health*, 19(4), 368–387

² Campbell, O. M. R., Benova, L., Gon, G., Afsana, K., & Cumming, O. (2015). Getting the basic rights - the role of water, sanitation and hygiene in maternal and reproductive health: A conceptual framework. *Tropical Medicine and International Health*, 20(3), 252–267.

³ Velleman, Y., Mason, E., Graham, W., Benova, L., Chopra, M., Campbell, O. M. R., ... Cumming, O. (2014). From Joint Thinking to Joint Action: A Call to Action on Improving Water, Sanitation, and Hygiene for Maternal and Newborn Health. *PLoS Medicine*, 11(12). <https://doi.org/10.1371/journal.pmed.1001771>

⁴ World Health Organization and the United Nations Children’s Fund, WASH in health care facilities: Global Baseline Report 2019, WHO and UNICEF, Geneva, 2019. License: CC BY-NC-SA 3.0 IGO.

⁵ Cronk, R., Bartram, J. Environmental Conditions in healthcare facilities in low-and middle-income countries: Coverage and inequalities. *International Journal of Hygiene and Environmental Health* (2018), doi.org/10.1016/j.ijheh.2018.01.004

conditions lead to higher rates of health care acquired infections (HCAIs) and increased rates of morbidity and mortality^{6,7}.

The objectives of this brief are to:

- Review common and effective indicators for monitoring environmental health conditions and measuring improvements in maternal and newborn health care
- Recommend opportunities to enhance monitoring of environmental health in maternal and newborn health care settings

Methods

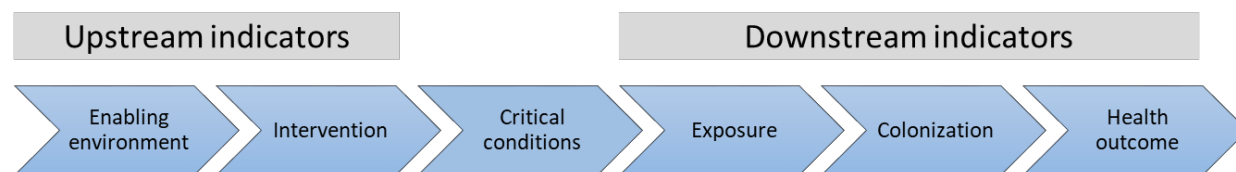
A review was conducted to identify indicators describing critical environmental health conditions necessary for maternal and newborn health care, including basic environmental health infrastructure (e.g. sanitation facilities, water supplies), environmental hygiene items for IPC, clean surfaces, effective and sustained hygienic behaviors, and effective facility design.

In addition, upstream (e.g. distal) and downstream (e.g. proximate) indicators⁸ associated with these environmental health conditions were identified (Figure 1).

Upstream indicators are defined as those indicating whether the critical conditions are likely to be met (for example, policies in place for environmental health in HCFs, adequate supply chains, training). In the context of environmental health improvements, upstream indicators include enabling environment indicators and intervention indicators. Enabling environment indicators are those related to governance, policy, financing, and human resources factors that influence environmental health conditions in HCFs. Intervention indicators represent strategies, approaches, and tools that link environmental health improvements and reductions in contamination, improvements in quality of care, and reductions in adverse health outcomes.

Downstream indicators are defined as those that link the environmental health critical conditions necessary to secure maternal and newborn health to exposures and health outcomes of interest. Downstream indicators reviewed were indicators of exposure, colonization indicators, and health outcome indicators. Exposures include a direct measure of contamination associated with the critical condition indicators, such as surface, hand, or water contamination. Colonization indicators are those that demonstrate that a patient is colonized with pathogens linked to the exposure indicators. Health outcomes are the specific health condition of the patient, specifically HCAIs.

Figure 1. Monitoring upstream and downstream indicators related to critical conditions for environmental health in health care facilities



⁶ Allegranzi B, Bagheri Nejad S, Combescurre C, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet* 2011;377:228–41. doi:10.1016/S0140-6736(10)61458-4 and WHO. Report on the burden of endemic health care-associated infection worldwide. Geneva, Switzerland: World Health Organization, 2011; and

⁷ Watson, J., D'Mello-Guyett, L., Flynn, E., Falconer, J., Esteves-Mills, J., Prual, A., ... & Cumming, O. (2019). Interventions to improve water supply and quality, sanitation and handwashing facilities in healthcare facilities, and their effect on healthcare-associated infections in low-income and middle-income countries: a systematic review and supplementary scoping review. *BMJ global health*, 4(4), e001632.

⁸ World Health Organization (2015). *Pregnancy, childbirth, postpartum and newborn care: a guide for essential practice*. 3rd ed. Geneva, Switzerland. Available from: <http://apps.who.int/iris/bitstream/handle/10665/249580/9789241549356-eng.pdf>.

As part of the review, websites including washinhcf.org, Infection Control Africa Network (ICAN), and the Maternal and Newborn Task Force were reviewed for relevant publications and reports. The following information was tabulated for indicators: description of indicators; developer of the indicators; indicator availability; methods for data collection, cost (if available); and frequency of data collection (if recommendations were provided).

Results

Critical environmental health conditions to secure maternal and newborn health

Indicators compiled by the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation, and Hygiene (JMP) are widely used to define environmental health critical conditions⁹. The core indicators produced by the JMP includes indicators for water, sanitation, hygiene, health care waste management, and environmental cleaning practices in HCFs. The JMP core indicators can be used to construct service levels for no service, limited service, and basic service.

These indicators are commonly collected through health care facility surveys, such as the Service Provision Assessment (SPA) supported by USAID through the Demographic and Health Survey (DHS) program¹⁰, the Performance Monitoring and Accountability 2020 (PMA2020) initiative¹¹, the Emergency Obstetric and Newborn Care (EmONC) surveys¹², the Service Delivery Indicators (SDI) project¹³, and other sub-national program and project monitoring initiatives. Many of these health care facility surveys, including the SPA, contain indicators for standard precautions and conditions for client examination such as the availability of sharps boxes and disposable gloves.

Table 1: WASH and IPC critical conditions, from the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) and the Service Provision Assessment (SPA)

Source and domain topic	Indicator	Response categories
JMP: water	What is the main water supply for the facility?	Piped supply inside the building; Piped supply outside the building; Tube well / Borehole; Protected dug well; Unprotected dug well; Protected spring; Unprotected spring; Rain water; Tanker truck; Surface water (river/dam/lake/pond); Other (specify); Don't know; No water source
	Where is the main water supply for the facility located?	On premises; Up to 500 meters away; 500 meters or further
	Is water available from the main water supply at the time of the survey?	Yes; No
JMP: sanitation	What type of toilets/latrines are at the facility for patients?	Flush / Pour-flush toilet to sewer connection; Flush / Pour-flush toilet to tank or pit; Pit latrine with slab; Composting toilet; Flush / Pour-flush toilet to open drain; Pit latrine without slab/open pit; Bucket; Hanging toilet/latrine; No toilet/latrine; Other (specify)
	Is at least one toilet usable (available, functional, private)?	Yes; No

⁹ <https://washdata.org/report/jmp-2018-core-questions-monitoring-winhcf-en>

¹⁰ The DHS Program, 2011. The Service Provision Assessment (SPA). Calverton, MD

¹¹ Zimmerman, L., Olson, H., PMA2020 Principal Investigators Group, Tsui, A., & Radloff, S. (2017). PMA2020: Rapid turn-around survey data to monitor family planning service and practice in ten countries. *Studies in family planning*, 48(3), 293-303.

¹² AMDD. Needs Assessments of Emergency Obstetric and Newborn Care Overview and Introduction to Materials. Available from <https://www.mailman.columbia.edu/sites/default/files/pdf/naoverview.pdf>

¹³ Bold, T., Svensson, J., Gauthier, B., Maestad, O., & Wane, W. (2011). Service delivery indicators: Pilot in education and health care in Africa. CMI Report.

Source and domain topic	Indicator	Response categories
	Are there toilets that ...3. Are dedicated for staff? 4. Are in sex-separated or gender-neutral rooms? 5. Have menstrual hygiene facilities? 6. Are accessible for people with limited mobility?	Yes; No (for each response)
JMP: hygiene	Is there a functional hand hygiene facility at points of care on the day of the survey?	Yes; No, there are hand hygiene facilities at points of care but not functional, or lacking soap and water or alcohol-based hand rub; No, no hand hygiene facilities at points of care; No, no hand hygiene facilities at the health care facility
	Is there a functional handwashing facility at one or more toilets on the day of the survey?	Yes; No, there are handwashing facilities near the toilets but lacking soap and/or water; No, no handwashing facilities near toilets (within 5 meters)
JMP: health care waste management	Is waste correctly segregated into at least three labelled bins in the consultation area?	Yes, waste is segregated into three labelled bins; No, bins are present but do not meet all requirements or waste is not correctly segregated; No, bins are not present
	How does this facility usually treat/ dispose of infectious waste?	Autoclaved; Incinerated (two chamber, 850-1000 °C incinerator); Incinerated (other); Burning in a protected pit; Not treated, but buried in lined, protected pit; Not treated, but collected for medical waste disposal off-site; Open dumping without treatment; Open burning; Not treated and added to general waste; Other (specify)
	How does this facility usually treat/dispose of sharps waste?	Autoclaved; Incinerated (two chamber, 850-1000 °C incinerator); Incinerated (other); Burning in a protected pit; Not treated, but buried in lined, protected pit; Not treated, but collected for medical waste disposal off-site; Open dumping without treatment; Open burning; Not treated and added to general waste; Other (specify)
JMP: environmental cleaning	Are cleaning protocols available?	Yes; No
	Have all staff responsible for cleaning received training?	Yes, all have been trained; No, some but not all have been trained; No, none have been trained; No, there are no staff responsible for cleaning
SPA: standard precautions	Sharps container (safety box)	Observed; Reported, not seen; Not available
	Disposable latex gloves	Observed; Reported, not seen; Not available
	Disinfectant (e.g. chlorine)	Observed; Reported, not seen; Not available
	Single-use standard disposable syringes with needs or auto-disposable	Observed; Reported, not seen; Not available
	Medical masks	Observed; Reported, not seen; Not available
	Gowns	Observed; Reported, not seen; Not available
	Eye protection	Observed; Reported, not seen; Not available
	Guidelines for standard precautions	Observed; Reported, not seen; Not available

Upstream indicators

Enabling environment indicators

Relevant enabling environment indicators include those measured in the Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) survey, implemented by the World Health Organization (WHO). The GLAAS is a biannual national survey on human resources, financing, and the enabling environment related to WASH. The GLAAS informs global processes, national government planning, and provides government accountability¹⁴.

The GLAAS includes several HCF-related indicators that were developed based on good practices and theory of change; however, the survey instrument is not a comprehensive representation of environmental health conditions. Relevant HCF indicators in the 2018 GLAAS include those on the existence of national policies, plans for WASH and IPC, and the level of implementation of those policies and implementation plans (Table 2). The GLAAS asks about the presence of clearly defined procedures in laws or policies for participation by service users and communities in planning programs for WASH in HCFs and the level of participation in those activities. Health sector actors are consulted on the responses to this survey.

Table 2: Examples of input indicators from the WHO GLAAS survey¹⁵

Topic	Indicator	Response options
Institutional WASH in policies and plans	Is WASH in health care facilities included in any national policy or plan?	Not Applicable; Not effective; Partially effective; Effective
Institutional WASH in policies and plans	In your opinion, to what extent is the content of national policies effective for achieving national WASH [in health care facilities objectives]?	No national policy; National policy under development; National policy formally approved; Existing national policy undergoing revisions
Hygiene promotion policy and plan	To what extent does a national policy and implementation plan exist for hygiene promotion? Does the hygiene promotion policy or plan address hygiene promotion in health care facilities?	No national policy; National policy under development; National policy formally approved; Existing national policy undergoing revisions
Community and user participation	Are there clearly defined procedures in laws or policies for participation by service users and communities and what is the level of participation? (for Water, sanitation, and hygiene in health care facilities)	Procedures defined in law or policy, Yes; No If yes, does law or policy specifically mention women's participation? Yes; No Extent to which service users / communities participate (very low to very high) Extent to which women participate (very low to very high)
Monitoring	When were the last national assessments conducted (month/year) on sanitation, drinking-water supply, hygiene, the health sector (for WASH in health care facilities) and the education sector (for WASH in schools)?	Month/year of last national assessment; name of latest national assessment; how many national assessments took place between 2012 and 2018
Use of monitoring data	For the following decision-making areas, to what extent are data available, collected, and used: Identifying priority health care facilities needing WASH improvements	Only limited data collected and limited availability; partial data available, but not generally used; data available, analyzed and used for a minority of decisions; data available, analyzed and used for a majority of decisions

¹⁴ World Health Organization. (2019). UN-Water Global Analysis and Assessment of Sanitation and Drinking-water (GLAAS). Retrieved from http://www.who.int/water_sanitation_health/monitoring/investments/glaas/en/

¹⁵ Note: Table 2 contains a simplified version of the GLAAS 2018/2019 survey. For the full survey and instructions please visit: https://www.who.int/water_sanitation_health/monitoring/investments/glaas-2018-2019-country-survey-en-270718.pdf?ua=1.

Topic	Indicator	Response options
Financing plan	Has the government developed a medium to long-term financing plan(s) linked to national strategies for WASH, WASH in health care facilities, and WASH in schools, that clearly assesses the available sources of finance and strategies for financing future needs (i.e. who should pay for what), that is agreed (publicly available) and used for decision-making?	No financing plan; Financing plan in development; Financing plan agreed, but insufficiently implemented; financing plan is agreed and used for some decisions; Financing plan is agreed and consistently used in decisions

Intervention indicators

There are several types of intervention indicators. A 2019 systematic review and supplemental scoping review found that several WASH and IPC intervention packages, including hand hygiene training, were linked to reduced HCAI rates in low- and middle-income countries¹⁶. However, the effects of specific components of these interventions could not be differentiated nor quantified in the available studies identified through the review.

Checklists and behavioral audits are widely used tools in healthcare to ensure patient safety¹⁷. These tools are typically applied at the facility level for internal and quality improvement purposes. Tools relevant to environmental health in HCFs include the WASH FIT¹⁸ tool and the Teach Clean audit tool¹⁹. A simple evaluation demonstrated that implementation of the WASH FIT audit tool led to an increase in availability of WASH resources and compliance with basic WASH and IPC standards²⁰. Other well established process indicators that are indirectly linked to critical conditions for WASH and IPC are the availability of records, proper record keeping, supportive management, and the availability of IPC teams²¹.

Table 3: Examples of intervention indicators for environmental health in HCFs

Indicator	Response option	Source
A protocol for operation and maintenance, including procurement of WASH supplies is visible, legible and implemented	Yes; No	WASHFIT
Regular ward-based audits are undertaken to assess the availability of hand rub, soap, single use towels and other hand hygiene resources	Yes; No	WASHFIT
New health care personnel receive IPC training as part of their orientation programme	Yes; No	WASHFIT
Health care staff are trained on WASH/IPC each year	Yes; No	WASHFIT
Facility has a dedicated WASH or IPC focal person	Yes; No	WASHFIT
All staff have a job description written clearly and legibly, including WASH-related responsibilities and are regularly appraised on their performance	Yes; No	WASHFIT
Are cleaning activities routinely supervised?	Yes; No	TEACH CLEAN
Is feedback given to staff involved in cleaning activities on their performance?	Yes; No	TEACH CLEAN
Are regular reports made with regard to cleaning standards and performance?	Yes; No	TEACH CLEAN
When was the last training session on IPC/environmental hygiene held for medical staff?	No training delivered; within the last 6 months; within the last year; more than 1 year ago	TEACH CLEAN

¹⁶ Watson, J., D'Mello-Guyett, L., Flynn, E., Falconer, J., Esteves-Mills, J., Prual, A., ... & Cumming, O. (2019). Interventions to improve water supply and quality, sanitation and handwashing facilities in healthcare facilities, and their effect on healthcare-associated infections in low-income and middle-income countries: a systematic review and supplementary scoping review. *BMJ Global Health*, 4(4), e001632.

¹⁷ Spector, J. M., Agrawal, P., Kodkany, B., Lipsitz, S., Lashoher, A., Dziekan, G., ... & Gawande, A. (2012). Improving quality of care for maternal and newborn health: prospective pilot study of the WHO safe childbirth checklist program. *PLoS one*, 7(5), e35151.

¹⁸ WHO. Water and Sanitation for Health Facility Improvement Tool (WASH FIT). Geneva: World Health Organization; 2017. License: CC BY-NC-SA 3.0 IGO.

¹⁹ The Soapbox Collaborative. The TEACH CLEAN Package. Available from http://soapboxcollaborative.org/?page_id=5512

²⁰ Weber, N., Martinsen, A. L., Sani, A., Assigbley, E. K. E., Azzouz, C., Hayter, A., ... & Gelting, R. (2018). Strengthening healthcare facilities through water, sanitation, and hygiene (WASH) improvements: a pilot evaluation of "WASH FIT" in Togo. *Health security*, 16(S1), S-54.

²¹ World Health Organization. (2017). Water and Sanitation for Health Facility Improvement Tool (WASH FIT): a practical guide for improving quality of care through water, sanitation and hygiene in health care facilities

Downstream indicators

Pathogen exposure indicators

Exposure indicators provide context to the critical condition indicators by indicating the presence and level of contamination in a water source, on a surface, or on the hands of health care workers. For example, while there are well-established, low-cost survey indicators for a “basic water service” (e.g. an improved water source within 30 minutes round trip) and it is well established that basic water services are less likely to be contaminated than unimproved sources, microbial tests provide specific information on whether a source is in fact contaminated and the level of contamination. Similarly, while surfaces or hands may be reported or observed as clean in a survey, swabbing tests may reveal undetected contamination and levels of contamination.

Tests to identify surface contamination and water contamination vary in level of specificity and cost. For example, low cost drinking water quality tests are reviewed in the literature and are accessible for MNH programs²². These tests provide an easy and low-cost tool by which to assess presence / absence of contamination and levels of contamination but these are usually limited to specific indicators (e.g. *E. coli*). More specific tests for contaminants of importance in HCF settings, such as *Legionella*, *Pseudomonas*, mycobacteria, *Clostridioides difficile* (*C. diff*), *Staphylococcus aureus* (staph), and others are available but these typically require accessible laboratories to process the samples (which are not always available in some countries) and are more costly.

Low-cost swab tests include the ATP surface test. The ATP surface test is used to rapidly measure actively growing microorganisms through detection of adenosine triphosphate, or ATP. The gel dots method has been used in studies of health care facility cleanliness, where the gel does not measure the presence of organisms but are used to mark objects and track if objects are being cleaned thoroughly^{23,24}.

Colonization indicators

The WHO refers to colonization as “the presence of microorganisms on skin or mucous membranes, in open wounds, or in excretions/secretions, but without any overt adverse clinical signs or symptoms”²⁵. Though colonization itself does not entail disease or injury, it is important to measure in a health care context as it means that a microbe is present in the environment and can be detected in patients.

Colonization rates can be assessed through colonization surveys²⁶ – for example, taking hand, nasal or throat swabs from a simple random sample of patients, health care workers, family members, etc. and characterizing the microbes from these swabs. Within health care settings, colonization rates have been measured in studies of IPC efforts in LMICs²⁷. To link exposures to HCAs, microbial isolates can be tested for antimicrobial resistance or genetic markers to determine if they are likely hospital-associated²⁸. However, “...colonization surveys are time and resource intensive and are not generally necessary to direct control or prevention efforts,” and this may not be the most effective use of resources when trying to monitor impacts in low-resource settings.

²² Bain, R., Bartram, J., Elliott, M., Matthews, R., McMahan, L., Tung, R., ... & Gundry, S. (2012). A summary catalogue of microbial drinking water tests for low and medium resource settings. *International journal of environmental research and public health*, 9(5), 1609-1625.

²³ Carling, P. C., Parry, M. F., Bruno-Murtha, L. A., & Dick, B. (2010). Improving environmental hygiene in 27 intensive care units to decrease multidrug-resistant bacterial transmission. *Critical Care Medicine*, 38(4), 1054-1059.

²⁴ Mitchell, B. G., Hall, L., White, N., Barnett, A. G., Halton, K., Paterson, D. L., ... & Gericke, C. A. (2019). An environmental cleaning bundle and health-care-associated infections in hospitals (REACH): a multicentre, randomised trial. *The Lancet Infectious Diseases*, 19(4), 410-418.

²⁵ World Health Organization. (2011). Report on the burden of endemic health care-associated infection worldwide.

²⁶ https://epi.dph.ncdhhs.gov/cd/mrsa_ca/ncph.html

²⁷ Gill, C. J., Mantaring, J. B., Macleod, W. B., Mendoza, M., Mendoza, S., Huskins, W. C., ... & Hamer, D. H. (2009). Impact of enhanced infection control at 2 neonatal intensive care units in the Philippines. *Clinical Infectious Diseases*, 48(1), 13-21.

²⁸ Abd El-Hamid, M. I., Bendary, M. M., Merwad, A. M., Elsohaby, I., Mohammad Ghaith, D., & Alshareef, W. A. (2019). What is behind phylogenetic analysis of hospital-, community-and livestock-associated methicillin-resistant *Staphylococcus aureus*?. *Transboundary and emerging diseases*.

Health outcome indicators

The most frequent types of HCAs that link to environmental health critical conditions are urinary tract infections (UTIs), bloodstream (vascular catheter-associated) infections (BSIs), ventilator-associated pneumonia (VAP), hospital-acquired pneumonia (HAP) and surgical site infections (SSIs). Measurement of HCAs requires a clinical diagnosis and instructions on this are available from the U.S. Centers for Disease Control (CDC)²⁹. Many countries are either just starting to collect or do not track HCAs so there is little knowledge of the burden of HCAs.

There are a number of other infections that can occur in the healthcare setting, including gastrointestinal system infections (GSIs) commonly caused by *Clostridium difficile*, norovirus, *Escherichia coli*, Legionella, and Pseudomonas, among others.

Active infections could be tracked with reported cases or reported symptoms – fever, presence of bacterial toxins in stool, diarrhea, etc. – and would likely be less cost intensive, although this methodology would miss asymptomatic infections.

Recommendations

Little monitoring data on environmental health in HCFs makes decision-making difficult; weakens health systems; and limits the ability to respond to problems, outbreaks, and disasters; leading to the potential for substantial financial and human health cost. Monitoring environmental health in HCFs can enable effective decision making to implement robust safeguards, such as WASH and IPC; to ensure they are in place to prevent future hazards. Monitoring by multi-disciplinary teams may lead to greater accountability.

There are opportunities to improve MNH by generating data for action to improve environmental health critical conditions in HCFs. While some data are available, quality data are lacking and few MNH tools measure these indicators. Not all surveys and indicators are standardized, making it difficult to compare across countries and over time. Global and national monitoring instruments should be standardized and reflect global and national norms, such as water available at the point of care and gender-separated, functional toilets. These indicators should be used for facility monitoring of quality of care.

Standardizing indicators in MNH M&E and quality improvement tools and integrating WASH indicators into these tools is an important first step. Actors supporting MNH monitoring and evaluation development should adopt the JMP indicators for WASH, waste management and cleaning – defined in this brief as critical conditions – to enable data collection for comparison. Tools should also measure health care facility types, settings within facilities, facility multipliers (e.g. number of beds, number of patients per day) and other important meta-data to enable data pooling, sharing, and comparison.

Beyond the critical conditions, other indicators should be added based on the purpose and scope of the monitoring and evaluation exercise. Many of intervention indicators may add a marginal additional cost to the critical conditions indicators and these can be added to available MNH monitoring tools. Monitoring exposure, colonization, and health impact indicators are more expensive and require specialized training. These indicators might be used only in large scale, rigorous evaluations.

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²⁹ Horan, T. C., Andrus, M., & Dudeck, M. A. (2008). CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. *American journal of infection control*, 36(5), 309-332.