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Water Quality in Primary Healthcare Facilities (PHCFs) and its effects on universal health coverage (UHC)

Priscilla Chidinma Ogbonna [1,*], Evangeline Tochi Oparaocha [2], Chimezie Christian Iwuala [2] and Christopher C.A. Okereke [2]

[1] *Department of Biological Sciences, Faculty of Basic and Applied Sciences, University of Africa Toru-Orua Bayelsa State Nigeria.*
[2] *Department of Public Health, School of Health Technology, Federal University of Technology Owerri Imo State, Nigeria.*

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Abstract

Primary healthcare facilities are the first point of call in the health delivery system ladder especially in the rural areas. This study was carried out to assess the level of contamination of water in primary healthcare facilities in Bayelsa State, Nigeria. The study utilized an experimental study approach selecting five primary healthcare facilities for the study. Water samples were collected using standard conventional procedures. Laboratory analyses were done at Wiz-link Consults Ltd Bayelsa State using standardized laboratory methods. Results showed that physical and chemical parameters tested were in conformity with World Health Organization (WHO) permissible limit. Results further showed that all water samples had heterotrophic bacteria in them which ranged from 2±1x10 to 8.0±2x102 and only one (20%) was devoid of coliform bacteria. It was also discovered that there was fungal contamination in some of the water samples. The study therefore advocates for constant treatment and monitoring of water quality in primary healthcare facilities so as to prevent pollution that could lead to outbreak of water-borne diseases thereby compromising the achieving of Universal Health Coverage (UHC) come 2030.

Keywords: Water contamination; Nosocomial infections; Health; Disease prevention

1. Introduction

Primary healthcare facilities are at the least level of the healthcare delivery being the first point of call for people especially those who live in the rural areas. Primary health care is the least expensive form of health care and can defray significant costs. This is because it provides community-level screening, health education, and prevention advice at a significantly lower cost than, for example, a hospital will give. The world health organization (WHO) has opined that the concept of Primary HealthCare signifies a society approach to health that aims at ensuring the highest possible level of health and equitable well-being by focusing on people's needs and as early as possible so as to maintain health promotion and disease prevention to treatment, rehabilitation and palliative care, and as well as making health delivery as close as feasible to people's everyday environment," [1]. Hence Primary Health Care provides whole-person care for health needs throughout the lifespan, not just for a set of specific diseases. Primary health care ensures people receive quality comprehensive care and provides the means to achieving health related sustainable development goals and health security. It is a vital means to achieving universal health coverage, SDG3 because it is also critical to make health systems more resilient to situations of crisis, more proactive in detecting early signs of epidemics and more prepared to act early in response to surges in demand for services. The fact sheets of WHO had maintained that, scaling up primary health care (PHC) interventions across low and middle-income countries could save 60 million lives and increase average life expectancy by 3.7 years by 2030. Again, the majority of essential

* Corresponding author: Priscilla Chidinma Ogbonna

interventions (90%) for universal health coverage can be delivered using a PHC approach as it provides the foundation for the strengthening of the essential public health functions to confront public health crises and also approximately 75% of the projected health gains from the sustainable development goals could be achieved through PHC [1].

Healthcare facilities are among the sectors with largest water consumption level because they need high quantities of water in a high quality and hygiene [2].The quantity and quality of water in healthcare setting is very vital for the patients' health and daily operations of the facilities because it has a significant impact on public health and achieving universal health coverage [3]. As a first point of call for health service delivery, it is important that water used in PHCF should be free from contamination and all its parameters be within the permissible limits by WHO [4]. Also, improving water conditions can help establish trust in health services and encourage mothers to seek prenatal care and deliver in facilities rather than at home - important elements of the strategy to reduce maternal mortality [5].

World Health Organization [6] reports that 25 % of healthcare facilities have no basic water services, about 712 million people lacking access to water when they visit healthcare facilities. Cases of water-borne diseases have been reported in Nigeria and instances of outbreaks owing to unimproved water supply have also been noted in some towns of Nigeria and studies have shown that ordinary levels of metals and other chemicals exceeding the standard limit can be injurious to human health which may include mutagenicity, mortality, growth retardation, and structural malformations [7]. In 2015, the need for basic water services was reiterated in Goal 6 of the United Nations' Sustainable Development Goals (SDGs), where target 6.1 calls for universal access to "safe and affordable drinking-water for all" [8]. The WHO/UNICEF Joint Monitoring Programme (JMP) in its SDG monitoring considers "universal access" to drinking-water to include settings such as schools and healthcare facilities (HCFs) [9]. Sufficient, safe water is particularly important within healthcare facilities in order to maintain a clean environment and prevent the spread of healthcare-associated infections. When a primary healthcare facility water supply is of unsafe quality, its ability to provide safe medical services is compromised.

2. Material and methods

2.1. Study area

Bayelsa State is also one of the largest oil producing state of Nigeria; hence, oil exploration is an activity that is quite common to the people of the area. The activities associated with oil exploration have affected the atmosphere, the soil, surface and ground water, marine environment, biological diversity of the area. This is due to the poor environmental practices by these petroleum companies which in turn contaminates the environment and have direct consequences on the people's health, socio-economic well-being and the aesthetic nature of the environment [10]. The topography of Bayelsa State is generally low- lying, with fresh water and salt water, and a typical mangrove forest. Rainfall occurs generally every month of the year. The wet season is not less than 340days annually. Almost every part of the state is under water at one time of the year or another. Associated with high rainfall, long rainy days, porous and very sandy soils, is prolonged and disastrous flood [11]. Fishing is the major occupation of Bayelsa people because of the abundant creeks, lagoons, rivers and swamps within which commercial fishing is practiced. Christianity and traditional religion are the two main religions in the State. The major modes of transport in the state are waterways and roads [10].

2.2. Study design

This was an experimental study. Five primary healthcare facilities were randomly selected for the study.

2.3. Sample collection and analysis

The collection and analysis of water samples from the selected primary healthcare facilities (PHCFs) was conducted using conventional field and laboratory techniques. Samples were labeled as PHC A, PHC B, PHC C, PHC D, and PHC E to conceal the identity of the primary healthcare facilities. Data was analyzed using mean values and reported using World Health Organization's permissible limits as standard.

3. Results

Table 1 Background of the selected primary healthcare facilities

	PHC A	**PHC B**	**PHC C**	**PHC D**	**PHC E**
Ownership	Public	Public	Private	Public	Private
Location	Urban	Rural	Rural	Rural	Urban
Water source	Borehole	Borehole	Borehole	Rain water	Borehole

Table 2 Physicochemical parameters of water in primary health facilities in Bayelsa state

Physical parameters	**WHO permissible limit**	**PHC A**	**PHC B**	**PHC C**	**PHC D**	**PHC E**
Conductivity US/Cm	1000	124	38	57	4	194
TDS (ppm)	500	109	27	40	2	139
Temp (°C)	25-35	30°C	29	29	26	26
Colour (TCU)	5	0.2	2	2	3	1
Tubidity (NTU)	5	0	0.418	0.413	0.042	0.02
Chemical Parameters	**WHO permissible limit**	**PHC A**	**PHC B**	**PHC C**	**PHC D**	**PHC E**
pH	6.5-8.5	7.0	7.7	6.8	7.7	7.3
Fe (ppm)	0.3	0.00	0.042	0.047	0.006	0.002
Mg (ppm)	50	0.13	0.42	0.38	0.25	0.30
Lead(Pb) (ppm)	0.05	<0.001	<0.001	0.050	<0.001	<0.001
Copper (Cu) (ppm)	1-2	<0.001	<0.001	<0.001	<0.001<0.001	<0.001
Total Hardness	100-300	60.937	40.122	78.827	18.28	18.20

Table 3 Microbiological Parameters of Water in Primary Health Facilities in Bayelsa state

Sample	**PHC A**	**PHC B**	**PHC C**	**PHC D**	**PHC E**
THBC CFU/mL	$8.0 \pm 2 \times 10^2$	$6.0 \pm 10 \times 10^2$	$1.4 \pm 2 \times 10^2$	Cloudy growth	$2 \pm 1 \times 10$
TCC (CFU / mL)	$3.0 \pm 4 \times 10^2$	-	$4 \pm 2 \times 10^2$	$2.3 \pm 6 \times 10^2$	$1.5 \pm 3 \times 10$
Mold (SFU / mL)	0	0	0	0	$1 \pm 1 \times 10$
yeast(SFU / mL)	$3.2 \pm 4 \times 10$	$2 \pm 2 \times 10$	0	0	0

World Health Organization's permissible limit = 0cfu/100ml and 0sfu/100ml

Table 4 Identification of Bacterial Isolates

Isolate	**EMB(colour)**	**NUT (colour)**	**GRAM**	**CAT**	**CIT**	**TSI**	**FACILITY**
Enterobacter spp	BrownishPink	Grey	-rod	+	+	K/A, G	PHC E
Klebsiella spp	Dark pink mucoid	Grey	-rod	+	+	K/A, G	PHC B,PHC A, PHC C, PHC E
Klebsiella spp	Pink raised mucoid	Grey	-rod	+	+	K/A, G	PHC B
Pseudomonas spp	Light Pink	Blueish grey	-rod	+	+	K/K, G	PHC C

Escherichia coli	Purple (Dark Blue)	Grey	-rod	+	-	A/A, G	PHC D , PHC A, PHC E, PHC C
	pink	Red orange	-rod	+	+	K/A, G	PHC D
	Deep pink	Red orange	-rod	+	+	K/A	PHC D , PHC A
Salmonella spp	Light pink	Grey	-rod	+	+	K/A, H_2S	PHC D
Salmonella spp	Colourless	Grey	-rod	+	+	K/A, H_2S	PHC B, PHC A

Table 5 Identification of Fungal Isolates

Fungal Isolate	Colonial characteristics	Morphology and microscopy	FACILITY
Saccharomycessp	Dense white budding colony	Non-septate hyphae with large sporangia	PHC A; PHC B
Rhizopus ssp	White cottony colony grows to cover the plate	Ovoid sporangiospores. Non-septate mycelia.	PHC E

4. Discussions

4.1. Background of Primary Healthcare Facilities

Results showed that 2(40%) of the primary healthcare facilities are owned by private individuals while 3(60%) are owned by the government as shown in Table 1. It was also noted that 2(40%) of the primary healthcare facilities are located in the urban area of the state while 3(60%) are located in the urban area. While 1(20%) of the primary healthcare facilities had water sample drawn from rain water, the rest (80%) had water drawn from piped underground water (borehole).

4.2. Physicochemical Parameters of Water in Primary Healthcare Facilities in Bayelsa state

As shown in *table 2* above, all water samples were in conformity with world health organization standard with regards to physic-chemical parameters. The table showed the physical parameters which includes conductivity, associated with poor-tasting of water, total dissolved solids which have effect on palatability of water, temperature which affects the growth of micro-organisms, turbidity and colour which may indicate contamination. It was noted that all these parameters were within WHO permissible limit. *Table 2* also showed chemical parameters of the water samples in primary healthcare facilities in Bayelsa State. These parameters consist of pH, some elemental parameters and total hardness of the water sample. Results showed that these were within the permissible limit of WHO. This is in conformity with a study carried out by Rim [12] on water samples of emergency departments from 11 general hospitals of the Syrian Coast which showed that the physicochemical values of hospital water samples were within the permissible limits of standard procedure mentioned in Syrian standards S.N.S:45/2007 and World Health Organization standards. The study however differs from another carried out by Odjegba et al [13] in PHCs were selected from 70 Local Government Areas (LGA) across 3 Southwestern States in Nigeria where they discovered that most water samples were above WHO permissible limit with regards to physicochemical parameters. The study also differs from that of Ogbonna et al [14] on physicochemical analysis of hospital water in selected secondary healthcare facilities where some of the water samples in healthcare facilities were above WHO permissible limit.

4.3. Microbial Parameters of Water in Primary Healthcare Facilities in Bayelsa State

Table 3 showed the total Heterotrophic bacteria Count (THBC) which is used as an indicator of the overall microbial load in the water samples and it ranged from $2\pm1x10$ to $8.0 \pm 2x10^2$ with PHC E having the least and PHC A having the highest. PHC D has a cloudy growth which could not be enumerated. The Total coliform count (TCC) ranged from zero (0) to $4\pm2x10^2$. Only one of the water samples (PHC B) fell within the safe limit recommended by WHO for drinking water which is 0cfu/100ml while the rest of the water sample were well above the permissible limit for drinking water by WHO. Coliform bacteria are commonly used as indicators of fecal contamination and potential pathogenic organisms in water. Hence, according to WHO standard, presence of coliforms in any sample of drinking water suggests a high risk of contamination by fecal pathogens [15]. Only one (20%) of the healthcare facilities had mold in the water sample while the rest of the healthcare facilities (80%) were free from molds. Two (40%) of the healthcare facilities had yeast in their

water samples while 3(60%) had none. Though the presence of fungi in water used in these healthcare facilities is not typically considered harmful to the human person but their presence are indicative of underlying issues in water quality [16].

This study confirms another study of non-random assessment of 17 HCFs in Rwanda which found that 1 of 16 water samples contained *E. coli* [17], and a cross-sectional study found that 15% of water samples from HCFs in rural Uganda (n = 144) and 30% of water samples from rural Mozambique (n = 172) contained *E. coli* [18].

Also in a research carried out by Kayiwa *et al.,* [19] in healthcare facilities in Kampala Uganda where they assessed the water situation, 60 HCFs were selected for the study and the instrument for data collection was a tool developed by the centre for global safe water, sanitation and hygiene (CGSW) at Emory University known as WASHCon. Overall, 87.9% (51/58) of the HCFs had water that met the WHO microbial drinking water quality guidelines of 0 coliform forming units per 100ml of water.

4.4. Identification of Bacterial Isolates

Identification of bacteria isolates was done using forming patterns, colour and shapes. The bacteria isolates were of the genus, *Enterobacter spp, Klebsiella spp, Pseudomona aeroginosa, Salmonella spp* and *Escherichia coli* as presented in *table 4* above. The presence of these isolates in primary healthcare facilities water supplies is concerning as it can lead to waterborne infections, especially in vulnerable populations. These bacteria have been associated with outbreaks in hospitals and long term care facilities, where contaminated water sources can serve as a reservoir for transmission. The presence of antibiotic-resistant strains of these bacteria in water sources further complicates the treatment of infections caused by them.

4.5. Identification of Fungal Isolates

The fungi detected in the primary healthcare facilities' water samples (table 5) were yeast, *Saccharomyces spp* and the moulds *Rhizopus spp*. Even though these fungi may not be considered to be so harmful when present in water samples, they however serve as an indicator for deteriorating water quality. And for a healthcare facility where health of patients is already compromised, it is a thing of great concern and calls for treatment.

This is similar to results from the study carried out by Yashraj *et al.,* [20] which showed that there was 100% contamination of the water samples in the study health facilities and the organisms identified include *E.coli, Klebsiella, Enterobacter, Citrobacter, Proteus, Salmonella, Pseudomonas* and *Acinetobacter.*

4.6. Implication for Achieving Universal Health Coverage

The achievement of universal health coverage (UHC) depends on a strong primary health-care system that can provide essential health services for the entire population [21]. This is because PHC is intended for socially and geographically disadvantaged persons and for the purpose to be achieved, a well-designed and quality primary healthcare must be assured. A situation whereby health is further compromised on visit to a primary healthcare facility through drinking of contaminated water exacerbates the fear of not achieving UHC by 2030. Contamination of water in primary healthcare facility acts as a counterproductive effect to primary healthcare delivery system. With all the activities that require clean water in primary healthcare facilities which include drinking, administration of medication, immunization, delivery etc. it is only pertinent that water quality should be priority. This is very vital as PHCFs are usually the first point of call for most pregnant women for their antenatal visits and possible delivery. They are the setting for different kinds of immunizations for infants and adults. Water which is meant for such purposes must be safe so as to avoid neonatal and nosocomial illnesses that are water-borne.

All the water samples were found to be contaminated with one microbe or the other making it unwholesome for consumption and for administration of medication or vaccine. This calls for a great concern and a prompt for actions that will provide clean and safe water for the PHCFs.

The role of Primary healthcare in achieving universal health coverage can never be over emphasized. This is because Universal Health coverage which is basically 'health for all' is an indispensable need which must be integrated into an overall framework for organizing and delivering care based on a patient-centered, efficient, fair, and cost-effective way [22]. Report from a study on 102 low- and middle-income countries had it that primary health care services has been linked to longer life expectancy, lower infant mortality and lower under-five mortality, suggesting that investment in primary care is a wise choice [23].This becomes impossible when the quality of water in primary healthcare facilities is contaminated with agents of infectious disease outbreak. When water is contaminated in Primary healthcare facilities,

the aim of primary healthcare is defeated because in the case of a nosocomial infection, the patient has a long hospital stay and more economic burden.

Recommendations

Efforts should be made to provide clean and safe water in primary healthcare facilities in Bayelsa state so as to avoid the outbreak of water related infectious diseases. There should be a standardize water treatment procedure which ought to be carried out both in private and public primary healthcare facilities.

There should be constant monitoring of water quality in primary healthcare facilities so as to avoid emergency pollution.

Adequate financing of the primary healthcare services should be a top priority for the government of Bayelsa State, Nigeria.

5. Conclusion

Primary healthcare facilities are at the beginning of the healthcare delivery system and as such are available for easy accessibility to deprived populations thereby, providing a patient-centered care, prevention of disease progression, and reducing cost of medical treatment hence bridging the gap between the rich and the poor. It is the first point of call for pregnant women, those who seek immunization and wound care, people who cannot afford to go secondary and tertiary healthcare facilities and the only source of getting treatment for people who live in the rural areas. Contaminated water in such an institution is a misnomer to what that the institution stands for. This study shows that all water samples from the primary healthcare facilities were contaminated with one pathogen or the other. Therefore, efforts should be made for regular monitoring and treatment of water in primary healthcare facilities so as to avoid the outbreak of water borne infectious diseases and halting the movement towards achieving universal health coverage. If the issue of water quality in healthcare facilities is not addressed properly, then there is no likelihood of achieving Universal Health Coverage.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Ethical Consideration

The ethical approval for the research was obtained from the Ethical Committee of the Department of Public Health, Federal University of Technology Owerri Imo State, Nigeria and Bayelsa State Health Research Ethics Committee (BSHREC)

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