PUBLICATION N° 14

Int. J. Adv. Res. 11(01), 1717-1725

ISSN: 2320-5407

Available online at www.journalijar.com

International Journal of Advanced Research (IJAR)

ISSN 2320-5407

A Peer Reviewed, Open Access, CrossRef Indexed Journal

2021 Impact Factor: 7.33

Whatisapp at: +441223926516

Email: journalijar@gmail.com

Research and Review Articles are invited for Publication in January 2024 Issue. Authors can now access December 2023

CALL FOR PAPERS

Vol. 12, Issue 01, Jan 24

Paper Submission: 15 Jan 2024
Author Notification: 7 to 10 days
Journal Publication: 30 Jan 2024

Submit Article

Forthcoming Articles

SPECIAL ISSUE

SUBJECT AREA

LIFE SCIENCES

Agricultural
Biological Sciences
Biotechnology
Biochemistry
Genetics

more...

HEALTH SCIENCE

Medicine and Dentistry
Nursing and Health Professions
Pharmacology and Toxicology
Pharmaceutical Science
Veterinary Science

more...

PHYSICAL, CHEMICAL SCIENCES AND ENGINEERING

Welcome to International Journal of Advanced Research

International Journal of Advanced Research (IJAR) is an open access, Peer-reviewed, CrossRef Indexed International Journal, that provides rapid publication (monthly) of Research Articles, Case Reports, Review Articles, Correspondences and short communications in all subjects.

Every article published in IJAR is provided with unique DOI and the metadata is submitted to **CrossRef., Pubmed** and **Google Scholar.** For details Check **Indexing** link of **Journal.**

JOURNAL STATISTICS & APPROVAL DETAILS

MOST VIEWED / DOWNLOADED ARTICLES

WRITTEN REPORT OF UNILEVER AS A CONTRIBUTOR TO PLASTIC WASTE IN INDONESIA

Lintang Wahyu Charisa Raharjo

Article DOI: 10.21474/IJAR01/17967 **DOI URL:** http://dx.doi.org/10.21474/IJAR01/17967

Download PDF | View Abstract | Search in Crossref

No. of Downloads: 38 | No. of Views: 43

The Journal invites Research articles that have significant impact on Scientific and academic community. All the Submitted papers will be assigned Unique Manuscript Number with in 24 hours after submission. This journal uses double-blind review, which means that both the reviewer and author identities are concealed from the reviewers, and vice versa, throughout the review process. The Reviewing process is completed with in 10 days after submission. The manuscripts will be published online shortly after acceptance and the article proof will be mailed to the corresponding author. Please read **Instructions to authors** before submitting your manuscript.

Journal DOI: 10.21474/IJAR01

THOMSON REUTERS Publons

Why Publish with IJAR

- *Publication within a short period after acceptance.*

Impact Factor: 7.337
IC Value 94.33

Hard Copy

TRACK YOUR ARTICLE

Enter Manuscript Number

Enter Email

Submit

For all communication regarding how to:

- Publish a paper,
- Status of paper,
- Other general information,

mail us at:

Journalijar@gmail.com

AUTHORS MENU

Submit Your Paper Online
Check your Article Status
Download Invoice for Paper
Download your Certificate
Certificate Sample

E-JOURNAL DOWNLOADS

March 2017
Previous Issues

STATISTIC OF IJAR

Articles Viewed: 3,886,843
Articles Downloaded: 1,084,001

CAS Source Index (CASSI) Search Result

Displaying Record for Publication: International Journal of Advanced Research

Entry Type	Active Serial
Title	International Journal of Advanced Research
Abbreviated Title	Int. J. Adv. Res.
CODEN	IJARND
ISSN	2320-5407
Language of Text	English
Summaries In	English
History	v1 n1 2013+
Publication Notes	Avail. from Internet at URL: http://journalijar.com/
Publisher Name	Research Communications

Disclaimer

Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/16197
DOI URL: http://dx.doi.org/10.21474/IJAR01/16197

RESEARCH ARTICLE

CONTRIBUTION TO THE ESTABLISHMENT OF A SUSTAINABLE MANAGEMENT SYSTEM FOR BIOMEDICAL WASTE IN BENIN

Fossou S. Arlette R[1,2,3], Agbangnan Dossa C. Pascal[2], Agnimonhan F. Hyacinthe[3], Azonhe Thierry[4] and Wotto Valentin D.[1]

1. Physical Chemistry, Materials and Molecular Modeling Laboratory, Faculty of Science and Techniques, University of Abomey-Calavi (LCP3M/FAST/UAC), 01BP 526 Cotonou Benin.
2. Laboratory of Study and Research in Applied Chemistry, Polytechnic School of Abomey-Calavi, University of Abomey-Calavi (LERCA/EPAC/UAC), Benin.
3. Laboratory of Physical Organic Chemistry and Synthesis, Faculty of Sciences and Techniques, University of Abomey-Calavi, 07 BP 213 Cotonou, Benin.
4. Pierre PAGNEY Laboratory: Climate, Water, Ecosystem and Development (LACEEDE/IGATE/UAC), Benin.

Manuscript Info

Manuscript History
Received: 30 November 2022
Final Accepted: 31 December 2022
Published: January 2023

Key words:-
Waste, Pollution, Nosocomial Infections, Environment

Abstract

The management of waste generated by hospitals, whether solid, liquid or gaseous, is a real problem given the risk it represents for human health and the environment. In order to contribute to the improvement of the management of Biomedical Waste (BMW) in health structures in Benin, a study was carried out at the hospital "La Croix" in “Zinvie” in 2014 on 105 individuals then resumed with 90 individuals in 2020. Qualitative and quantitative methods were used. The data collection instruments are the interview guide, the observation grid, the questionnaire and the laboratory analyses. From the results obtained, it appears that only 0.38% of the center's liquid biomedical waste (LBMW) is produced at the level of its various departments and constitutes infectious waste. This waste is then mixed with water similar to domestic water and discharged into the environment after a summary treatment with bleach while the values of their physico-chemical parameters (BOD_5, COD) exclude all self-purification hypothesis. In addition, approximately 37302 tons of infectious solid waste and 86 kg of anatomical waste are produced and managed each year in the center. Sorting at source, which was poorly done in 2014, is increasingly done in compliance with the legislation. It is therefore urgent to generalize this practice in hospitals in Benin, to promote the installation of LBMW treatment stations and/or to recommend a categorical treatment of the latter for better environmental protection.

Introduction:-

Like all chains of human activity, health care generates solid, liquid and gaseous waste which dangerously compromises the balance of ecosystems [1]. The management of all waste deserves to be carried out under appropriate conditions to prevent it from becoming a source of disease. In a hospital environment, poor management

Corresponding Author:- Agbangnan Dossa C. Pascal
Address:- Laboratory of Study and Research in Applied Chemistry, Polytechnic School of Abomey-Calavi, University of Abomey-Calavi (LERCA/EPAC/UAC), Benin.

of biomedical waste is therefore detrimental not only for the nursing staff but also for the patients, nurses and surrounding populations.

Numerous scientific works carried out in recent years on the methods of managing biomedical waste have demonstrated the interest that health professionals, scientists and the public authorities attach in particular to the protection of the environment and public health in general [2,3]. This awareness has imposed itself on everyone with the appearance of new micro-organisms (viruses, bacteria, parasites and prions) and has evolved with the progress of medical techniques and the appearance of rules of asepsis [4]. Hundreds of millions of health care users contract infections each year, and 15% of patients develop one or more infections during hospitalization [5].

In most developing countries and more specifically in Africa south of the Sahara, waste management appears to be a disaster. A 2002 WHO survey of 22 developing countries found that the proportion of healthcare establishments not applying appropriate waste disposal methods varies between 18% and 64% [6]. In their work carried out within five hospital structures in Dakar, Senegal, Ndiaye et al., affirm that we are witnessing irresponsible management methods which can be explained by the fact that the structures are unaware of the different stages that include the management of solid biomedical waste or do not put substantial resources into it [7]. These authors specify that for the pre-collette and collette phases, most health facilities use plastic bins, often without lids, or even buckets. It is in this same dynamic that the conclusions of Mbengue, quoted by Justin in 2016, show that in the countries located in West Africa, the management of solid waste was hopeless, chaotic and represents a permanent danger for man and his environment while the WHO continues to popularize the stages of treatment of DBM [8]. The results of a study carried out in India by the World Health Organization show that it is essential that sharp and prickly objects of an infectious nature be deposited in resistant containers then disinfected and "destroyed" in order to ensure the safety of workers, and more broadly, of the entire community [6].

As for the management of wastewater in hospital environments, some authors have stated that this water can contain dangerous chemical substances, pathogens and radioisotopes that can constitute a chemical, biological and physical risk for public health and the environment [9,10]. These effluents from the hospital environment, unlike those from the urban environment, contain various toxic or persistent substances such as pharmaceutical products, radionuclides, solvents and disinfectants [11]. Some authors have pointed out that the concentrations of micropollutants (antibiotics, analgesics, heavy metals) in hospital wastewater are 4 to 150 times higher than those in urban wastewater Verlicchi cited by [12]. The poor management of biomedical waste then constitutes a real public health problem because it is a potential source of disease.

In Benin, the situation is as catastrophic in hospitals as in other sectors [13,14]. These health facilities become dangerous places due to the high risk of transmission of pathogens to staff, patients and other users. The nursing staff, a priori, has a level of knowledge but, in practice and without follow-up, the behavior of these agents leaves something to be desired. A lot of work has been done on the subject but very little has been interested in the characterization and especially the quantification of the waste produced by hospitals. This study focused on the evaluation of the management of biomedical waste in a center that is not leftovers in Benin aims to improve practices in the management of DBM in health structures for the protection of man and of its environment.

Materials And Method:-

Presentation of the framework of the study

Located in "Yevie", district of "Zinvie" (municipality of Abomey-Calavi), the hospital "La Croix" is located between 659° and 635° North latitude and between 236° and 221° East Longitude. Still called "600", this hospital was inaugurated on May 5, 1980. Its challenge is to ensure the continuity of quality care not only for the local population but also for the sub-region because of its services led by surgical missions. It has about 277 beds distributed in several hospital departments. Its technical platform is made up of a radiology and ultrasound department, laboratories (biochemistry, microbiology, hematology and serology which houses the blood bank), an operating theater equipped with a sterilization room, a pharmacy, a maternity ward, an emergency department, a physiotherapy/isolation department, a paediatrics/neonatology department, three surgery departments A, B, C, a dressing department, a chaplaincy, a medicine and an administrative block.

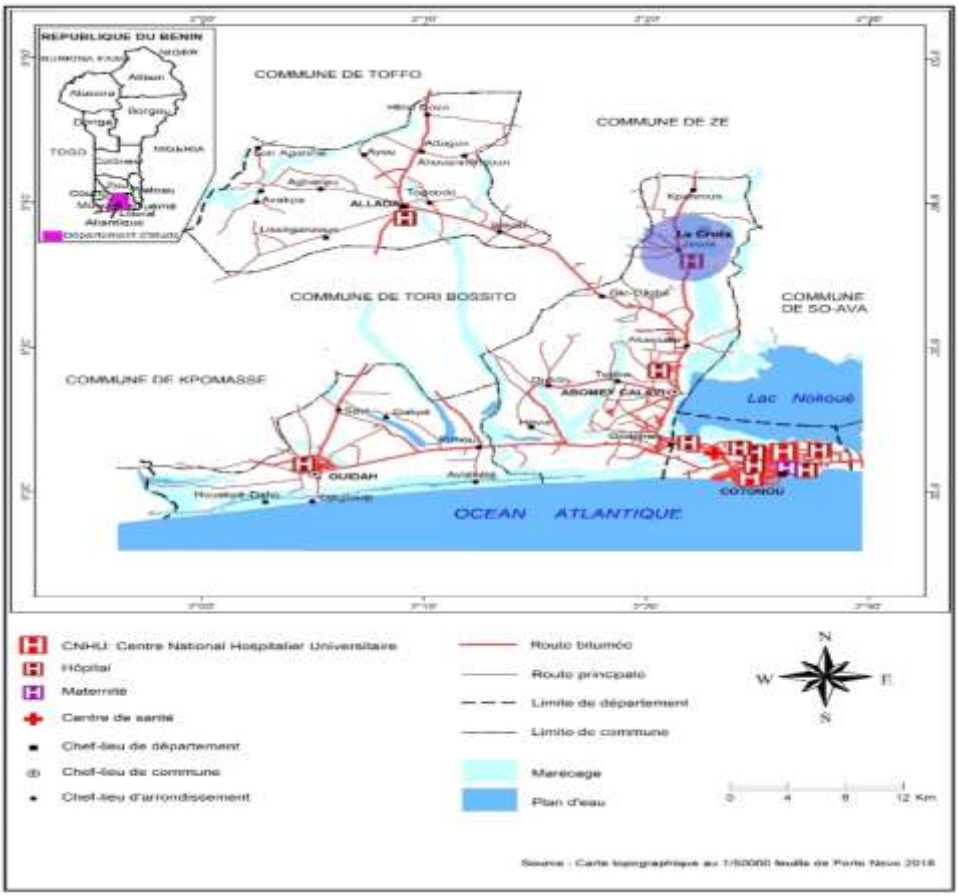

Figure 1:- Geographical location map of the hospital "La Croix" in Zinvié.

Nature of the study and sampling technique

This study is cross-sectional, descriptive and analytical in nature and took place from December 2013 to March 2014 and then from September to December 2020.This study is cross-sectional in nature, descriptive and analytical in nature and took place from December 2013 to March 2014 and then from September to December 2020. Three different methods and techniques were implemented in the survey phase i) the method probabilistic sampling with the simple random technique for health workers (doctors, nurses, midwives, laboratory and radiology technicians and nursing assistants), patients and nurses, ii) the non-probability one with techniques by convenience for the various services and the authorities of the center, and iii) the method of exhaustiveness for the cleaning agents. To carry out this survey, the various services were listed and then the personnel were identified by category. Data was collected from 105 individuals in 2014 and 90 in 2020.

Sample collection and analysis

Weighing of solid waste was carried out weekly for infectious waste and monthly for anatomical waste. The different garbage bags from the collection at the level of the different departments after sorting the waste at source are hung on a "Diamond" brand scale to measure the weight of the waste. Wastewater (discharges from the various devices, floor maintenance water, washing or rinsing water from devices/equipment, hand washing water, liquids sucked up during interventions and others) were collected in plastic buckets and then measured using a 1000mL graduated cylinder. The samples intended for the physico-chemical analyzes were taken in 1.5 L polyethylene bottles which had been washed and dried beforehand and then transported to the laboratory in thermostat coolers. The samples from the laboratory and the operating room were each combined into a composite sample after the various collections of the day. For the microbiological analyses, 25mL of waste water was collected in various sterile tubes and conveyed to the laboratory. The pH measurement was carried out " in situ " using a previously calibrated OHAUS brand pH meter. Total nitrogen (TN) was determined by the Kjeldahl method, Biochemical Oxygen Demand (BOD5), Chemical Oxygen Demand (COD), and Total phosphorus content were evaluated

according to French standards [15]. The evaluation of the microbiological quality of the samples taken consisted in counting the bacteria indicating contamination of fecal origin and in detecting the presence of pathogenic bacteria using standardized methods [16,17].

Results And Discussion:-

Solid Biomedical Waste Management (SBMW)

One of the problems noted in the SBMW management circuit in many hospitals in Benin is that of sorting at source [3]. However, this categorization of different waste conditions their best treatment [18]. Figure 1 shows the behavior of the staff at the hospital "la Croix" with regard to this prescription.

Figure 2. Comparative graph of the existence of sorting at source

In 2014, 88% of cleaners in charge of SBMW collection said that sorting at source was not well done. In 2020, on the other hand, we note a reversal of the trend. According to the same actors, only 23.1% of agents continue to neglect source separation (see figure 1).

The means of collecting the SBMW were made of plastics of all kinds and for the most part without lids (see figure 2). While the majority of services had yellow bins to collect sharp and sharp objects, the other types of waste did not benefit from any categorization.

Figure 3:- Bins without lids for all categories of waste (FOSSOU 2014).

At the end of the 2014 work, recommendations had been formulated for the authorities of the center and a few awareness sessions had been organized on good management practices for BMW. The application of these recommendations in accordance with the convention on the categorization of waste [18,19] and sorting at source have led to the creation of a hygiene service whose activities have had a very positive impact on the management of SBMW at the hospital "La Croix" (figure 3). However, contrary to what is observed in Figure 4, the room serving as the SBMW warehouse should be secure, locked, easy to clean, well lit, airy and made inaccessible to all strangers [7].

Figure 4:- Trash cans labeled and provided with a collection bag (FOSSOU 2020).

Figure 5:- Building used as a waste storage site (FOSSOU 2020)

In the **table 1** we therefore note an improvement in the management of the center's SBMW after our work in 2014, followed by awareness-raising.

Table 1:- Comparative table of SBMW management methods from 2014 to 2020.

Comparison criteria	Management in 2014	Management in 2020
SBMW collection means	Garbage cans of all colors with collection of waste and safety box for sharp objects (figure 2)	Bins and bags of different colors: red (anatomical waste), yellow (infectious waste) and black (household waste) and safety box for sharp waste (figure 3)
Existence of intermediate storage points	NO	YES (Figure 4)
Transport of SBMW to processing points	With a cart	By hand or with wheelbarrows
SBMW processing	• Open-air incineration (in a pit) for household waste and infectious waste from all departments except the operating theatre. • Incineration of sharp objects and infectious waste from the operating room.	• Open pit incineration (in a pit) exclusively for household waste • Storage of sharp objects and infectious waste from all departments in a hut provided as an intermediate storage point for incineration. • Treatment of anatomical and infectious waste by an external structure when the center's incinerator is down.
Existence of a hygiene service and a committee to fight nosocomial infections	NO	YES

For better management of the waste produced by the center and an evaluation of the cost of this management, a quantitative analysis of these wastes was necessary. Weighing carried out at intervals of time on the stored infectious and anatomical waste made it possible to estimate their annual production in the center (see **table 2**).

Table 2:- Quantity of infectious and anatomical waste produced by the hospital "La Croix".

Category	Average weekly quantity	Average monthly	Annual quantity (Kg)

	(Kg)	quantity (Kg)	
All infectious waste	811.85	3108.5	37302
Anatomical waste	Not assessed		86.16

The weekly production of solid infectious waste at the level of the various departments is thus evaluated at 811.85 kg, or more than 37 tons per year. As for the anatomical waste, essentially consisting of amputated organs and extractions of fibroids, cysts or embryos in the event of ectopic pregnancies, are evaluated at 86.16 kg. Some of this waste being carried away by certain patients or their parents for sociological reasons, the rest is kept in the refrigerator and then incinerated periodically.

In the event of a breakdown of the center's incinerator, infectious and anatomical waste is transported to a private partner structure for incineration through a contract. This treatment contract has a cost (approximately 700 euros) that the center had to include in these charges for the well-being of staff, users and surrounding populations. The values found for solid waste are much higher than those previously published by Sanogo M. et al [20]. who carried out their study Gabriel Toure Hospital (Mali), a reference center in Mali. The difference observed could be due to the difference in attendance linked to the demographic increase but also to the technical platform of the two centers or to the fact that these authors had to carry out their study during a period of almost effective cessation of the activities of the laboratory for lack of consumables.

Liquid Biomedical Waste Management

The total annual volume of liquid effluents produced by the various departments of the center amounts to 132,276 L and is recorded in table **3**.

Table 3:- Volume of liquid biomedical waste produced by department.

Service categories	Laboratory	Maternity	Operating room	Other services *	All services combined
Average daily volume (L)	90.6	51.23	45.22	175.35	362.4
Annual volume (L)	33069	18698.95	16505.3	64005	132276

* (Radiology and ultrasound, emergency, physiotherapy / isolation / ophthalmology, pediatrics / neonatology, surgery A, B, C, dressing, and medicine).

While the laboratory alone produces 25% of the operational rejection of all services, the maternity ward and the operating theater together produce approximately the same rate. And all the other services (radiology and ultrasound, emergency, physiotherapy/isolation/ophthalmology, pediatrics/neonatology, surgery A, B, C, dressing and medicine etc.) produce the remaining 50%. On reading these results, the different departments of a hospital center can be classified into three main categories, namely: high-production departments (laboratory), medium-production departments (maternity and operating theatre) and low-production departments. Although significant, this total annual volume of liquid effluents resulting from the operation of the various departments of a hospital center represents only a part of its liquid discharges. In order to determine the proportion occupied by this volume in the overall volume of the center's wastewater, a quantitative analysis is necessary.

According to the work of various authors, wastewater represents approximately 80% of the water consumed in the domestic environment [21] and 80 to 90% in hospital environment [22,23]. Considering the average of these values, it is possible to determine the total quantity of wastewater.

$$V_{wastewater} = 0.85 \times V_{water\ consumed} \quad \textbf{Eqn.1}$$

Moreover, in developing countries, the volumes of water consumed in hospitals are around 500 liters per bed per day Laber et al. para, 1999 cited by [24] hence the daily quantity of water consumed per center can be evaluated:

$$V_{water\ consumed} = Q \times N \quad \textbf{Eqn.2}$$

where Q represents the quantity of water per bed per day and N the number of occupied beds.

If we estimate the number of beds occupied at 80% of the existing one, we can deduct from the two previous equations the volume of wastewater produced by the center.

$$V_{wastewater} = 0.85 \times 0.80 \times Q \times N \quad \textbf{Eqn.3}$$

Knowing that there are 277 beds at the hospital "La Croix", the total volume of wastewater produced by this center can therefore be estimated.

$V_{wastewater} = 0.85 \times 500 \times 277 \times 0.8 = 94180 L/J$

Thus, 94180L of wastewater are produced daily by the center of which only 362.4L come from the operation of its various services. The volume of wastewater discharged for the operation of the center therefore represents only a tiny part, i.e. 0.38%, of the total volume of discharge calculated.

The results of Physico-chemical analysis of these liquid effluents sampled at different points in the center can be found in table 4 and reveals their non-biodegradability.

Table 4:- Average values of the physico-chemical parameters of the LBMW sampled in 2014.

Sampling location	pH	BOD_5 (mg/L)	COD (mg/L)	COD/BOD_5	TN (mg/L)	TP (mg/L)
Standars [25]	6 **-9**	**<30**	**<125**	**2-3**	**15-30**	**2-10**
Inside the laboratory	9.59	100.00	4380.00	43.8	14.50	11.50
Inside the block	6.69	210.00	1600.00	7.61	129.40	04.50
Sump	6.34	131.00	780.50	5.96	06.50	03.00

Source: field data, 2014

Almost all the values obtained in 2014 are out of range. The pH varies between 6.34 and 9.59, BOD_5 between 100 and 210mg/L, and COD from 780.50 to 4380 mg/L. The minimum and maximum values for total nitrogen are respectively 61.04 and 280mg/L. Total phosphorus oscillates between 7.31 and 49.02 mg/L. These values recorded in 2014 have changed somewhat in 2020 (see **Table 5).**

Table 5:- Average values of the physico-chemical parameters of the LBMW sampled in 2020.

Sampling location	**pH**	**BOD_5**	**COD**	**COD/BOD_5**	**TN**	**TP**
Inside the laboratory	10.29	2200.00	6480.00	2.94	280.00	49.02
Inside the block	6.69	82.00	140.00	1.71	101.30	16.28
Sump	6.61	66.00	100.00	1.51	61.04	7.31

Source: field data, 2020

The values of the physico-chemical parameters of the water samples collected in 2020 remained for the most part deviated from the normal values for the discharge of wastewater into the environment [25,26]. The considerable difference noted between the values of 2014 and those of 2020 on the laboratory samples (100mg/L and 2200mg/L) could be explained by the increase in the number of patients and therefore of laboratory activities. The COD/BOD_5 ratio, which indicates the biodegradability or otherwise of the effluents, shows values that are well above the standard in places. The high levels of nitrogen and phosphorus show the potential danger that these effluents constitute for the environment. These results agree with those of various authors [27,28,29] who reported a significant difference between the standard and the values of the physico-chemical parameters measured. Analysis of this table shows that the wastewater collected from inside the laboratory and the operating theater is more loaded with organic pollutants than that from the sump. This observation can be explained by the fact that this water with its loads is found diluted by the large quantity of wastewater coming from other services (equipment and hand washing water) and sewage from hospital wards. Given the small volume of liquid waste from the operation of services and its high load compared to liquid effluents similar to domestic wastewater, a categorical treatment of LBMW would reduce the cost of managing this waste and would certainly constitute a motivating factor for hospital centers for adequate management of the latter. Thus, the liquid effluents from the operation of the services (i.e. less than 1% of the total LBMW produced by the center) may be the subject of special treatment " in situ " or outside by an approved structure and the effluents liquids similar to domestic wastewater (more than 99% of the total LBMW produced) may undergo the usual treatment reserved for domestic effluents.

The microbiological analysis carried out on the samples taken from the sumps in 2014 and then in 2020 revealed as shown in table 6 the presence in these effluents of a few pathogenic germs.

Table 6:- Microbiological quality of LBMW sampled in 2014 and 2020.

Type of Sampling	**Year**	**Direct examination**	**Gram(-) bacteria(s) identified**	**Gram(+) bacteria identified**
Wastewater	2014	Leukocytes	Klebsiella pneumoniae	Staphylococcus aureus

from sumps		Yeasts		
	2020	Yeasts	Klebsiella pneumoniae; Escherichia Coli	

Source: 2014 and 2020 field data

We note the presence of some bacteria responsible for nosocomial infections such as Klebsiella pneumoniae and Escherichia Coli. These results agree with those of Chitnis et al., [30] then Guessennd et al., [31] who respectively detected in hospital effluents the presence of pathogenic bacteria such as Salmonella, Shigella, Enterobacter and multi-resistant bacteria.

Conclusion:-

Carried out over more than six years, this study aimed to evaluate the management of BMW in hospitals in Benin. The quantification of the various wastes (solid and liquid) and the physico-chemical and microbiological characterization of the liquid effluents from various departments and the discharge sump of the hospital "La Croix" show poor management in 2014 with a significant improvement in the management of SBMW in 2020. As for liquid waste, their management leaves something to be desired and deserves special attention from both center users and decision-makers. Indeed, almost all the average values of the physico-chemical parameters measured are higher than the international standards for wastewater discharge recommended by the WHO. At the microbiological level, we note the presence of several pathogenic germs potentially responsible for nosocomial infections. From a quantitative point of view, less than 1% of waste water is produced by the various departments of the center for their operation and is mixed with the wastewater from the hospital departments. Categorical management of these liquid effluents from the various departments would therefore constitute a possible alternative for a good intake at a reduced cost of LBMW in hospitals with a view to better protection of man and his environment.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement:-

We acknowledge the authorities and staff of the hospital "La Croix" of Benin.

References:-

1. Hisseien A, Kamga R, Mahamat TN, "Physico-chemical analysis of Logone River water at Moundou City in Southern Chad," Int. J. Biol. Chem. Sci., 9(3) (2015): 16541664. http://ajol.info/index.php/ijbcs.
2. Emmanuel E., Jean-Marie B, Gérard K, Yves P, "Chemical, biological and ecotoxicological characterization of hospital effluents", Francophone Review of Industrial Ecology, No. 22 - 2nd quarter (2001) 30-33
3. Billau P., "Estimation of the dangers of biomedical waste for health and the environment in Benin with a view to their management" Center Universitaire de Formation en Environnement de Sherbrooke, Québec, Canada, 2008, 58.
4. Cclin, "Elimination of liquid effluents from hospital establishments recommendations" Paris, France, 1999, 74.
5. Allegranzi B., Nejad SB, Combescure C., Graafmans W., Attar H., Donaldson L. and Didier Pittet. "Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis". Lancet, 377(2011), 228-241.
6. WHO (World Health Organization) "Management of solid health care waste in primary health care centres" Decision support guide, WHO, Geneva, 2005a.
7. Ndiaye, L. El Metghari, MM Soumah; MLSow; "Management of biomedical waste in five hospital structures in Dakar, Senegal"; Bull. Soc. Pathol. Exot. 105(2012):296-304. doi 10.1007/s 13149-012-0244-y.
8. Justin Ndié " study of hospital waste management in reference health structures in the northern Cameroon region" european scientific journal april edition vol.12(2016).
9. Fekadu S, Merid Y, Beyene H, Teshome W, Gebre-Selassie S. "Assessment of antibioticand disinfectant-resistant bacteria in hospital wastewater, South Ethiopia: a cross-sectional study". J Infect Dev Ctries, 9(2) (2015): 149–156
10. YF Kouamé et al., " Characterization of liquid discharges from the Daloa Regional Hospital Center and sizing of the lagoon treatment plant (Midwest, Ivory Coast)," J. Mater. About. Sci ,11(5) 2020, 833-843

11. A. Toure, A. Garat, C. Diop, M. Cabral, MJ Epote, E. Leroiy, M. Fall, A. Diouf, B. Dehon and D. Allorge." Presence of heavy metals and drug residues in the effluents of health establishments in Dakar (Senegal)" Int. J. Biol. Chem. Sci. 10(3).2016.: 1422-1432
12. Maheshwari M, Yaser NH, Naz S, Fatima M and Ahmad I. "Emergence of ciprofloxacinresistant extended-spectrum β-lactamase-producing enteric bacteria in hospital wastewater and clinical sources" J Glob Antimicrob Resist, 5(2016): 22–25 Doi: 10.1016/j.jgar.2016.01.008.
13. A S Adanlokonon, WG Kanhounnon, BC Chabi, DC Adjahouinou, L. Koumolou, B. Bonou, ED Fiogbe and PA Edorh. "Physicochemical and microbiological characterization of effluents from the "Centre Hospitalier Universitaire de la Mère et de l'Enfant Lagune (CHU-MEL)" discharged in the Cotonou lagoon in Benin" Int. J. Biol. Chem. Sci. 12(4), (2018): 1955-1964
14. Mickael Saizonou, Boniface Yehouenou, Honoré S. Bankolé, Roger Gérard Jossé, Henri Soclo**,** "Impacts of waste from the Cotonou slaughterhouse on the degradation of groundwater quality", J. Soc. West-Afr. Chem, 30(2010): 79-91.
15. AFNOR. "Compendium of Environmental Standards and Regulations" Water Quality, 2005, vol. 1, 552.
16. Levallois P, Festy B, Hartement P, Ledrans M, Payment P, Tricard D. "Water quality "In: environment and public Health-Foundations and practices, Éditions Tec&Doc (Paris), 2003. 333-368. Google Scholar
17. Payment P, Berte A, Provost M, Ménard B, Barbeau B. "Occurrence of pathogenic micro-organisms in the SaintLawrence River (Canada) and comparison of health risks for populations using it as their source of drinking water" Canadian Journal of Microbiology, 46(6) (2000): 565-576. PubMed
18. WHO, Safe Management of Medical Waste (Healthcare Waste) – Summary, No. WHO/FWC/WSH/17.05, License: CC BYNC-SA 3.0 IGO, World Health Organization, Geneva, 2017, 24.
19. Republic of Benin, 2002, Decree No. 2002-484 of November 15 on the rational management of biomedical waste in the Republic of Benin. Official Gazette of the Republic of BENIN
20. Sanogo M, Sokona F, Guindo S, Oumar A and Kanoute G "Contribution to the establishment of a sustainable biomedical waste management system at Gabriel Touré Hospital (Mali)" Pharm Hosp, 42 (170) (2007): 143-147
21. Roger G., "Analyzing the demand of users-and future users-of water and sanitation services in African cities PDM/pS-eau", methodological guide .2011 n° 3.
22. Jehannin, "Characterization and management of hospital liquid discharges – Special study of the situation of the Hyères Hospital Center (Var)" Final dissertation, National School of Public Health, Rennes, 1999, 71 p.
23. Qadouri A., "Application of a method for the quantitative and qualitative study of hospital liquid discharges in the region of Marrakech Tensift El Haouz" Morocco, European Scientific Journal, 2016 12(32). doi: 10.19044/esj. 2016.v12n32p110
24. Evens Emmanuel, Yves Perrodin, Jean-Marie Blanchard, Gerard Keck and Paul Vermande" Methodological approach to the assessment of the ecotoxicological risks of hospital effluents vis-à-vis the local step and the receiving aquatic ecosystem" French-language review of industrial ecology n ° 35 - 3 ^{e} quarter, 2004, 27p
25. Republic of Benin. Decree No. 2001-109 of April 4, 2001 setting the quality standards for waste water in the Republic of Benin. Official Gazette of the Republic of Benin. 1- 27.
26. Word Health Organization. "Safe Management of Wastes from Health-care Activities" (2nd edn). WHO 2014: Geneva.
27. Sadek S, Elkharrim K, Khadmaoui A, Guissouss M, Benelharkati F, Elmarkhi M and Driss B. "Physico-chemical characterization of wastewater from the provincial hospital of Sidi Kacem (Morocco)" Science Lib., 4 (2012): 1–8.
28. Berrada S, Squalli FZ, Squalli HT, Hannin M, El Oua lti A and El Ouali Lalami A. "Recycling of effluents from the hemodialysis department of Al Ghassani hospital in the city of Fez: characterization before and after treatment" J. Mater. About. Sci., 5(2O14**)**: 2265-2277.
29. Verlicchi P, Al Aukidy M, Galletti A, Petrovic M and Barcelo D. Hospital effluent: investigation of the concentrations and distribution of pharmaceuticals and environmental risk assessment. Science. Total Environ., 430(2012): 109–118. DOI: https://doi.org/10.1016/j.scitotenv.2012.04.055.
30. Chitnis, V. et al., "Hospital effluent: A source of multiple drug-resistant bacteria". Current Science Association, (2013) 989–991. doi: 10.2307/24104814.
31. Guessennd NK, Ouattara MB, Ouattara ND, Nevry RK, Gbonon V, Tiekoura KB, Dosso M, and le GER BMR "Study of multi-resistant bacteria in hospital effluents from a hospital and university center (CHU) in the city of Abidjan (Ivory Coast)" J. Appl. Biosci, 69(2013)5456 – 5464. https://dx.doi.org/10.4314/jab.v69i0.95071.