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## **Problem of the Destruction of Waste and Unusable Pharmaceutical Products (PPI), its Impact on Environmental Degradation: Case of Health Establishments in the Abobo-EST Health District in Ivory Coast**

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### **Abstract**

The environment is under severe strain in recent decades due to the discharge of all kinds of waste into nature. The contribution of pharmaceutical waste or Unusable Pharmaceutical Products (UPPs) to the degradation of the ecosystem is undeniable. The institutional failure in the management of hospital waste, particularly UPPs in health establishments in Côte d'Ivoire, is indicative of the dysfunctions observed in the UPPs production, management and elimination chain. Thus, in order to better understand the impact of this phenomenon in the Abidjan 1 health Region, a study was carried out in the Abobo-Est health district in order to analyse the management and elimination of UPPs and propose solutions. To do this, the methodology adopted was based firstly on documentary research. Then, the second step of the approach was the field survey. The field survey was about interviewing sixty-eight (68) health

workers in the 17 health facilities of the Abobo-East health district, involved in the management and elimination of UPPs; after that a questionnaire has been submitted to one hundred and nineteen (119) actors other than those interviewed, including seventeen (17) doctors and nurses, thirty-four nurses and fifty-one (51) patients in order to assess this management of the UPPs and the effects on the health population. The result of this analysis is that institutional failure, inappropriate management conditions (collection, handling, storage and destruction) represent a major health and environmental risk. Furthermore, the lack of interest of health authorities in the management of UPPs coupled with the lack of funding for the sector aggravate the already chaotic situation in health facilities in general, but in particular in the health district of Abobo East.

**Keywords:** Management and Disposal, Unusable Pharmaceutical Products, Environmental Impact, Health Facilities, Abobo East Health District, Côte D'Ivoire

### **1. Problem**

Faced with the dizzying degradation of the environment, its protection has become a collective concern and a global or even planetary issue in view of the many changes and natural disasters that occur on planet earth. Long periods of drought, heat and cold waves, floods, climatic changes etc., all testify to the dynamic nature of the environment. This situation due to anthropogenic activities in its frantic quest to satisfy its generic needs (.....) must appeal to the collective conscience for a full and real involvement of all actors in better waste management which is one factors contributing to this degradation. Thus, the problem of waste management and disposal is entirely especially in developing countries. It affects every individual on a daily basis, both professionally and familywise (Bousnane 2018, p.b). Moreover, a link is quickly made between health, environmental and even socio-cultural problems and the waste produced. This concern is shared by Deleuze (1992, 23), regarding the environment-waste relationship. The author sees this relationship as a global concern and discusses the link between population health and environmental degradation.

Among the waste managed there is biomedical waste (DBM), including unusable pharmaceutical products that are the subject of our analysis. This type of waste represents 15% of hazardous waste related to health care. The inappropriate management of HBMs (collection, handling, storage and destruction) constitutes a health and environmental risk for the population in general, health personnel and agents in charge of waste collection in particular. According to a study carried out in 2017 by USAID through its supply chain support structure CHEMONICS IVOIRE/IHSC-TA on behalf of the Ministry of Health and Public Hygiene, Côte d'Ivoire holds around 1,700 Tons of expired drugs including less than two (2) tons for the district of Abobo East in these stores. The accumulation of large quantities of unusable pharmaceutical products at the level of this district is likely to

be a concern for environmental pollution and the origin of diseases. These risks of environmental pollution and public health are the consequences of poor management and inappropriate disposal of PPI with these corollaries of problems because in reality these stocks are not managed properly.

To remedy this, as Iraqi explained, it is essential to carry out a constructive critique of the health/environment interaction as it is conceived by the contemporary mind, before looking into the motivation required for membership. And mobilization around a new social project (Iraqi, 2017:1). For this reason, a diagnosis of the problem of the management of hospital waste as a whole and of PPI in a specific way is essential in order to find innovative solutions adapted to the realities of this district. This diagnosis must be made on the basis of rational and scientific references constituted by international conventions and regulatory texts, in particular decrees, orders and national procedures for the management of hazardous waste, and take into account the question of the long-term financing of waste in Côte d'Ivoire and especially in our health establishments in particular in those of the health district Abobo EST.

In addition, burning in the open air, the use of artisanal incinerators are practices for the management and disposal of hospital waste observed in the majority of health establishments in the district of Abobo East with regard to the adoption of the method. Incineration as the preferred method for the destruction of drugs in Côte d'Ivoire. These practices cause harm to both the social and natural environment that require commitments to environmental protection. It is in this context that it seemed necessary to us to analyze the management and elimination of PPI in the health facilities of the district of Abobo EST in order to propose solutions to reduce the risks of contamination and improve the state environmental and public health.

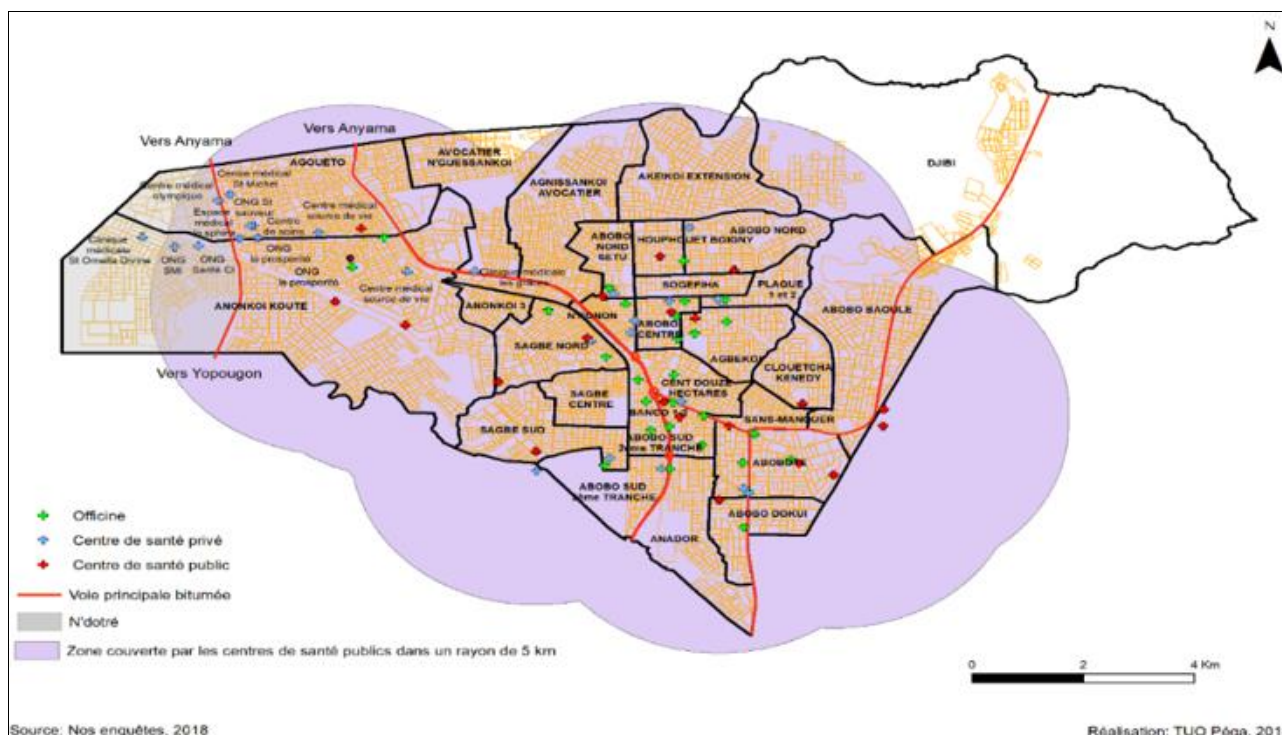
## 2. Materials and method

### 2.1 Study area

The commune of Abobo is one of the 13 communes constituting the district of Abidjan. It is located north of the agglomeration of Abidjan, about ten kilometers from the city center. Abobo has been administered as a full-service municipality since 1980, in accordance with Law No. 80-1182 of October 17, 1980 relating to municipal organization.

The communal territory of Abobo covers an area of 9,000 ha (90 km<sup>2</sup>); i.e. a density of 166 inhabitants per hectare. It is one of the most populated municipalities in the district (about 1,340,083 inhabitants according to INS-RGPH, 2021). It is a vast plateau bordered by talwegs covering nearly 2,460 hectares and representing 31% of its area. This relief is marked by basins whose diameter varies from 100 to 500 meters. The maximum altitude is about 125 m, which explains the installation of antennas of the Ivorian radio-television and radios on this highest point. The climate of the commune of Abobo is humid tropical with 2,200 mm of rain per year over seven months (National Action Plan for the Environment of Côte d'Ivoire, 1994). Temperatures are generally high with an average of 30°C. This climatological and geomorphological profile has a strong influence on the epidemiological profile of Côte d'Ivoire and in particular of the commune of Abobo.

The municipality of Abobo includes 28 neighborhoods and villages. The city is limited to the north by the commune of Anyama, to the south by the forest of Banco, to the east by the commune of Cocody, to the west by the commune of Yopougon and the sub-prefecture of Songon. It notably houses the Banco2 railway station, on the Abidjan–Niger railway line linking Côte d'Ivoire to Burkina Faso, as well as a bus station.



Map 1: Location of the study area

In terms of health, the municipality of Abobo is home to two health districts located in the Abidjan 1 health region,

including the Abobo-East Health District. It was created by Order No. 212 of July 11, 2007 of the Ministry of Health

and Public Hygiene and Universal Health Coverage. It covers part of the commune of Abobo. (See map 1)  
 The Abobo Est health district is limited to the North: by the Anyama health district, to the South: by the Adjamé-Plateau-Attécoubé health district, to the East: by the Cocody-Bingerville health district and to the West: by the Abobo West Health District. The Abobo Est health district covers an area of 67 km<sup>2</sup> with an estimated population of 695,744 inhabitants/km<sup>2</sup>. He coordinates the activities of the health programs carried out at the level of the health centers in his area. It ensures compliance with the directives published by the Ministry of Health, Public Hygiene and Universal Health Coverage (MSHP-CMU) and the quality of the services offered at the level of the health centers, thanks to a training plan for health providers on the one hand and a good system for monitoring and evaluating the health activities carried out on its territory on the other.

**2.2 Data and Method**

The working methodology adopted is essentially based on documentary research, field research and data processing. The documentary research consisted of consulting works dealing with issues of management and disposal of unusable pharmaceutical products in health facilities around the world and particularly in the health districts of Abidjan and their impacts on the environment. This bibliographic research made it possible to collect data and quantitative information relating to the elimination of unusable pharmaceutical products in the health establishments of the district and the pharmacy of the Abobo-Est district on the one hand and qualitative data relating to the degradation and to the environmental impact on the other hand.  
 Regarding the field survey, it consisted of making an observation supplemented by interviews and a questionnaire survey.  
 The field observation made it possible to assess the state of the environment in which the health establishments of the Abobo-Est district were immersed, that is to say at the level of the management of health care waste (strategic inputs) and the disposal sites for unusable pharmaceutical products. The actual field survey involved conducting an interview with sixty-eight (68) health workers in the 17 health facilities of the Abobo-Est health district, with an average of four categories (4) of people per structure visited. Namely: the head of the structure, a pharmacy manager (Pharmacist or PGP), a biologist technician at the laboratory level and an officer responsible for waste management. Thus, the number of target population amounts to approximately 68 agents

interviewed. This number was determined from this calculation:  
 Target population = Sample size x average of agents surveyed  
 Target Population = 17 x 4 = 68 Agents surveyed  
 The second stage of the field survey is a questionnaire, developed and submitted to one hundred and nineteen (119) actors other than those who were interviewed, including health workers (Table 1)

**Table 1:** The target population surveyed by questionnaire

Actors who answered the questionnaires	Number
Doctors	17
Nurses and/or nurses	34
Nurses	17
Patient(s)	51
Total	119

Source: Field survey, 2022

To determine the size of the sample, we chose to use all the (17) establishments or health areas in the Abobo Est health district. From this sampling, the target population is made up of health workers including one (1) doctor and caregivers, two (2) nurses and three (3) patients per structure. district health.

The choice of this commune of Abobo and by extension of the Abobo East health district is explained by the enormous environmental challenges and the lack of basic urban services facing this commune, these are the management of solid and liquid waste and the sanitation. The surveys of health establishment agents took place from September 2, 2021 to November 30, 2021.

At the end of data collection, the information collected underwent manual and computer processing. The input mask was developed with SPSS software. Word and Excel software were used respectively for text entry and the development of tables and graphs.

**3. Results**

**3.1 Identification of sources of production of Unusable Pharmaceutical Products**

Several health facilities working in the area of the Abobo Est health district carry out variable activities. They can range from prevention, through examinations (radiological, urinary, blood, etc.), care to treatments and therapies. These activities generate variable quantities of medical waste whose production sources are themselves variable. These are among others:

**Table 2:** Primary and secondary sources of medical waste generation

Main sources	Secondary sources
- District pharmacy - Public hospitals; - Private clinics; - Medical analysis laboratories; - Health centers and dispensaries; - The blood transfusion centre; - Morgues and autopsy centres.	- Medical practices; - Dental surgeries; - Infirmaries; - Outpatient consultation centers; - Beauty practices; - Veterinary offices.

Source: Field survey, 2022

These health facilities produce several types of healthcare waste during their activities:

- Waste from health activities with an infectious risk and similar (DASRI)
- Waste from health activities with chemical and toxic risks (DASRCT)
- Waste from health activities with a radioactive risk (DASRR):

▪ Identifiable anatomical parts.

In these categories of waste related to health care, waste related to unusable pharmaceutical products is distinguished which consists of medical waste, cytotoxic waste, waste containing heavy metals and chemical waste.

The handling of this waste is likely to cause an infection, it can be likely to seriously harm the people in contact and the environment.

**3.2 Conditions of collection, transport and storage**

The Departmental Directorate of Health and Public Hygiene and Universal Health Coverage Abobo Est (DDSHP-CMU), is a health district with an internal pharmacy that gets its supplies of health products from the central purchasing (NPSP). Like any health district in Côte d'Ivoire, it distributes drugs and other health products in its health area to all its health facilities and provides reverse logistics, i.e., the collection, storage and disposal of unusable pharmaceuticals. Furthermore, the conditions for managing PPIs are not optimal. The problem observed in the management of this waste in the majority of the establishments visited is the lack of sorting. Indeed, separation or sorting is the most important step for a successful management of medical care waste, however no effort is made to identify beforehand and classify PPI after the inventories. The absence of categorization prevents any quantification. The sorting of PPI is not done at the source as indicated by the procedures and protocols for the classification of waste, i.e., by galenic form, by liquid products, by aerosol cans including atomizers with propellant gas and inhalers. Among this medical waste to be incinerated, in addition to waste similar to household waste, there are expired drugs, empty bottles of pharmaceutical products, sharp and sharp objects, etc. (Picture 1 and 2).

Picture 1 and 2 show this mesh of waste during the collection of this waste from the treatment or dispensing room despite the identification of the garbage bags by color. This same provision, i.e., ineffectiveness of sorting, is observed in the places of regrouping before incineration.

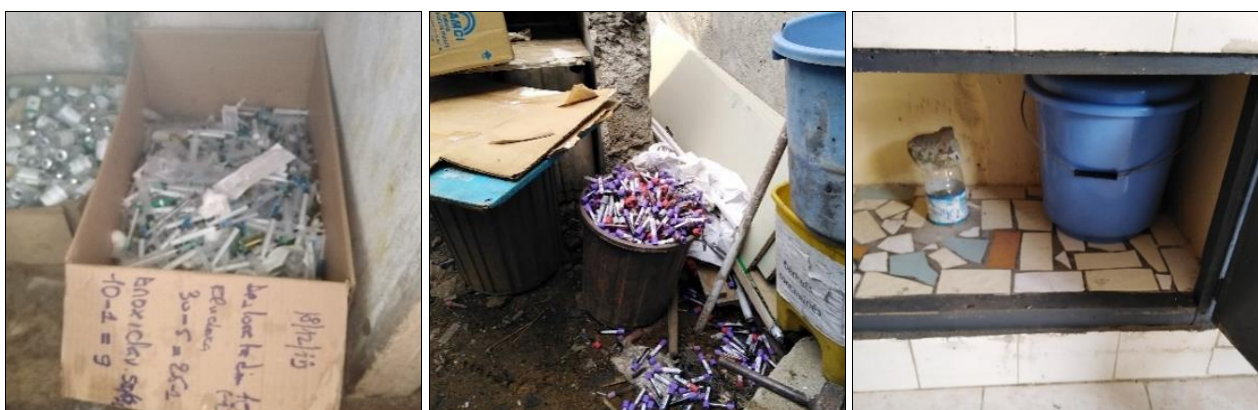


Picture 1: No separation of waste during production



Picture 2: No sorting before disposal

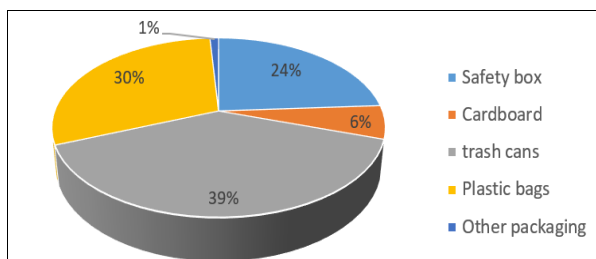
In these district health structures and particularly in the pharmacy and laboratory services, the separation or sorting of PPI is not systematically done, which makes their elimination difficult and costly. Sorting can significantly reduce the cost of treatment and the amount of waste to be disposed of up to 10 to 25% of hazardous medical care waste. Also, it significantly reduces the risk of infection for workers who handle medical care waste. Thus, during the collection phase of unusable pharmaceutical products, there is no identification or sorting. In these health establishments, the iterative breakdown of collection equipment (garbage bags, bins, safety boxes, etc.) hinders the proper functioning of services in terms of health waste management. Indeed, the collection of PPI and especially strategic inputs is done in garbage bags and safety boxes but often it is done in boxes and makeshift garbage cans or unconventional containers (Picture 3).



Picture 3: Makeshift containers for the collection of medical and pharmaceutical waste

The containers used (safety boxes, garbage cans, garbage bag, cardboard and others) for the collection of this type of waste vary according to the health establishments present.

Thus, Fig 1 shows the rate of use of containers within the area of the Abobo Est health district.



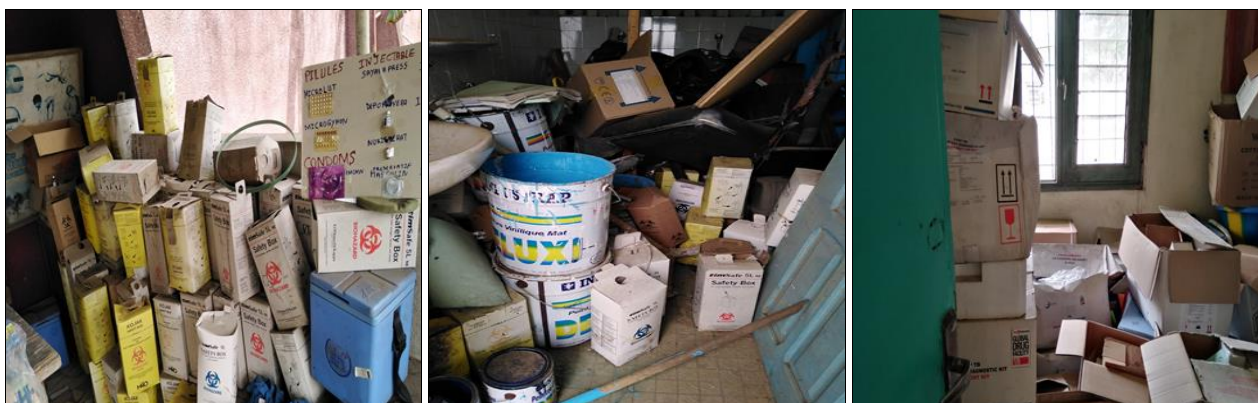
**Fig 1:** Proportion of containers used for PPI storage

With regard to Fig 1, garbage cans occupy a prominent place in the collection of PPI, i.e. 39%, followed by garbage bags (30%) and safety boxes. However, the frequent rupture of these containers leads to the use of unconventional

containers such as cardboard boxes (6%) and other packaging (1%) such as seals, empty water bottles, etc. for the storage of unusable pharmaceutical products and medical waste.

The storage and transport conditions are still precarious with the use of rudimentary tools such as the wheelbarrow, tricycles for transporting waste from the collection point to the storage point.

Healthcare waste including PPI is temporarily stored before being treated/disposed of on site or transported off site. However, the storage of PPI is done in unidentified and unsanitary stores or makeshift places (Picture 5). These storage places are not protected and most often accessible to everyone.



**Picture 5:** Unidentified and unsanitary makeshift store or storage

Means of transporting waste in situ (off-site) practically do not exist in order to ensure the treatment of waste outside health establishments, if there were any, equipment for the collection and transport of solid waste, production at storage or disposal sites, often do not comply with international standards with waste packaging, correct labeling of containers to be transported and identification of vehicles by a packing note from the collection point to the treatment as noted above. Extremely rare health establishments in the district that have suitable vehicles for transporting PPI to storage and destruction sites. These transfers are generally done by motorcycle, by public transport, personal vehicles and often on foot..., the fractions of liquid waste are often spilled directly into the evacuation channels without prior treatment and evacuated by the collective sanitation network. This poses enormous environmental risks to the entire population. These activities are often carried out in non-compliance with the environmental standards in force.

these establishments, there are some modern, artisanal incinerators and open burning sites which are used for the destruction of biomedical waste (Picture 6, 7).

**3.3 Incineration of medical waste (PPI), what consequences on the environment and the population?**

**3.3.1 Facilities used for the disposal of medical and pharmaceutical waste**

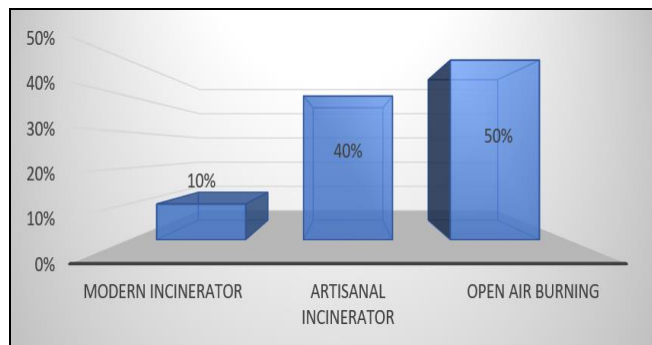
The destruction of Unusable Pharmaceutical Products (WPP) requires appropriate facilities. However, the Abobo Est health district does not have enough modern incinerators. Nevertheless, some health facilities in the district area use incinerators for the disposal of medical care waste such as compresses, cotton, gloves, empty medicine boxes, cardboard boxes, expired medicines or damaged and strategic inputs. For the treatment and disposal of medical care waste or PPI, facilities use a variety of facilities. In



**Picture 6:** Modern incinerator, CAT Abobo



**Picture 7:** Artisanal incinerator at CMS Aboboté



**Fig 2:** Proportion of use of facilities by health facilities

In the Abobo Est health district area, there are several methods and various facilities available for the disposal of

unusable pharmaceutical products. Fig 2 below shows the proportion of facility utilization. Thus, 50% of medical and pharmaceutical waste or PPI are destroyed or burned in the open air, 40% of this waste is incinerated from artisanal installations and 10% from modern incinerators which include a double combustion chamber with a temperature of 850°C for the decomposition of the products into ash and gas and a post-combustion chamber with 1200°C for the neutralization of the combustion gases.

**3.3.2 Consequences of waste disposal practices on the environment**

In health facilities that do not have an incinerator, open burning pits are used as shown in Picture 8.



**Picture 8:** Open-air burning of medical and pharmaceutical waste within health establishments and near residential areas

This practice of disposing of medical care waste and expired drugs is not without consequences for the environment. Indeed, the exhaust of smoke from the burning of composite waste contributes to the release of toxic pollutants (carbon monoxide, carbon dioxide, dioxins, and chlorofluorocarbons) into the atmosphere likely to affect the ozone layer. Also, the products resulting from this elimination are not completely destroyed with a high risk of recovery. The fauna and flora are partly threatened by this practice, to cause the infiltration of leaching products, therefore microbial proliferation and chemicals that infect the soil, the risk of injury to animals by the residues of non-incinerated waste.

In addition, a particularity should be noted in this management, apart from essential drugs and other outdated

recoverable health products for which health facilities are responsible according to the polluter-pays rule. So-called "targeted free" drugs such as antiretrovirals and outdated strategic inputs relating to the care of People Living with HIV/AIDS must be sent to a common district disposal site according to the polarization policy enacted by the State of Côte d'Ivoire for pooling management costs. However, a significant portion of PPI escapes this circuit and lands in artisanal incinerators, uncontrolled landfills, illegal deposits ending up in an open pit. They were periodically burnt there and the unburned ones were superimposed in partially degraded stratified layers (see photo 8). The ashes resulting from these incinerations are neither treated/evacuated from the burning sites, nor buried in a protected pit (see picture 9).



**Picture 9:** Ash from the incineration of untreated medical waste stored at CMSSC ABOBOTE

Similarly, the ashes containing heavy metals, dioxins and furans resulting from this incineration as shown in photo 9, are neither managed nor treated by the producers of these health establishments in the Abobo East district area. These ash particles released into the atmosphere (air) are a source of environmental pollution and poorly buried, they can contaminate groundwater reserves.

The staff in charge of handling PPI often escapes the supervision of the establishment's pharmacist and for the most part does not wear personal protective equipment (PPE). Handling this waste exposes this type of personnel to the risk of inhaling gas or dust containing pathogenic micro-organisms and injury.

The pollution generated in such conditions by waste is becoming more and more worrying with regard to the emissions of flammable, corrosive and toxic gases called landfill gases (Bangoura, 2017: 90) and gives off bad odors which directly affect the populations living near the health facilities where this operation takes place.

Among the factors limiting the optimization of this management, the lack of financial means is mentioned. It would be at the root of the lack of equipment and the insufficiency of infrastructures adapted to the elimination of unusable pharmaceutical products, the high cost or the high cost of the installations and their maintenance. The lack of training and clearer and more complete information would explain the notable lack of rigor in the management of PPI and the ignorance of the dangers incurred by the agents responsible for the management of this type of waste. In some health facilities, due to a lack of storage space, expired products are not removed from available and usable stocks, which can cause a risk of dispensing to patients, PPI are not often inventoried and systematically removed from stocks, if they are, there is a problem of traceability caused by the frequent breakdown of management tools. These PPI are packaged in boxes without prior sorting. They are mostly stored in archive stores, in unused toilets or buried in containers without any management. As a result, there are no dedicated staff to manage PPI and often HCW including PPI is not weatherproof. The size of the storage rooms pushes some managers to incinerate them without any preventive measures and in non-compliance with environmental standards. These practices are likely to aggravate the risks of contamination, environmental degradation and negatively impact the living environment and the health of populations.

#### 4. Commentary and discussion

The relevance of our study is justified by the fact that waste management and disposal in general constitute a major health and environmental problem for countries around the world and in particular for developing countries such as the Côte d'Ivoire. Ivory. This management, when it is not carried out according to the required standards, constitutes an obstacle to the process of sustainable development. The poor management and inappropriate elimination of PPI in the health district of Abobo Est are likely to cause risks of contamination of the environment and the health of the population by their magnitude, gravity and vulnerability (Cheick Fall, 2003:5) <sup>[1]</sup>. In 1970, environmental concerns raised by the countries of the South in the direction of the countries of the North, gave rise to reflections and reactions from international organizations for questions of sustainable development, particularly in the environmental field. These

concerns show the extent of the problem of waste management, but particularly PPI. Thus, the Stockholm 1972 declaration in its principle 1: "It is the solemn duty of man to protect and improve the environment for present and future generations" and that of Rio (June 1992) in its principle 7: "*States must cooperate in a spirit of global partnership in order to conserve, protect and restore the health and integrity of the terrestrial ecosystem*" endorse or confirm the seriousness of the situation and bear witness to two major concerns that have arisen: the deterioration of the environment and the need to protect it. The seriousness of the problem is linked to the risks of contamination both for all the staff of the health establishments of the Abobo East district taking charge of hospital waste (biomedical waste and unusable pharmaceutical products) and for patients, visitors and the population. Residents because of the unsafe storage of waste (PPI) and often their incineration in the open air and in open pits by some health establishments. These same risks of contamination are observed at the environmental level, in particular air pollution due to smoke and ash particles from incinerated contaminated waste that can be inhaled by local residents, contamination of groundwater reserves. Indeed, dwellings near health facilities often housing wells used for consumption are likely to be contaminated by the flow of leachate. Add to these practices, the accumulation for more than 10 years of PPI stocks in makeshift storage places, in health facilities. Wastewater from mismanagement of the liquid waste fraction typically contains a wide range of substances that may pose risks to human health and the environment (CCME, 2011). Thus, the discharge of waste in general and PPI negatively impacts the receiving environments (water, soil, air) (Bangoura, 2017) and World Bank, (2003, p.139) <sup>[3]</sup> whose corollaries of such a situation is the increased risk of disease transmission (UNEP, 2002) <sup>[4]</sup>, similarly, the UNDP estimates that about 50% of chronic respiratory diseases are due to air pollution (UNDP, 1999, p.398) <sup>[5]</sup>. Another factor to take into account in the degradation of the environment in the commune of Abobo sheltering the area of the district of abobo EST, is the strong demographic growth of its population. Indeed, the population of Abobo is estimated at nearly 1,030,658 inhabitants out of 4,395,243 inhabitants in the ten (10) municipalities of the Autonomous District of Abidjan, i.e. (23% of the population) (INS, 2014:9). This growth rhymes with the production and management of waste, in particular PPI, and induces the growth of needs such as "to eat", "to treat oneself", "to move" according to Coulibaly (2017, p.318) <sup>[6]</sup>. One of the consequences of this urban demography is the exponential increase in types of waste (managers and industrial) which are in phase with the production of consumer goods. This population growth and increasing urbanization in this commune of Abobo have led to an increase in the production of urban waste, including unusable pharmaceutical products and the use of strategic inputs (sharp objects, sharp objects and contaminated waste) constantly increasing in all health establishments and their dangers are increasing with regard to their nature, the quantity produced and the management conditions. It poses a serious threat to humans and the environment (Daoudi, 2008, p.2) <sup>[7]</sup>, hence its vulnerability. The notion of vulnerability refers here to a set of elements that make waste (PPI) a risk for urban society, not only in health and environmental terms, but also in economic and social terms.

It is due to the fact that the risks associated with DBMs are highly reducible thanks to good management planning (Fall C., & all, 2003, p.4). Thus, the implementation of a management plan for medical care and pharmaceutical waste which requires the establishment of intervention mechanisms (Călin, 2011) in particular an internal procedure should take into account the aspects of waste management. solid waste and the liquid fractions of this waste, the need to train healthcare personnel in systematic sorting and collection of waste in order to avoid an increase in the proportion of hazardous waste. The practice of implementing this management plan and the PPI destruction procedure is possible because the material resources and the technology exist and are accessible. If the strict application of the regulatory texts which constitutes the basis of the planning of a system in terms of good management is carried out in a rigorous manner in the health establishments of the Abobo Est district, it should contribute to minimizing the risks for human health and the environment and reduce the costs of managing and disposing of PPIs by rationalizing them. The proper execution of a management plan should facilitate its financing and make it sustainable, hence the need to disseminate and popularize the manual of procedures for the destruction of PPI to provide specific guidance on the storage of unusable pharmaceutical products and others. waste (waste related to the use of strategic inputs) inside the structures in identified places (PPI storage room) far from the available and usable stock of the pharmacy, that the collection and transport of the products be ensured by unfortunately often untrained support staff, using garbage cans and garbage cans to storage places or carrying out disposal using personal protective equipment in health facilities in the Abobo East district. To avoid the collateral effects of poor PPI management, Halbwachs (1994) <sup>[9]</sup> recommended the use of personal protective equipment (gloves, scrubs, safety shoes, goggles, etc.) for personnel in charge of the waste management question (PPI) must be mandatory. Precautionary measures must also be taken to avoid pollution and degradation of the immediate environment of health facilities.

The treatment of contaminated waste such as used strategic inputs (sharp-sharp object), sampling tubes and other waste such as contaminated cottons, compresses, espadas packaged in garbage bags must be systematically decontaminated using iodized water or by other processes such as the use of diluted disinfectant in small quantities (max. 50 l/day, under the supervision of the pharmacist) by discharge into the sewer or into a fast-flowing watercourse (WHO, 1999) and also the use of crushing-disinfection equipment not only to reduce the volume of waste to be destroyed, but also to decontaminate infectious waste similar to household waste by disinfection. The decontamination of used strategic inputs before disposal is a necessary and even compulsory process which makes it possible to modify the appearance of the waste and reduce its microbiological contamination. If this decontamination is optimal, it reduces the bacteria by more than 8 log, the mass of waste by 25% and its volume by 80% using a trivializer (Abdellatif & Larbi, 2014) <sup>[10]</sup>. It allows the recovery and recovery of certain glass or PVC containers after decontamination and/or sterilization (Giroult E, 1996, p.12) <sup>[11]</sup>.

Sorting is the most important step for successful HCWM. It

must be done at the source to separate the waste according to its nature (piercing waste, non-sharp infectious waste and ordinary waste), and identify the type of waste (USAID, 2011, p.8) <sup>[12]</sup>. Regarding waste related to ordinary pharmaceutical products, sorting should be done by galenic form. Separating hazardous and non-hazardous waste dramatically reduces the cost of treatment and the amount of waste to be disposed of by 10-25% of hazardous healthcare waste and the risk of worker infection. However, to ensure the protection of staff, patients and visitors, the simplest and safest waste sorting system "Basic three-bin system" into containers should be applied (WHO, 2017) <sup>[13]</sup> to effectively achieve strict collection of waste pharmaceutical products. This sorting is based on a system of color codes which aims to ensure immediate and unequivocal identification of the risk associated with the types of hospital waste to be handled or treated.

Regarding the collection of Unusable Pharmaceutical Products (PPI), the Abobo East district and its health facilities should have a health waste management plan and internal procedures for the daily management of their waste. Furthermore, the storage of pharmaceutical waste requires two pre-treatment processes; the first is encapsulation, an inexpensive process that avoids injuries and cuts (Girout, 1996, p.16) <sup>[11]</sup> and the second by grinding/disinfection: (thermal and wet disinfection) using an autoclave (Durand, 1996 p.20) <sup>[14]</sup>. Warehousing or storage of collected PPI must be under safe PPI treatment/disposal conditions. Each health establishment must have an intermediate and central storage site, a place through which the PPI stock must pass. Storage of expired products (drugs and used strategic inputs) must be done using garbage bags, cardboard boxes and safety boxes in health establishments and placed in rooms or stores reserved for PPI with limited access. Storage, as observed in training and in the pharmacy of the health district of Abobo East, involves risks of diversion and injury because of the use of unsecured places and makeshift rooms for the conservation of this type of waste.

The transport/transfer of waste pharmaceutical products requires that all safety measures be taken when moving the PPI stock from the place of storage to the place of disposal using conventional means (trolleys, adapted collection truck). This operation must be carried out in complete safety in compliance with the regulations in force. However, the transport of waste and particularly PPI is not optimal in the health district of Abobo East, the evacuation of waste in health facilities is done using wheelbarrows, on foot within the establishments by health workers. Collection as well as by unsuitable vehicles between the health facility and the district. The practices observed in general in all health facilities in Côte d'Ivoire but in particular in most health facilities in Abobo East and should be done from a circuit far from the areas frequented by patients and visitors (Giroult E. 1996, p.12) <sup>[11]</sup>.

Elimination consists of the desire for the disappearance of waste (PPI). However, it is never complete. Waste treatment produces new waste that may contain hazards that can cause environmental degradation.

The collection and temporary storage of PPI in the warehouses of establishments and the health district before destruction only increase or increase the stocks of PPI in the storage warehouses of pharmacies and the risks of contamination of staff and patients in these establishments. This storage, far from constituting a solution to the disposal



problem, only increases the PPI flow.

One of the waste disposal methods is open burning. This method as practiced in most health facilities in Côte d'Ivoire and especially in those of the Abobo East district involves the risk of releasing toxic pollutants into the atmosphere due to the fumes of highly toxic or carcinogenic substances (heavy metals, harmful gases, particles of organochlorine substances). The waste resulting from this operation is often not completely destroyed with the risk of injury, recovery and contamination of the environment and the population. It will therefore be strongly discouraged to burn waste in the open air, because you never know exactly what you are burning, (Ndiaye P. 2000, p.35) [15].

The other method of disposal is incineration. It remains the method of choice for the destruction of unusable pharmaceutical waste (PPI) provided it is carried out under adequate conditions of equipment, maintenance, handling and monitoring. However, the use of poorly constructed artisanal installations (temperature below 850°C) and poor management of the ash from incineration are the determinants of environmental degradation. In addition, the high cost or high cost of facilities (incinerators, universalizers, etc.) and their maintenance constitute an obstacle to the acquisition of such a structure for most health facilities in Côte d'Ivoire and in particular in those of the district of Côte d'Ivoire. 'Abobo East. Thus, it would be useless to recommend sophisticated treatment techniques whose implementation would remain outside the possibilities for the establishments of the health district of Abobo Est Hibwachs (1994, p.15).

In other themes, the solution best suited to the problem of the management and disposal of unusable pharmaceutical products in the context of establishments in the health district of Abobo Est remains the burial of PPI based on the methods neutralization and solidification or encapsulation. This process can be done in situ within the premises of the establishment, or in an off-site landfill. The risks associated with this process are great for health: On the professional level, the poor working conditions and materials for the pre-collection and transport of hazardous waste (PPI), the informal sector of collectors and recyclers, for the population and the environment, these risks can be linked to the pollution of the soil, surface water and groundwater due to the residential areas located around the burial pits in situ or outside the site that contain wells used for household consumption. This is why the choice of a safe and ecological treatment option is more than necessary to ensure the protection of groundwater, the recovery and treatment of leachates and the monitoring of gases. Thus, the treatment of PPI by neutralization methods and by solidification or encapsulation becomes a prerequisite for the successful burial of unusable pharmaceutical products.

The results of this study show that there is a relationship between the poor management or the approximate disposal of healthcare waste, in particular unusable pharmaceutical products, environmental degradation and the health of the populations in the district of Abobo East. The observation is that the more medical and pharmaceutical waste is poorly managed, burnt in the open air, in artisanal incinerators within health establishments and near homes, the more the environment (soil, water, air) becomes more polluted. and health workers and local residents are increasingly exposed to several nuisances and diseases of all kinds. The long duration (period) of storage of waste in care production units

with these corollaries of nuisances such as the nauseating odors of waste in putrefaction, the appearance of leachate and maggots in certain storage places. Risks related to the activities of healthcare personnel such as visual and olfactory nuisances and contact with waste. Other nuisances linked to the poor management of waste are the persistent odors that are sources of unsanitary conditions and lack of hygiene in the health establishments and in the neighborhoods of the commune of Abobo, the presence of insects and rodents vectors of disease transmission. Touré S., (2010:93) [16] confirms this assertion "the proliferation of waste is a source of visual nuisance, animal morbidity and lung and carcinogenic diseases" the piling up and incineration of waste without sorting leads to gas emissions and the pollution of the atmosphere. It is necessary to add to all these nuisances, the flow of rainwater in this commune of Abobo and in particular in the district abobo EST which is made difficult because of the insufficiency of collective sanitation networks, drainage gutters of rainwater as pointed out by Tuo (2015:29) [17] in the Williamsville district in the commune of Adjame in Abidjan. Also, the discharge of boxes or empty bottles of medicines and other solid and liquid waste into the sewers, gutters and pipes leads to the obstruction of the sanitation network and causes, in addition to flooding, the stagnation of trapped water. In hollows and small depressions where breeding places for larvae and flies develop

## 5. Conclusion

The management and destruction of waste and especially unusable pharmaceutical products (PPI) is a very important activity for maintaining a healthy living environment and protecting the environment. Significant quantities of PPI (15%) are accumulated in secondary level health establishments, particularly in reference hospitals and health districts without being truly managed. These stock flows are justified by the implementation by the State of Côte d'Ivoire of a waste polarization strategy towards a common disposal site in order to pool management costs. However, the absence of sorting, the insufficiency and/or lack of collection equipment and storage space lead to poor management of PPI stocks. Expired products are not sorted, packaged in unidentifiable boxes, transported in conditions that do not meet international standards and often stored in makeshift rooms. A significant quantity of these dangerous products are either dumped in public landfills or either incinerated in the open air or in artisanal incinerators. The practices observed in all the health departments, particularly in the Health District of Abobo East, have consequences:

- The flora and fauna by the infiltration of leaching products, and therefore of microbial proliferation and chemical products which infect the soil, the risk of injury to animals, the pollution of groundwater and aquatic life by the liquid fraction garbage,
- The atmospheric system therefore air pollution, the release of chemical and toxic elements during burning in the open air (carbon monoxide, carbon dioxide, dioxins, chlorofluorocarbons) likely to affect the layer of ozone,

Le risque physique et infectieux pris par l'ensemble de la population particulièrement certaines catégories professionnelles comme les éboueurs ou les récupérateurs à la recherche de restes à recycler dans les décharges publiques reste la forme la plus dangereuse

pour la santé de l'Homme.

- This study concluded that the discharge of biomedical waste (PPI) in uncontrolled landfills, incineration in the open air and in poorly carried out artisanal installations are the determinants of the degradation of the environment in Côte d'Ivoire. Ivory and particularly in health establishments.
- From these main results derive the following suggestions for solving problems related to environmental degradation:
- This study shows that institutional failure is one of the determining factors in the poor management of unusable pharmaceutical products in health establishments. To remedy this, the state and the decentralized structures that are the regional and departmental health directorates must initiate hospital reforms taking into account issues related to regulatory texts, the training of health professionals in the management of PPI, the sustainable financing system for waste and especially PPI in Côte d'Ivoire.
- Another factor of environmental degradation remains the management and destruction practices of biomedical waste and in particular PPI. For a healthy living environment and a sustainable environment, waste management and disposal practices must comply with international standards for the management of hazardous products, institute an award of excellence for the best health facility in protection of the environment and the professional environment. This would encourage the heads of establishments to be more involved in the management and destruction of usable pharmaceutical products (PPI).

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