Hospital Wastewater: Existing Regulations and Current Trends in Management

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Abstract Wastewater refers to any water whose quality has been compromised by human activities. It includes liquid waste discharged from domestic homes, agricultural commercial sectors, pharmaceutical sectors, and hospitals. Hospital wastewater (HWW) can contain hazardous substances, such as pharmaceutical residues, chemical hazardous substances, pathogens, and radioisotopes. Due to these substances, hospital wastewater can represent a chemical, biological, and physical risk for public and environmental health. Nevertheless, very frequently there are no legal requirements for hospital effluent treatment prior to its discharge into the municipal collector or directly onto surface water after pretreatment.

In this chapter a brief introduction about the role of hospital wastewater on the environmental contamination was reported. Subsequently the main principles on the hospital wastewater reported in different legislation around the world have been addressed. Moreover the main content reported in the WHO guidelines, EPA guidelines, and guidelines about radionuclide releases to the environment from hospitals was described. A case study of excellence on hospital wastewater management was also illustrated. The chapter ends with some brief final remarks.

Keywords Hospital wastewater, Management, Regulation

Contents

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1 Introduction

Wastewater refers to any water whose quality has been compromised by human activities. It includes liquid waste discharged from domestic homes, agricultural commercial sectors, pharmaceutical sectors, and hospitals. In hospitals, water is consumed in various places such as hospitalization areas, surgery areas, laboratories, administrative units, laundries, and kitchens. In the process, its physical, chemical, and biological quality decreases and is converted to wastewater [1]. Compared to urban wastewaters (UWW), hospital wastewaters (HWW) contain a variety of toxic or persistent substances such as pharmaceuticals, radionuclides, solvents, and disinfectants for medical purposes in a wide range of concentrations [2–4]. In a review, Verlicchi et al. [5] highlighted that concentrations of micropollutants (e.g., antibiotics, analgesics, heavy metals) in HWWs are between 4 and 150 times higher than in UWW. Moreover hospital wastewater is considered one of the major reservoirs of pathogenic bacteria. Wastewater or natural water supplies into which wastewater has been discharged are likely to contain pathogenic organisms mainly coming from human excreta [6]. For example health-care facilities, where the use of antibiotics is more frequent and intensive and where antibiotic resistant bacteria may have a selective advantage over the susceptible counterparts, are regarded as important reservoirs of antibiotic resistance [7].

Considering this information related to the criticality of the wastewater and to the risks associated, very frequently there are no legal requirements for hospital effluent treatment prior to its discharge into the municipal collector or directly onto surface water after pretreatment.

As a matter of fact, in the major part of countries, it is impossible to find specific regulations regarding the management of hospital effluent and not even specific references in this regard within more ample regulations such as those referring to the management of wastewater in general. Therefore, the effective revisions of regulations, in the context of this chapter, have revealed a great difficulty in discovering (at an international level) specific norms, precisely because they are lacking. What is more, if these are present, they are difficult to find because they are in the original language and so difficult to translate with research engines or the Web.

2 Regulations about Hospital Wastewater

The regulations discussed in this paragraph are listed in Table 1. The border between the discipline regarding water and waste is a complex issue and much debated in various productive sectors: often the distinction between the two definitions is not always clearly identified, assumes legal issues and very importantly, management. For this reason, it is necessary to clearly identify the boundary between the waste products identified as wastewater and those identified as liquid waste.

Generally, the waste products of a health facility are considered:

– *Waste*, in the case where the product to be disposed of is a solid, a sludge, or a liquid contained in a container or a liquid absorbed to a solid.
– *Wastewater*, in the case in which the liquid sewage is discharged directly into a sewer.

The two definitions can be confusing when the regulatory parameters of hospital wastewater are reported in the legislation relating to waste management. This occurs, for example, in India, where the characteristics of the effluent produced by hospitals – either connected to sewers without a terminal sewage treatment plant or not connected to public sewers – are described in the regulations on waste management [8]. On the contrary, for discharge into public sewers with terminal

Table 1 Regulations on hospital wastewaters

Nation	Law	Year	Regulation on
UE	European Directive n. 91 of 21 May 1991 on urban wastewater treatment	1991	Wastewater
	Directive 2008/98/EC on hazardous waste	2008	Waste
Spain	Decreto 57/2005, de 30 de junio, por el que se revisan los Anexos de la Ley 10/1993, de 26 de octubre, sobre Vertidos Líquidos Industriales al Sistema Integral de Saneamiento	2005	Wastewater
	Decreto n 26,042-S-MINAE. (1997). Reglamento de Vertido y Aguas Residuales. La Gaeta n. 117, Jueves 19 de junio de 1997	1997	Wastewater
Germany	Wastewater Ordinance (AbwV)	2004	Wastewater
Italy	DPR n. 227/2011 on simplification on environmental law	2011	Wastewater
	DLgs n.152/2006 on environmental protection	2006	Wastewater
India	Environment (Protection) Act	1986	Wastewater
	The Bio Medical Waste Management and Handling Rules S O 630 E 20/7/1998	1998	Waste
China	National Standard of Integrated Water Discharge Standard	1998	Wastewater
Vietnam	Law on environmental protection	2014	Wastewater
	National Technical Regulation on Health Care Wastewater	2010	Wastewater

facilities, the general standards as described under the Environment (Protection) Act, 1986 shall be applicable [9].

A matter of considerable practical relevance to the legal and operational implications arising therefrom is to define if the waters from a particular activity are comparable to domestic wastewater or industrial wastewater. In fact in most of the regulations the wastewater is divided into:

– *Domestic wastewater:* wastewater from residential settlements and services, i.e., water that originates predominantly from the human metabolism and from household activities;
– *Industrial wastewater*: any type of wastewater discharged from premises or facilities in which businesses or production of goods take place, excluding domestic wastewater and by water run-off rain.

In Europe there is no specific directive or guideline for the management of hospital effluents. However, the European Directive n. 91 of 21 May 1991 [10] (91/271/CEE modified from Directive 27 of February 1998 n. 98/15/CE [11]) on urban wastewater treatment aims to protect the environment from the adverse effects of wastewater discharges; it concerns the collection, treatment, and discharge of:

- domestic wastewater
- mixtures of wastewater
- wastewater from certain industrial sectors.

Specifically the Directive requires: (1) the collection and treatment of wastewater in all agglomerations of >2,000 population equivalents (p.e.); (2) secondary treatment of all discharges from agglomerations of >2,000 p.e., and more advanced treatment for agglomerations >10,000 p.e. in designated sensitive areas and their catchments; (3) a requirement for pre-authorization of all discharges of urban wastewater, of discharges from the food-processing industry, and of industrial discharges into urban wastewater collection systems; (4) monitoring of the performance of treatment plants and receiving waters; and (5) controls for sewage sludge disposal and reuse, and treated wastewater reuse whenever it is appropriate.

As reported previously regarding the treatment of UWW, European regulations require a pre-authorization (if the wastewater is considered to be industrial) before its discharge into UWW collection systems. Moreover, the European Directive n. 98 of 19 November 2008 (2008/98/CEE) [12] about the management of hazardous wastes and the list of hazardous wastes of the European Decision n. 532 of 3 May 2000 (2000/532/CEE) [13] state that some hospital liquid waste (pharmaceutical products, medicines, residues from substances employed as solvents, soaps, non-halogenated organic substance, etc.) must not be discharged into a foul sewer, but must be treated as a waste product and collected and disposed of as such. For the effluents of the hospital foul sewer, there is no specific disposition; so the various member states of the European Union have their own legislation, evaluation, and selection criteria for HWW quality and its management. If a hospital facility is considered, by the legislation of the state, to be industrial or like a facility that discharges not only domestic wastewater (as in Spain [13] [14]), specific characteristics of the wastewater will be required in order to obtain permission to discharge it into the municipal WWTP; usually a pretreatment is required.

On the other hand, in a country where the HWW is considered to be domestic or communal, neither authorization nor specific characteristics are required (as in Germany, [15]). In other cases, if the HWW complies with the specific characteristics established by the WWTP authority, the wastewater may be considered a domestic effluent and therefore discharged into WWTPs without any permission [16]. For example, in Italy at present, in health facilities with fewer than 50 beds and not provided with analytical and research laboratories, the wastewaters produced by the hospital are treated as domestic wastewater, with the result that these can be discharged without authorization [17]. In all other cases, the discharge of wastewaters produced by health facilities must be authorized according to the Italian Legislative Decree no. 152/2006 [18]. In Italy the authorizing Authority changes from area to area (once were ATO, Ambiti Territoriali Ottimali, and now are provinces or Città Metropolitana), and it usually delegates the integrated water cycle manager. However, the hospital effluents are generally considered of the same pollutant load of domestic ones.

The Chinese normative considers hospitals to be industries [19]. In addition, the number of beds is a determining factor, as in Italy. Specifically, the Chinese normative requires the search for certain indicators (e.g., fecal coliforms) in hospitals with more than 50 beds.

In other countries, the legislation explains specifically how to treat and manage the hospital wastewater. For example, in Vietnam, in the law on environmental protection, there is a specific section on environmental protection regarding hospitals and medical facilities [20]. Article 72 of this law indicates that "Hospitals and medical facilities are obliged to: (a) Collect and treat medical wastewater in accordance with environmental standards." Moreover, unlike what is stated in other regulations, the environmental standards are established considering the use of the water bodies that collect the hospital wastewater. In fact the maximum value of different standards can be calculated using the following formula:

$$C_{\max} = C \times K$$

where C is the value of parameter and it is generally lower when the water resource which collects the wastewater, is used for drinking or for other purposes. K is the coefficient of the size and type of health facility [21]. For example, considering the parameter "total coliforms," the law reports two different values: (1) 3,000 MPN/100 ml if the water resource is used as drinking water supply, and (2) 5,000 MPN/100 ml if the water is not used for drinking water supply. For some parameters (e.g., pH, total coliforms, *Salmonella*, *Shigella*, and *Vibrio colera*) the value of K coefficient is always $=1$.

3 Guidelines for the Management of Hospital Wastewater

The main guidelines on the management of hospital wastewater are reported in Table 2.

3.1 WHO Guidelines

The only existing guidelines concerning hospital effluents were published by the World Health Organization (WHO) in 1999: "Safe Management of Wastes from Health-care Activities" [22] and updated in 2014 [23]. In particular, this document spends a specific chapter on the description of the collection and disposal of hospital wastewater, described in detail subsequently. The guidelines divide the health-care wastewater into three categories:

- *Blackwater* (sewage) is heavily polluted wastewater that contains high concentrations of fecal matter and urine.
- *Greywater* (sullage) contains more dilute residues from washing, bathing, laboratory processes, laundry, and technical processes such as cooling water or the rinsing of X-ray films.
- *Stormwater* is technically not a wastewater itself, but represents the rainfall collected on hospital roofs, grounds, yards, and paved surfaces. This may be lost to drains and watercourses and as groundwater recharge, or used for irrigating hospital grounds, toilet flushing, and other general washing purposes.

Obviously, the wastewater might contain different chemical, physical, and biological contaminants in relationship to the service level and the tasks of the health-care facility. The management of HWW could represent a risk mainly in developing countries, in which the major part of the health-care wastewaters, with no or only partial treatment, are discharged into surface watercourses or risk leaching into underlying groundwater aquifers.

Subsequently, the guidelines report the hazards related to liquid chemicals, pharmaceuticals, and radioactive substances. Moreover, the main wastewater-related diseases are presented. For example, nitrate in the groundwater from untreated wastewater can result in methemoglobinemia, particularly in babies. By disposing of untreated wastewater in the environment the nutrient can increase algal production and algal blooms that will favor potentially hazardous bacteria

Table 2 Guidelines on the management of hospital wastewaters

Guideline	Source	Year	Last revision
Effluent Guidelines and Standards (CFR 40)	EPA	1976	2016
Safe management of wastes from healthcare activities	WHO	1999	2014
Release of patients after radionuclide therapy	IAEA	2009	–
Release of patients after therapy with unsealed radionuclides	ICRP	2004	2013

(e.g. *Cyanobacteria*). Wastewater discharged in an uncontrolled manner into the environment can lead to several waterborne diseases that are a threat to human life, especially in developing countries. A specific section presents a selection of these diseases found widely in the world (e.g. campylobacteriosis, cholera, hepatitis A and E). After a brief evaluation of the amount of wastewater produced in high-income countries and primary health-care clinics, there follows an interesting description of the composition of wastewater produced by different sources in health-care facilities (e.g., kitchen, hemodialysis, dental department).

Whereas segregation, minimization, and safe storage of hazardous materials are just as important for liquid wastes as they are for solid wastes, a specific section is dedicated to the management of liquid health-care waste. In particular, the set-up of sewerage systems for health-care facilities and the kind of pre-treatment of hazardous liquids (e.g., blood, stool) are described in detail.

The main topic of the following paragraphs is the management of the discharge of hospital wastewater. In particular, discharge into the municipal sewage system is recommended if the municipal sewage-treatment plant fulfils the local regulatory requirements and satisfies some minimum requirements such as a treatment that ensures at least a 95% removal of bacteria or a plant that has primary, secondary, and tertiary treatment. If these requirements cannot be met, the wastewater should be treated in an onsite wastewater system or managed applying a minimum approach. The most efficient onsite plant for treating the hospital wastewater – divided by kind of treatment (primary, secondary, and tertiary) – is described. The text goes into detail about the disinfection of wastewater, the disposal of sludge, and the possible reuse of wastewater and sludge, including the application of emerging technologies (e.g., membrane biological reactor, anaerobic treatment) for hospital wastewater treatment.

Typical problems in the operation of wastewater are subsequently reported. Considering that the disposal of liquid hazardous waste via the sink is still practiced daily and commonly, the first indication of a problem is the large wastewater losses between the entry points (sinks, toilets, drains) and the arrival at an onsite treatment plant or tank or discharge point into a municipal sewerage system. Moreover the operation of wastewater-system monitoring is described, considering control of the sewerage system and the effluent quality: the most common parameters to be used for the evaluation of the effluent quality are listed (e.g., temperature, BOD_5, presence, and concentration of *Escherichia coli*).

After the description of the best practices for management of the HWW, the WHO document treats the minimum approach necessary to manage the HWW. In particular, considering that in many health-care facilities in developing countries patients have no access to sewer-based sanitation facilities, human sanitation is often by pit latrines or something similar, and, at worst, by open defecation in the grounds of the health-care facility or nearby, the WHO guidelines underline the prime importance of providing access to adequate sanitation in every health-care facility by providing sufficient toilets. Moreover when no other way for hazardous liquid waste disposal is available, the text describes the management of the main liquid waste using the appropriate Personal Protective Equipment (PPE). For

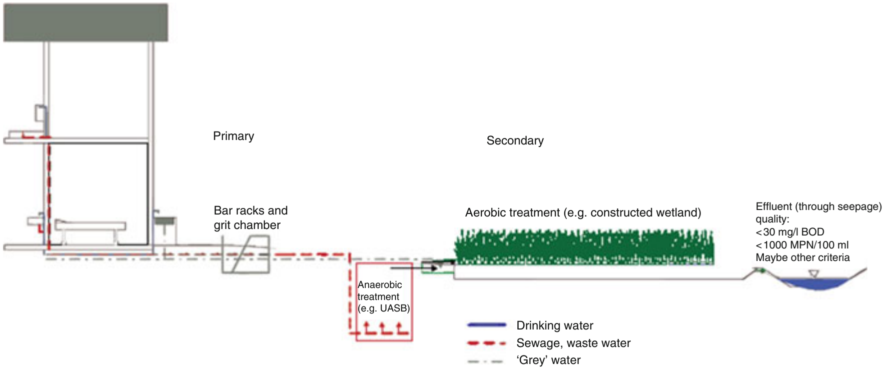

Fig. 1 Basic hospital wastewater-treatment system with two treatment stages [23]. *BOD* biological oxygen demand, *MPN* most probable number, *UASB* upflow anaerobic sludge blanket

example stool, vomit, and mucus from highly infectious patients (e.g., cholera patients) should be collected separately and thermally treated before disposal (e.g., by an autoclave reserved for waste treatment). Lime milk (calcium oxide) can be used during emergencies and if no autoclave or appropriate disinfectants are available. The WHO Guidelines report a useful scheme of a basic hospital wastewater-treatment system consisting of a primary and secondary treatment stage, which is considered as the minimum treatment for primary and secondary level rural hospitals (Fig. 1).

Finally the WHO Guidelines indicate desirable improvements to the minimum approach, divided into enhancements to the minimum (e.g., set up a budget line to cover wastewater-treatment costs; enforce liquid hazardous waste management; segregate and pretreat hazardous waste, etc.) and enhancements for intermediate approaches (e.g., disinfect the wastewater by UV or change to chlorine dioxide or ozone; regularly inspect the sewerage system and repair whenever necessary). In conclusion a table that lists the key points to remember is presented (Table 3).

3.2 EPA Guidelines

In the USA, the major environmental law governing surface water discharges is the Clean Water Act (CWA) [24]. The EPA, states, and local city pretreatment programs implement the CWA through publication of specific regulations and discharge permits for point sources of wastewater pollution. Each discharge to the surface waters or municipal wastewater treatment plants (called publicly owned treatment works, POTWs) must comply with the more stringent of the technology-based standards ("effluent guidelines") and local-site specific effluent limitations ("local limits").

Table 3 Key points to remember [23]

Untreated wastewater from health-care facilities may result in waterborne diseases and environmental problems, and can pollute drinking-water resources
A separate financial budget, a routine maintenance system, and a working management system for liquid hazardous waste are key elements in developing and operating an efficient wastewater-management system
Basic systems can reduce the risk of waterborne diseases drastically if appropriately planned and implemented; more advanced systems reduce the risk further
Pharmaceuticals and other hazardous liquid wastes in wastewater may form a serious future problem and must be carefully observed and minimized. This includes reducing to an absolute minimum the presence of antibiotics and pharmaceutical residues in wastewater
Low-cost and low-maintenance systems, such as anaerobic treatment and reed bed systems, are available
A good, well-maintained sewerage system is as important as an efficient wastewater-treatment plant

Effluent limitation guidelines and standards (ELGs) are an essential element of the nation's clean water program, which was established by the 1972 amendments to the CWA. ELGs are technology-based regulations used to control industrial wastewater discharges. The EPA issues ELGs for new and existing sources that discharge directly to surface waters, as well as those that discharge to POTWs (indirect dischargers). ELGs are applied in discharge permits as limits to the pollutants that facilities may discharge. To date, the EPA has established ELGs to regulate wastewater discharges from 58 categories of point-sources. This regulatory program substantially reduces industrial wastewater pollution and continues to be a critical aspect of the effort to clean the nation's waters. In addition to developing new ELGs, the CWA requires EPA to revise existing ELGs when appropriate. Over the years, the EPA has revised ELGs in response to developments such as advances in treatment technology and changes in industry processes. To continue its efforts to reduce industrial wastewater pollution and fulfill CWA requirements, the EPA conducts an annual review and effluent guidelines planning process. The annual review and planning process has three main objectives: (1) to review existing ELGs to identify candidates for revision, (2) to identify new categories of direct dischargers for possible development of ELGs, and (3) to identify new categories of indirect dischargers for possible development of pretreatment standards [25].

A typical health-care facility has a wide variety of wastewater sources, such as lavatories, sinks, showers, laboratories, photo processing labs, washing machines and dishwashers, boilers, and maintenance shops. The facility will fall under one of two sets of regulations, depending on where the water goes next. Facilities that discharge their wastewater into a municipal sewer system are referred to as indirect dischargers, while those that discharge directly to streams or rivers are considered direct dischargers.

The vast majority of health-care facilities are indirect dischargers. Such facilities are subjected to regulations by their local sewer authority, which are in turn regulated by the CWA. Typically, indirect dischargers must obtain a permit (defined as an *industrial user permit*), and are required to comply with the specific rules stated in the permit. CWA regulations expressly prohibit any indirect discharger from releasing any of the following into the sewer:

- fire or explosion hazards
- corrosive discharges (pH < 5.0)
- solid or viscous pollutants; heat (in amounts that cause the treatment plant influent to exceed 104 °F)
- pollutants that cause toxic gases, fumes, or vapors
- any other pollutant (including oil and grease from a cafeteria) that will interfere with or pass through the municipal treatment plant.

Beyond that, the local sewer authority will establish rules and limits for the facility that take into account local conditions, and the requirements of the authority's own permit.

Some hospitals, primarily larger ones located in smaller communities, may be designated by their sewer authority as a *significant industrial user*. This designation is usually associated with manufacturing facilities, but a sewer authority can apply the designation if a facility has a "reasonable potential for adversely affecting" the operation of the sewage treatment plant. A hospital designated as a significant industrial user must sample and analyze its wastewater and submit reports to the sewer authority twice a year.

In addition to the specific rules discussed above, the CWA provides municipalities with regulatory flexibility so that they can meet their specific needs. Many municipalities have chosen to establish local rules that apply specifically to medical waste discharges. Examples range from blanket prohibitions on "all medical waste" to more specific prohibitions regarding items such as recognizable body parts or radioactive compounds.

For hospitals that are direct dischargers, the EPA has established national discharge standards, which are numerical limitations for certain specific pollutants. These standards are much more difficult to meet than the limitations for indirect dischargers, which is understandable, given that the wastewater from direct discharge hospitals flows directly into a stream or river, without having been treated or monitored by a municipal system. To meet the direct discharge limitations, a hospital would have to obtain a permit from its state environmental agency or the EPA (depending on the status of the state agency) and install a complex wastewater treatment plant.

3.3 Guidelines about Radionuclide Releases to the Environment from Hospitals

Nuclear medicine involves the use of unsealed radionuclides. This critical issue regards the exposure of the treated patient to radionuclides, but also the release of the radionuclides to the environment from the hospital laboratories and through the disposal of the excreta of hospital patients. Radioactive iodine treatment is the main source of exposure to the public and relatives from patients who have received unsealed radionuclides. Other radionuclides traditionally used in therapy are usually pure beta emitters (e.g., 32P, 89Sr, and 90Y) that pose much less risk to others. Recently, a number of new therapeutic methods have come into clinical use like 177Luoctreotate, 68Ga-octreotate, and 90Y-SIRS particles [26]. In this context some guidelines regarding the release of patients after radionuclide therapy were produced. The guidelines produced by the International Atomic Energy Agency [27] underline that the predominant issue regards how the patients could represent a risk through their radioactive excreta (urine and feces). Much of the activity initially administered is eventually discharged to sewers. Table 4 shows the proportion for some therapeutic radionuclides typically discharged by this route.

As reported in this table the main radionuclide discharged into the environment following radionuclide therapy is radioiodine (I131). Owing to its half-life of 8 days, I131 can be detected in the general environment after medical use. However, the degree of dilution and dispersion caused by mixing with normal waste, and the length of time required for any contamination to be returned to the ecosystem, reduces the environmental impact to a level that is below that suggested in all available guidelines.

Also the International Commission on Radiological Protection (ICRP) published a guideline for the release of patients after therapy with unsealed radionuclides [28, 29]. This document reported that Technetium-99m dominates discharges to the environment from the excreta of nuclear medicine patients, but its short half-life limits its importance. The second largest discharge, iodine-131, can be detected in the environment after medical uses but with no measurable environmental impact. Radionuclides released into modern sewage systems are likely to result in doses to sewer workers and the public that are well below public dose limits. In this context it is important to highlight that the ICRP recommendations do not explicitly require that patients are hospitalized for radionuclide therapy. On the other hand, guidance from the IAEA of 1992 indicated that in radioiodine therapy for cancer: “it is not

Table 4 Proportion of administered activity discharges to sewers [27]

Nuclide and form	Disease or condition treated	Amount of activity discharged to sewers (%)
Au-198 colloid	Malignant disease	0
I-131	Hyperthyroidism	54
I-131	Thyroid carcinoma	84–90
I-131 MIBG[a]	Phaeochromocytoma	89
P-32 phosphate	Polycythemia, etc.	42
Sr-89 chloride	Bone metastases	92
Y-90 colloid	Arthritic joints	0
Y-90 antibody	Malignancy	12
Er-169 colloid	Arthritic joints	0

[a] *MIBG* meta-iodobenzylguanidine

recommended to let the patient return home immediately. Instead, he or she should be kept at the hospital for a period of between some hours and several days." Moreover in the more recent guidelines of 2009 it is reported that the major advantage of retaining a patient in hospital is that, with good practice, the environment and the associated risks are controlled.

4 Case Study

The management of HWW as described above is therefore not easy, but the growing emphasis on the possible role of the hospital effluents as microbial and chemical contamination sources has provided the stimulus for the creation of case studies of excellence. An example is the creation of the pilot site Bellecombe, born of necessity in 2009, by the municipal grouping of Bellecombe (SIB), to provide for extension work of its wastewater treatment plant due, in particular, to the construction of a new hospital on its territory. Located in the Haute-Savoie "department," near the border with Switzerland, the pilot site consists of: the Geneva Hospital Alps (CHAL) commissioned in February 2012, with a 450-bed capacity of the plant; the wastewater treatment plant (WWTP) of Bellecombe, with two separated processing lines for isolating the hospital effluents; an acceptor: the Arve River, which provides a portion of water intended for human consumption. An important feature of the system is the possibility of treating hospital wastes separately or mixing them with domestic effluent and distributing all effluent on three lines, with a total capacity of 26,600 population equivalent as reported in Fig. 2 [30].

A first meeting in March 2010, which brought together the founding members and partners, allowed the establishment of the project basis SIPIBEL (Pilot Site Bellecombe), which aims to define the characterization, treatability, and impacts of hospital waste in the urban sewage treatment plant. SIPIBEL was created with local actors (e.g., Sanitation managers, hospital), public research laboratories, industrial designers, and institutional partners. To get an initial reference before the opening of the hospital in February 2012, a monitoring program was created in 2011. The observatory has been working routinely since February 2012. 2013 saw the beginning of the Franco-Swiss Interreg IRMISE project, which placed the SIPIBEL in a broader context and made it cross-border. SIPIBEL is an observation and research institution consisting of:

– the *Observatory*, which aims to monitor the effluents and their impact on the receiver environment
– implementation of *research programs* in support of SIPIBEL
– a development and *communication center*.

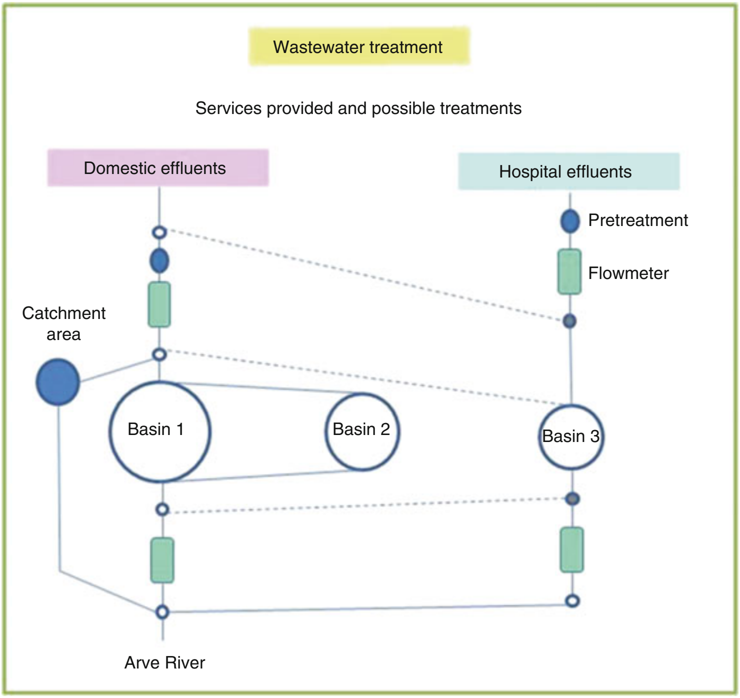

Fig. 2 Scheme of wastewater treatment in the Bellecombe site (adapted from [30])

The *Observatory's purposes* are:

- the definition and management of measurement campaigns with scientists and field workers: the monitoring of the physico-chemical and ecotoxicological quality effluent, but also the monitoring of sociological elements of the territory
- capitalization of data through an online data management system with national and European approaches
- valuation analysis after the results of validation and interpretation: disseminating analytical reports to partners, communication via the website, the organization of knowledge transfer activities (conferences, joint publications), associated research programs.

The *research programs* in the SIPIBEL framework have been specifically developed to address the major issues of knowledge and strategies identified in the various national and regional plans being implemented.

An enhancement and *communication center* whose purpose is to ensure:

- the integration between observation and research
- their inclusion in national and European standardization process plans

– the combination of broader approaches to territorial policies and the exchange of experiences (contractual health facilities, civic initiatives, the management of non-domestic effluent).

The coexistence of diverse realities in the Bellecombe site demonstrates the need and the utility of a multidisciplinary approach to the management of hospital wastes, both from the scientific point of view and that of communication. It is important to underline that SIPIBEL was created prior to the opening of the hospital, thereby highlighting a correct preventive approach to the management of hospital wastes. Such an approach is to be hoped for in other realities as well.

In the previous years also other projects were funded on the study of the spread of pharmaceutical residues in the environment (NoPills project) and on the role of hospital wastewater in this context (SIPIBEL RILACT project).

In the 2012 started the "NoPills" project funded by European Interred IVb Programme. This project aimed to provide further information on the fate of pharmaceutical residues in the aquatic environment, and provide practical experience on the identification of potential and actually implemented technical and social intervention points across the medicinal product chain with a focus on consumer behavior, wastewater treatment, and multi-stakeholder engagement [32].

The SIPIBEL RILACT project financed by French national funds in 2014, currently still in progress (will be completed in 2018), is the natural continuation of the SIPIBEL project and has several key objectives:

– developing methods for the identification and quantification of drugs, detergents, and biocides and of their metabolites and degradation products
– characterizing the sources of drugs and their dynamics in hospital and municipal wastewater
– contributing to the environmental risk assessment for the evaluation of the biological effects
– developing research and a sociological study
– enhancing and transferring gained results and knowledge [31].

5 Final Remarks

The consideration of what has been written here means that certain critical points emerge. A fundamental aspect is the dishomogeneity of hospital waste management legislations amongst different countries, which makes comparison quite difficult. In many countries there are not even specific legislations for the management of these wastes, which are in some cases considered domestic and in others industrial. In regard to the guidelines available at present, there emerges the need to furnish not only specific indications for the management of hospital wastes, but also to provide indications as to the parameters for quality and control of this type of waste.

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