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Environmental Impacts associated with solid waste management practices at Alberto Sabogal Sologuren National Hospital, Callao

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Resumen

Hoy en día se generan gran cantidad de residuos sólidos a nivel mundial, de los cuales solo un 10% es reutilizado. La cantidad de residuos sólidos reaprovecharle disminuye si es que los residuos tienen algunas características que los hacen peligrosos, como es el caso de los residuos sólidos hospitalarios. A esto se suman los impactos ambientales que los residuos y su manejo inadecuado conlleva. Esta investigación muestra la asociación de las prácticas de manejo de residuos sólidos con los impactos ambientales en el Hospital Nacional Alberto Sabogal Sologuren. Para ello, se tomó en cuenta la segregación, transporte interno de residuos sólidos, la limpieza y desinfección del equipo y la disponibilidad del equipo de protección personal. Para lograrlo se realizó una evaluación de su manejo en, que se llevó a cabo visitando cada uno de los servicios y/o ambientes del Hospital, una caracterización física de los residuos sólidos durante siete días donde se identificaron y cuantificaron los residuos sólidos de todas las áreas y servicios, una entrevista con el personal que labora en el centro hospitalario y una identificación de factores ambientales que son impactados a consecuencia de las prácticas de manejo de residuos.

Palabras clave: Residuos sólidos hospitalarios, manejo, impactos ambientales

Abstract

Today, a large amount of solid waste is generated worldwide, of which only 10% is reused. The amount of solid waste reused is reduced if the waste has some characteristics that make it hazardous, as is the case of hospital solid waste (HSW). To this are added the environmental impacts that the waste and its inadequate handling entails. This research shows the association of solid waste management practices with environmental impacts in the Alberto Sabogal Sologuren National Hospital. For this, segregation, internal transport of solid waste, cleaning and disinfection of the equipment and the availability of personal protective equipment were taken into account. To achieve this, an evaluation of its management was carried out, which was carried out by visiting each of the services and / or environments of the Hospital, a physical characterization of solid waste for seven days where solid waste was identified and quantified. areas and services, an interview with staff working in the hospital center and an identification of environmental factors that are impacted as a result of waste management practices.

Keywords: Hospital solid waste, management, environmental impacts

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1. Introduction

Pollution by the waste produced by the human being directly affects our environment and the health of the population. Institutions of different nature seek to reduce the generation of domestic waste and high dangerousness for humans and the environment. This is because there is a lack of knowledge about the management of waste generated in hospitals, clinics, clinics and even more about the impacts caused by them. Many entities in the health sector have realized the importance of proper management of solid waste and are concerned with implementing increasingly effective control measures. In the Alberto Sabogal Sologuren National Hospital, around 88000 kg / month are generated, causing high costs of external collection and disposal, these are collected by a Service Provider Entity (EPS) and also by the municipality of Bellavista. Among the main problems presented by the Hospital regarding the management of hospital solid waste (HSW) are: lack of equipment and tools for the stages of conditioning, segregation and internal collection, inadequate infrastructure for intermediate storage, accumulated waste in corridors or passages what causes the dissatisfaction of the personnel that works in the center, cross contamination when common waste comes in contact with biocontaminated or special waste, there have been cases of work accidents by sharp objects (hypodermic needles). There are laws that regulate the environmental management of solid waste in Peru. These are: the General Law of the Environment, General Law of Solid Waste, the Technical Health Standard No. 096-MINSA / DIGESA: Management and Management of Solid Waste in Health Establishments and Medical Support Services at a National level.

The modified Leopold matrix uses evaluation criteria assigning scores to the impacts. These are: (1) Direction, (2) Geographical extension, (3) Duration, (4) Magnitude, (5) Frequency, (6) Probability of occurrence; and (7) Reversibility.

Classification of Hospital Waste

According to the Technical Health Standard N ° 096-MINSA / DIGESA, hospital waste is classified as:

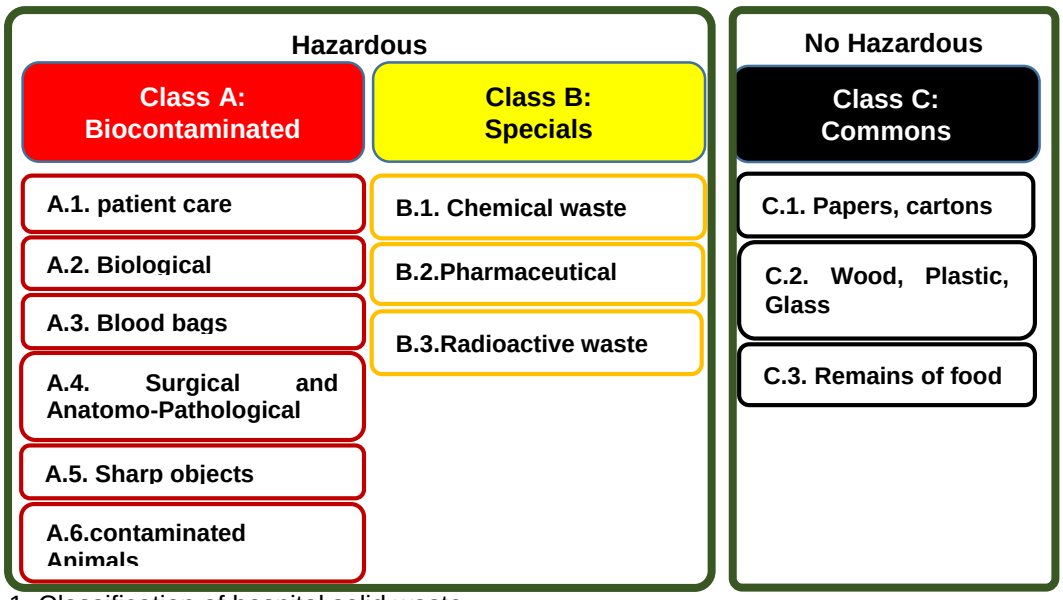

Figure 1. Classification of hospital solid waste
Source: Adapted from Technical Health Standard, N° 096-MINSA/DIGESA, 2012

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Stages of the management of Hospital Solid Wastes (HSW) It is important to identify each of the stages of the management of HSW appropriate techniques should be considered in a series of steps that begins with the conditioning materials, supplies and equipment needed to segregate properly, at this stage the waste will be classified according to their nature and danger to avoid cross contamination or other inconveniences, for this reason it is necessary the commitment and participation of the staff of the hospital center. The stages of the management of hospital solid waste are detailed below:

1. Conditioning
2. Primary storage and segregation
3. Intermediate storage
4. Internal collection
5. Internal transport
6. Central storage
7. Treatment (Sterilization by autoclave, Incineration, Microwave disinfection)
8. Collection and transportation outside the hospital facilities
9. Final provision

2. Materials and Methods

The present investigation is of non-experimental design since there is no manipulation of any variable. It is correlational in nature, because it studies the relationship between both variables.

Figure 2. Area of Hospital Nacional Alberto Sabogal Sologuren, Lima, Peru.

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The research was carried out at the Alberto Sabogal Sologuren National Hospital for seven days (from May 06 to May 13, 2016). This hospital is located in the district of Bellavista, Province of Callao, Department of Lima, Peru.

Stages of the investigation:
• Identification and quantification of hospital solid waste.
• Evaluation of the management of HSW.
• Determination of environmental impacts.

The modified Leopold matrix with its respective evaluation criteria was used.

Table 1. Evaluation Criteria of the Modified Leopold Matrix.

Criterion	Evaluation	Definition
Direction	Positive (+)	Benefit for the resource
	Neutral (0)	No benefit or harm to the resource
	Negative (-)	Damage to the resource
Geographical extension	Local (1)	Confined to the area directly disturbed by the project
	Sub-regional (2)	It surpasses the areas but it is within the limits of the study area of the evaluation
	Regional (3)	It extends beyond the regional limits
Duration	Short term (1)	Less than 1 year
	Medium term (2)	Between 1 and 5 years
	Long term (3)	More than 5 years
Magnitude	None (0)	No change is expected
	Low (1)	It is predicted that the disturbance will be somewhat greater than the typical conditions
	Medium (2)	The effects are predicted to be considerably above typical existing conditions, but without exceeding the criteria established in the permissible limits or causing changes in the economic, social, and biological parameters under the ranges of natural variability or social tolerance.
	High (3)	Predictable effects exceed established criteria or permitted limits associated with potential adverse effects or cause a detectable change in economic, social, biological parameters, beyond natural variability or social tolerance
Frequency	Continuous (4)	It will happen continuously
	Isolated(3)	Confined to a specific period
	Periodical (2)	Occurs intermittently but repeatedly
	Occasional (1)	Occurs intermittently and sporadically
	Accidental (0)	It happens rarely
Probability of occurrence	Low (0.1 – 0.3)	Unlikely
	Medium (0.4 – 0.7)	Possible probable
	High (0.8 – 1.0)	Certain
Reversibility	Short term (0)	It can be reversed in a year or less
	Medium term (1)	It can be reversed in more than a year, but less than ten.
	Long term (2)	It can be reversed in more than ten years
	Irreversible (3)	Permanent effects

Source: Technical Health Standard, N° 096-MINSA/DIGESA, 2012

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Table 2. Evaluation criteria for the stages of hospital solid waste management

Assessment	Description
1	comply
0.5	Partially Comply
0	Not comply
X	Do not apply

Source: Technical Health Standard, N° 096-MINSA/DIGESA, 2012

Table 3. Criteria for valuation of Checklist N3

Very poor	Poor	Acceptable	Satisfied
Score less than 3.5	Score between 3.5 and 5	Score equal to or greater than 5.5 to less than 10	Score of 10

Source: Technical Health Standard, N° 096-MINSA/DIGESA, 2012

Table 4. Value range of importance of impacts

Valoración			Categorización de Impacto	Código de color
15	a	10.1	Altamente positivo	
10	a	5.1	Moderadamente positivo	
5	a	0	Levemente positivo	
-0.1	a	-5	Levemente negativo	
-5.1	a	-10	Moderadamente negativo	
-10.1	a	-15	Altamente negativo	

Source: Technical Health Standard, N° 096-MINSA/DIGESA, 2012

3. Results

Identification and Quantification of Hospital Solid Wastes

Hospital Solid Waste was identified and quantified. The bags of solid waste generated in each service were identified, these were collected through internal collection to the point of collection, which was the place chosen for the operation, where they proceeded to inspect the inside of each bag. First of all, the waste bags were weighed at the collection point, then the waste volume was determined with the help of a container of known volume, the waste was introduced into the container, ensuring that no empty spaces remained. . When the volume and weight data of the waste were obtained, the waste was classified, the garbage was separated manually according to its type and they were weighed again. Subsequently, the weights of each component were added together and a comparison was made with the total weight of the waste generated. In this way, the percentage by weight of each type of waste was calculated.

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Table 5. Generation of solid waste by type in each area of the Alberto Sabogal Sologuren National Hospital.

Area	Biocontaminated (kg)	Special (kg)	Common (kg)	Total	kg residue/Day
Medicine I Hospitalization	620.79	0.00	157.95	778.74	111.25
Medicine II Hospitalization	863.26	0.00	184.45	1047.71	149.67
Hemodialysis	546.04	0.00	58.05	604.09	86.30
UCEMI	653.32	0.00	125.79	779.11	111.30
Operations room	723.23	0.00	259.59	982.82	140.40
Cardiology Hospitalization	327.47	0.00	107.00	434.47	62.07
Surgery Hospitalization	358.50	0.00	91.86	450.36	64.34
Urology Hospitalization	540.17	0.00	124.64	664.81	94.97
UCIN	648.95	0.00	129.39	778.34	111.19
Doctor's Office	279.80	0.00	262.95	542.75	77.54
Laboratory	294.43	0.00	83.48	377.91	53.99
Emergency	1058.22	0.00	312.05	1370.27	195.75
Unit Chemoteraphy	295.70	160.58	82.04	538.32	76.90
Medical specialties Hospitalization	532.78	95.06	145.03	772.87	110.41
Pediatric surgery Hospitalization	422.84	0.00	135.04	557.88	79.70
Transitory Hospitalization	420.75	0.00	101.76	522.51	74.64
Blood bank	478.48	0.00	114.40	592.88	84.70
Drugstore	0.00	0.00	49.68	49.68	7.10
Nutrition	2269.40	0.00	0.00	2269.40	324.20
High obstetric Risk	432.55	0.00	89.20	521.75	74.54
Maternity	666.13	0.00	52.65	718.78	102.68
Neonatology	774.93	0.00	133.18	908.11	129.73
Pediatrics Hospitalization	558.03	22.24	157.20	737.47	105.35
Traumatology Hospitalization	653.13	0.00	78.67	731.80	104.54
Neurosurgery Hospitalization	454.45	0.00	106.88	561.33	80.19
UCI	735.33	0.00	133.28	868.61	124.09
Others	146.02	0.00	314.72	460.74	65.82
Administrative zone	73.61	0.00	153.42	227.03	32.43
Residency	117.32	0.00	0.00	117.32	16.76
Laundry	0.00	0.00	246.77	246.77	35.25
Cartons	0.00	0.00	365.67	365.67	52.24
Total	**15945.63**	**277.88**	**4356.79**	**20580.30**	**2940.04**

Source: HSW Characterization of 05/06/2016 - 05/13/2016

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The areas that generate the highest amounts in kg of biocontaminated waste are nutrition (2269.40 kg / week) and emergency (1058.22 kg / week). The areas that generate the highest quantities in kg of special waste are Chemotherapy Unit (160.58 kg / week) and Medical hospitalization specialties (95.06 kg / week). The areas that generate the highest amounts in kg of common waste are nutrition (324.20 kg / week) and emergency (195.75 kg / week).

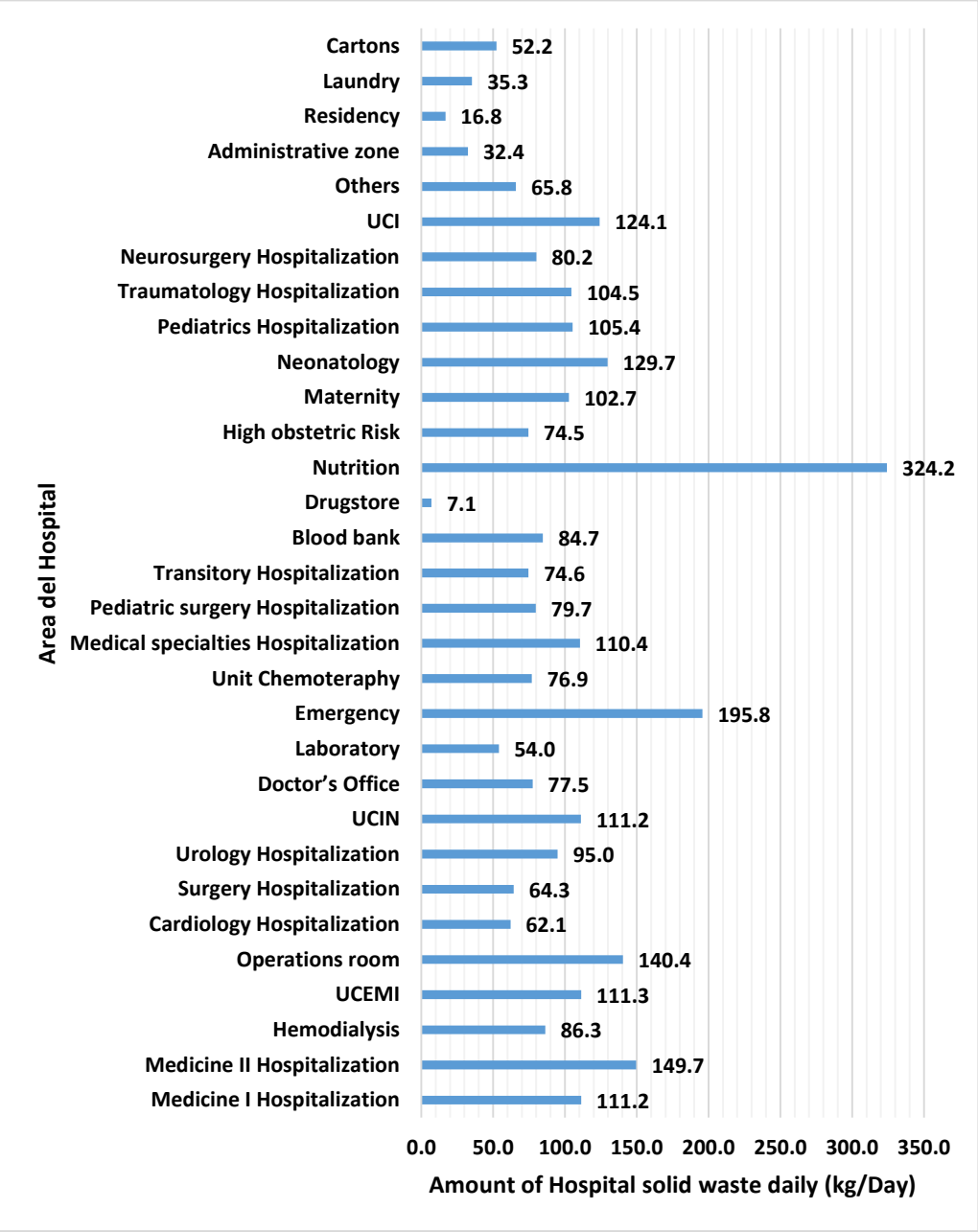

Figure 3. Average hospital solid waste generation in kilograms
Source: HSW Characterization of 05/06/2016 - 05/13/2016

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The areas that generate the highest quantities in kg of hospital waste are: nutrition (324.2 kg / day), emergency (195.8 kg / day), Medicine II Hospitalization (149.7 kg / day), Operating room (140.4 kg / day). The areas that generate lower amounts in kg of hospital waste are: Drugstore (7.1 kg / day), Residency (16.8 kg / day), Administrative zone (32.4 kg / day), and Laundry (35.3 kg / day).

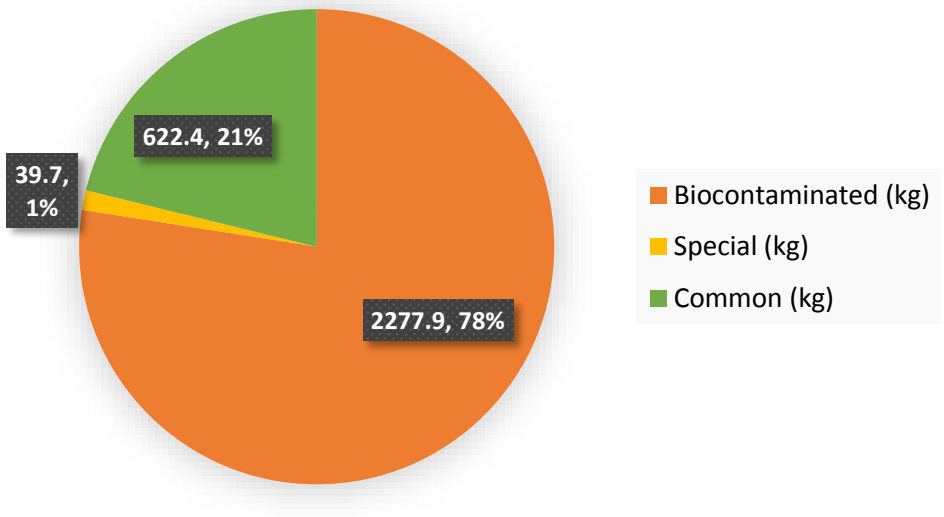

Figure 4. Percentage in Weight by type of waste of the National Hospital Alberto Sabogal Sologuren.
Source: Characterization of HSW of 05/06/2016 - 05/13/2016

Figure 4 represents the percentage by weight of average hospital solid waste generated in the Alberto Sabogal Sologuren National Hospital with each type. Approximately 2940.04 kg / day of solid waste are generated in total, of which 622.4 kg are common waste which is equivalent to 21% of the total generated. The biocontaminated waste reaches up to 2277.9 kg of generation per day, which represents 78%, while only on average 39.7 kg of special waste is generated per day, equivalent to 1% of the total generated.

Evaluation of the management of Hospital Solid Waste

Table 6. Assessment of the handling of solid waste Hospital

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Area	Month	1. Conditioning	2. Segregation and primary storage	3. Intermediate storage	Total	Assessment
Pediatric surgery Hospitalization	April	2	1.5	0	3.5	Deficient
	May	2	1.5	0	3.5	Deficient
	June	2	2	0	4	Deficient
Transitory Hospitalization	April	2	1.5	0	3.5	Deficient
	May	2	1.5	0	3.5	Deficient
	June	1.5	2	0	3.5	Deficient
Blood bank	April	1.5	2	0	3.5	Deficient
	May	2	2	0	4	Deficient
	June	2	2	0	4	Deficient
High obstetric Risk	April	2	1.5	0.5	4	Deficient
	May	2	1.5	0.5	4	Deficient
	June	2	1.5	1	4.5	Deficient
Maternity	April	2	1.5	0.5	4	Deficient
	May	2	1.5	0.5	4	Deficient
	June	2	1.5	1	4.5	Deficient
Neonatology	April	2	2	0.5	4.5	Deficient
	May	2	2	0.5	4.5	Deficient
	June	1.5	2	1	4.5	Deficient
Pediatrics Hospitalization	April	1.5	2	0	3.5	Deficient
	May	2	2	0	4	Deficient
	June	2	1.5	0	3.5	Deficient
Traumatology Hospitalization	April	2	2	0	4	Deficient
	May	2	1.5	0	3.5	Deficient
	June	1.5	2	0	3.5	Deficient
Neurosurgery Hospitalization	April	1.5	2	0	3.5	Deficient
	May	2	2	0	4	Deficient
	June	2	1.5	0	3.5	Deficient
UCI	April	1.5	1.5	0	3	Very Deficient
	May	2	1.5	0	3.5	Deficient
	June	2	2	0	4	Deficient
Unit Chemoteraphy	April	2	2	0	4	Deficient
	May	2	2	0	4	Deficient
	June	2	2	0	4	Deficient
Medical specialties Hospitalization	April	2	1.5	0	3.5	Deficient
	May	2	2	0	4	Deficient
	June	2	1.5	0	3.5	Deficient

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Area	Month	1. Conditioning	2. Segregation and primary storage	3. Intermediate storage	Total	Assessment
Medicine II Hospitalization	April	1.5	1.5	0	3	Very Deficient
	May	2	1.5	0	3.5	Deficient
	June	2	2	0	4	Deficient
Medicine I Hospitalization	April	2	1.5	0	3.5	Deficient
	May	2	2	0	4	Deficient
	June	2	1.5	0	3.5	Deficient
Hemodialysis	April	2	1.5	0	3.5	Deficient
	May	2	2	0	4	Deficient
	June	2	2	0	4	Deficient
UCEMI	April	2	1.5	0	3.5	Deficient
	May	2	1.5	0	3.5	Deficient
	June	2	2	0	4	Deficient
Operations room	April	2	2	1.5	5.5	Acceptable
	May	2	2	1.5	5.5	Acceptable
	June	1.5	2	1.5	5	Deficient
Cardiology Hospitalization	April	2	1.5	0	3.5	Deficient
	May	2	1.5	0	3.5	Deficient
	June	2	1.5	0	3.5	Deficient
Surgery Hospitalization	April	1.5	1.5	0	3	Very Deficient
	May	1.5	2	0	3.5	Deficient
	June	1.5	1.5	0	3	Very Deficient
Urology Hospitalization	April	2	1.5	0	3.5	Deficient
	May	2	1.5	0	3.5	Deficient
	June	2	1.5	0	3.5	Deficient
UCIN	April	2	1.5	0	3.5	Deficient
	May	2	2	0	4	Deficient
	June	2	2	0	4	Deficient
Doctor's Office	April	1	1.5	0	2.5	Very Deficient
	May	1.5	2	0	3.5	Deficient
	June	2	2	0	4	Deficient
Laboratory	April	2	1.5	1.5	5	Deficient
	May	2	2	1.5	5.5	Acceptable
	June	2	2	1.5	5.5	Acceptable
Emergency	April	1.5	1.5	0	3	Very Deficient
	May	1.5	1.5	0	3	Very Deficient
	June	1.5	2	0	3.5	Deficient

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Determination of Environmental Impacts

Table 7. Modified Leopold Matrix of Environmental Impacts

Affected elements	Sub component	FACTOR AMBIENTAL	Segregation					Treatment	Internal transport	Cleaning and disinfection	Central storage	Cleaning and disinfection	External transport		Total
			Handling of surgical waste, punches, etc.	Accident risk due to sharps objetcs	Handling waste from clinical analysis	Handling of special waste	Handling of common waste	Autoclaving of laboratory waste	Internal Transportation of Hospital Solids Residues	Car wash for internal transfer	Inner time storage of Hospital Solid Wastes	Washing of infrastructure for temporary collection Internal solid waste	External transfer and disposal of waste outside the hospital	Potential risk of hospital solid waste spillage	
Physical Chemists	Soil	Soil quality	-1.2	0	-1.2	-1.2	-1.2	0	-3.2	-3	-1.92	-1.2	-1.2	-0.5	-15.82
	water	water quality	0	0	-0.9	0	0	0	0	-5.6	-5	-5.6	0	-0.4	-17.5
	Atmosphere	air quality	0	0	0	0	0	0	-2.4	0	-2	0	-4.2	0	-8.6
Cultural	Human facilities and activities	Structures	0	0	0	0	0	0	0	0	-3	-3	0	0	-6
	Cultural aspects	Health and security	-2	-1.5	-2	-2.5	-2.5	-1.2	-2.5	-2.5	-3	-2.5	-2.5	-3.2	-27.9
		Employment	7	0	7	7	7	5.6	7	7	6.3	7	7	4.9	72.8
	Ecological Relations	Insects, desease vectors	0	0	0	0	0	0	0	0	-4	0	0	-0.9	-4.9
		Total	3.8	-1.5	2.9	3.3	3.3	4.4	-1.1	-4.1	-12.62	-5.3	-0.9	-0.1	-15.84

Table 7 refers to the environmental impacts that are generated from hospital solid waste management practices. From the segregation of common and biocontaminated waste there are slightly negative impacts on the quality of the soil and water, as it has scores between -1.2 and -0.9, due to the fact that the waste is deposited in public spaces and gardens, as well It presents a slight direct affection to the safety and health of the operators with a score ranging from -2.5 to -1.5 since events related to punctures have occurred during the direct handling of the waste. During internal transport practices there are slightly negative impacts on the quality of soil, air and health and security of workers with scores of -3.2, -2.4, -2.5. During the practices of cleaning and disinfection of the equipment there is a critical point with a moderate impact (score of -5.6) towards the quality of the water since this activity is carried out frequently 2 or 3 times a day and making use of aggressive disinfectants in order to eliminate or reduce pathogens, these waters are finally poured down gutters to the drain without any previous treatment or in some cases part of these waters reach the fertile soil causing it to lose its quality. During the storage stage and the temporary collection of waste, there are slight negative impacts on the quality of soil, water and air, as well as the infrastructure and the safety and health of the workers.

The environmental factors that receive the greatest impact are the quality of water and the safety and health and security of workers with scores of -17.5 and -27.9 respectively. With respect to water quality, it is mainly impacted during the cleaning and disinfection stage and the equipment used in the management of hospital solid waste and the lack of use of personal protective equipment makes this also an environmental factor that is strongly impacted.
Within the stage of management of HSW that causes greater impact is the storage and collection of solid waste since at a given time the waste has contact with environmental components such as soil quality, water, air, obtaining a negative value of – 15.82, -17.5 and -8.6 respectively.
However, there are also moderately positive impacts on the stages and practices of solid waste management, since these activities necessarily require an operator to execute them, promoting the generation of employment, their score ranges from 4.9 to 7. It should be noted that It has a total value of 72.8 for the generation of employment as a single environmental factor.

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In general, current solid waste management practices generate high negative impacts, obtaining a total value of -15.82.

4. Conclusions

Due to the inadequate handling and segregation of solid waste, it generates a greater quantity of biocontaminated solid waste. On the other hand some biocontaminated waste is considered as common waste and is treated as such. Due to this inadequate practice, approximately 5% of reusable waste is contaminated and loses any opportunity to give it a new useful life.

The Hospital does not have an established route nor a collection frequency because the generation of solid waste in the different services are very variable. During the days of field verification, this situation was observed mostly in the services that are on the first floor such as Medicine I, NICU, ICU, Emergency. The waste is temporarily deposited in corridors, green areas waiting for cleaning personnel to pick them up.

Due to the cleaning and disinfection of the equipment used in the management of solid waste, the risk of proliferation of vectors, insects or rodents diminishes, although moderately negative impacts are generated for water quality, since at this stage disinfectant products with a Frequency of 3 times a day for computers and 1 time a day for storage infrastructure in order to eliminate agents.

The safety and health of workers as a single environmental factor is highly impacted because it obtains a value of -27.9. The main causes are focused on the lack of protection equipment during the stages of handling, segregation, transport or storage. There is no respiratory, visual and hand protection for 30% of the operating personnel. As a consequence, there is the risk of suffering from an occupational disease.

There is a relationship between solid waste management practices at the Alberto Sabogal Sologuren National Hospital and environmental impacts. The environmental factors that are moderately impacted are the quality of water and the safety and health of workers with an assessment of -17.5 and -27.9 respectively. However, the HSW management practices also have a positive impact on the environmental factor of employment generation, obtaining a positive value of 72.8.

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