Journal of Environment Sciences (2025), **Volume XI**, 124-135
https://doi.org/10.3126/jes.v11i1.80591

# The Current Status and Composition of Bio-Medical Waste Management in Narayani Hospital of Birgunj Metropolitan City

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## Abstract

The biomedical waste generated during treatment, immunization of human or animals, diagnosis, laboratory activities from Narayani hospital and other medical center in the Birgunj Metropolitan City become a serious public and environmental concern. Therefore, the general objectives of the study are to identify the current status and practices of bio-medical waste management with specific objectives to find out the status and composition of bio-medical waste and to access the method of management in Narayani Hospital and other also. The simple random sampling technique used to collect data from Narayani hospital and 50 responses on the day of one week. The study showed total biomedical waste generation rate is 48kg/day and 0.16 kg/bed/day. Generally, generated biomedical waste were Vials, Syringe, Saline bottle, Gloves, Cardboard box, Plastic Wrapper, Intravenous Set and Cotton gauge. The result showed, there are 36 hospitals with 2500 beds in Metropolitan city from which 54.92 tons/year of Intravenous set, 21.89 tons/year of Vials, 1.64 tons/year of plastic wrapper, 8.65 tons/year of Cotton gauge, 10.08 tons/year of syringe, 20.02 tons/year of saline bottles, 8.78 tons/year of gloves and 19.79 tons/year of Cardboard box generated from entire hospitals. Similarly, from entire hospital 0.43 tons/day, 3.00 tons/week, 13.02 tons/month and 156.19 tons/year of recyclable biomedical waste generated. In case of disposal and management approach 88 percent respondents to collect waste in dustbin and 12 percent in Polyethene bags. Hence, it concluded segregation, collection, transportation, storage, disposal and management practice of the biomedical waste was found satisfactory.

**Keywords**: *Biomedical Waste, Collection, Segregation, Transportation, Disposal*

## Introduction

The generation of medical waste by healthcare facilities has grown drastically and become a serious public and environmental concern around the globe. According to World Health Organization (WHO, 2018) said that approximately 85% of biomedical waste are non-hazardous, around 10% are infectious and 5% are hazardous wastes. The biomedical waste is categorized as Human anatomical waste (human tissues, organs, body parts), Microbiology & Biotechnology waste (wastes from laboratory cultures, glass slides, stocks or specimens of microorganisms), Sharps waste (needles, syringes, scalpels, blades, glass etc.), Solid waste (blood contaminated cotton, dressings, soiled plaster casts, lines etc.), Liquid Waste (body fluids, laboratory and washing, cleaning, house-keeping and disinfecting activities) and discarded medicines and cytotoxic drugs (Lakshmi Bhaskar et al., 2020*)*.

After Birgunj became a metropolitan city, an influx of migrants and ward mergers increased the city's population load. Better healthcare services, education, infrastructure, connectivity, and drinking water have drawn many visitors as well as citizens from the surrounding region. Birgunj Metropolitan City has 36 hospitals, according to statistics published by the Metropolitan City Public Health Section. Among 36 private hospitals, the Narayani Central hospital is the only public hospital that provides various medical services to people. The generated medical wastes are directly kept on roadsides, dump on backyards, through on public places, discharge on drainage, open burning and so on. A major issue related to current biomedical waste management in public and private hospitals is that the implementation of biomedical waste regulation is unsatisfactory as some hospitals are disposing of waste in a haphazard, improper and

indiscriminate manner in the Birgunj Metropolitan City. In metropolitan, lack of segregation practices results in mixing of hospital wastes with general waste making the whole waste stream hazardous (Department of Health and Forest, Environment and Disaster Management of Birgunj Metropolitan City).

Biomedical waste management has become a critical challenge for health institution, hospital and local body, due to a lack of adequate infrastructure and technology. The inappropriate disposal of hospital waste causes a wide range of issues in the community and spreads various infectious diseases. As a result, the proposed study is précised general as well as specific goal as, to identify the current status and practices of bio-medical waste management in Narayani hospital of Birgunj Metropolitan City, to find out the status and composition of bio- medical waste and to access the practices and method of bio- medical waste management.

## Material and Methodology

### *Study Area*

There are 35 private and only one public hospital in Birgunj Metropolitan City (Department of Health of Birgunj Metropolitan City., 2024). The Narayani Hospital is only the public hospital of metropolitan city situated in ward 03 and 04 considered as study area. From geographical point of view, Narayani Hospital covers the region between the northern latitude of 27° 0’14.19"N - 27° 0’14.45"N and the eastern longitude of 84°52’15.82"E - 84°52’18.42"E. The altitude ranges from 108 meters to 110 meters above the sea level.

The Narayani hospital is government hospital from which the collection of data and other document is easy and it also consist of huge number of patients with various department. The hospital is situated in ward no 3 and ward no 4 of metropolitan city, which consist of 7604 population in ward no 3 and 3285 population in ward no 4. Mostly population in these wards are employed in various sector. The population of these wards are highly depended and harvesting the medical facilities from the Narayani hospital.

Also, there are various medical center in these wards. However, the Narayani hospital is the affordable service provided hospital with various medical facilities to both for poor and rich people. As, theses wards are highly developed in the metropolitan city, most of the people receiving the medical services from Narayani hospital. Therefore, it is selected as suitable for the study.

### *Nature and Source of Data*

The current study is based on primary and secondary data gathered through a field survey of the selected hospital and surrounding area. The primary data contained key informant data and an interview plan to acquire the essential data. The secondary sources of data were obtained through the usage of related books, journals, periodicals, and other references linked to the study’s topic.

### *Sample Size and Sampling Procedure*

Only Narayani Hospital selected for study in which 50 responses, 25 from inside the hospital from different department and 25 around the hospital area were chosen on the day of one week of sampling from patients and general public (Prakash Awasthi et al., 2023 & ADB, 2013). The one week of biomedical waste collection volume were taken for the study. The biomedical waste was kept in color dustbin in each ward and from ward waste were collected manually by worker at morning and evening. The biomedical waste transported by trolly in storage center. In the storage center waste segregated to identified the composition and each component was weighing by digital spring balance and digital balance in each day of one week. Some of the biomedical waste such as syringe and vials weighted at same time of collection in ward.

### *Techniques and Tools of Data Collections:*

The primary and secondary data used to complete the study. The researcher obtains 50 primary data from respondents in one week duration of the sampling by using the approaches as below.

### Questionnaire and Consultation:

Structured questionnaire used for gathering the real and accurate data about the collection and

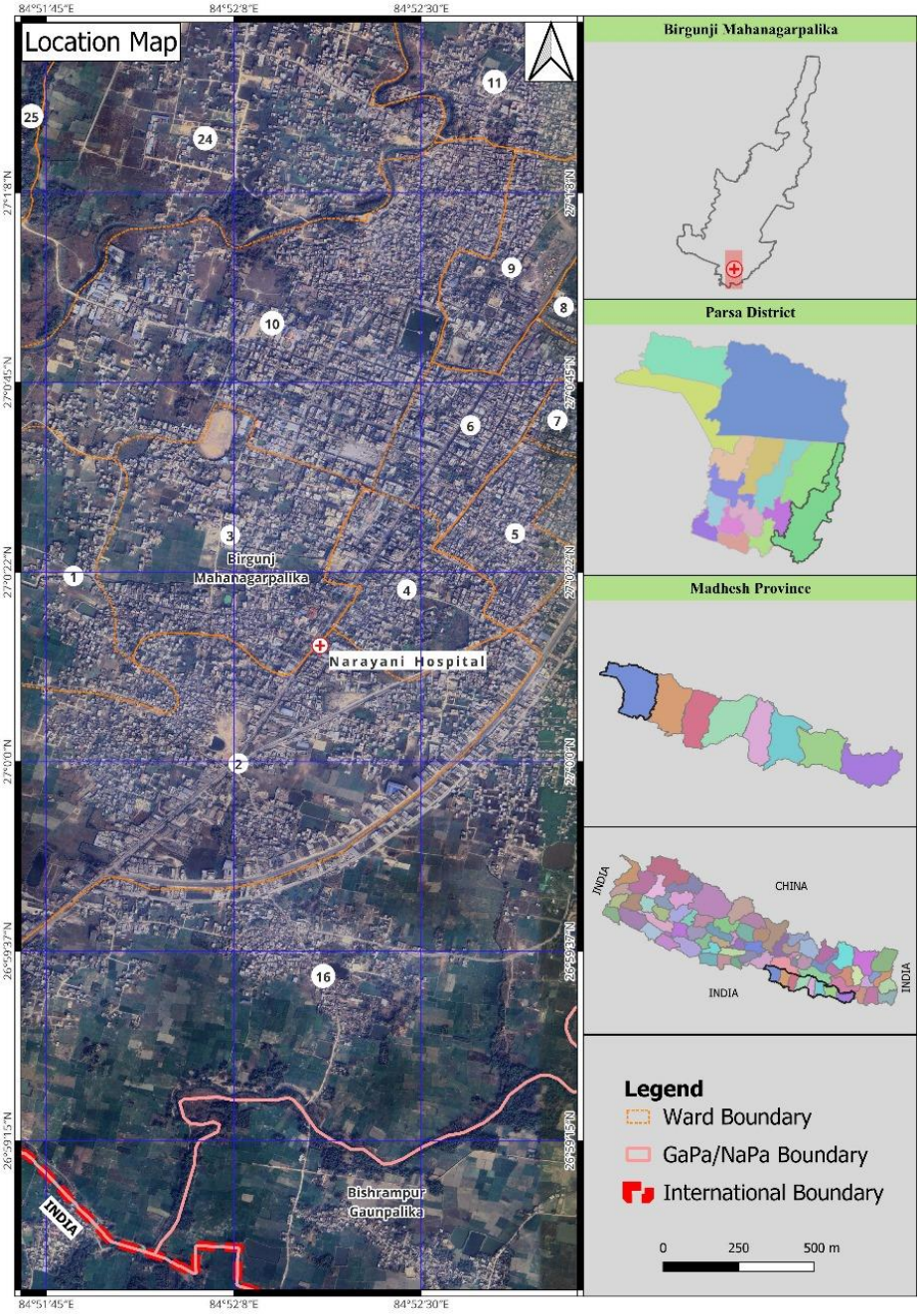


**Figure 1:** Location Map of the study area

management practices of biomedical waste from Narayani Hospital by survey of patients and general public.

**Key Informant Interview:**

The primary data was gathered from 10 key informants via semi- or unstructured interviews to get essential data for bio-medical waste collection and management. The interview is used to cross-check data acquired from the questionnaire. To gather essential information from key informants such as the hospital management committee, worker leader, department head, local leader, and stakeholders, interviews were conducted.

**Field Visit:**

From the field visit, observations were made to capture problems in the ground and to take photographs. Such images were used to assess, the major healthcare issues and waste production and the current management of healthcare waste.

### *Data Analysis*

In this study Statistical Package for the Social Sciences (SPSS) and Microsoft Excel used for arranging the data, data analysis, plotting of graph and bar diagram.

## Result and Discussion

### *Types of Biomedical Waste Generated by the Hospital*

According to Department of Health, in the metropolitan, there are so many private hospitals, clinic, diagnostic center, health post but Narayani is the only largest hospital which serve 300 beds along with 19 departments and 9 wards recently. It serves 1000- 1200 residents/days, 23,290 outdoor patients/ months, 1,353 indoor patients/months and 600-900 outdoor patients per day. The total biomedical waste generation rate is 48 kg/day and 0.16 kg/bed/day. The hospital appointed 10 workers and 3 categories of color-coding dustbins to collect segregated waste from each ward and disposal into waste management center of the hospital. Generally, the generated biomedical waste were Vials, Syringe, Saline bottle, Gloves, Cardboard box, Plastic Wrapper, Intravenous Set (IV Set) and Cotton gauge.

### Vials:

A vial is a small glass or plastic vessel which is often used to store medication in the form of liquids and powders. In the medical ward the average high volume of vials recorded as 1.13 kg/day followed by Laboratory 1.07 kg/day and ICU 0.97 kg/day. In the NICU the volume recorded as 0.04 kg/day and Radiology 0.07 kg/day as the least. The figure 2 showed generation of Vials in kg/day from different ward.

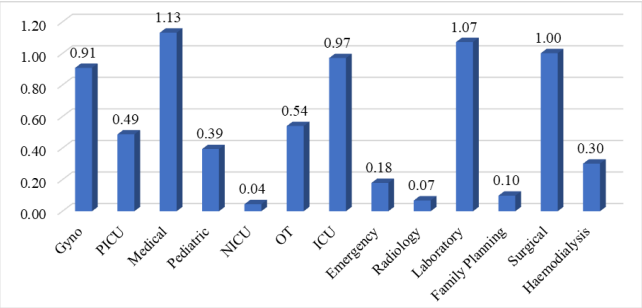


**Figure 2:** The average rate of Vials in kg/day from different ward

### Syringe:

The result showed maximum volume of 0.95 kg/day of syringe generated from laboratory ward followed by medical ward 0.38 kg/day. The minimum volume of syringe recorded from Radiology 0.05 kg/day. According to the study, Radiology department consist of CT- Scan, MRI, X-rays and Ultra-Sound and syringe are only used in MRI for injecting gadolinium-based contrast agents, which is 4-5 number discarded regularly. Therefore, the volume of syringe recorded minimum. The average rate of Syringe in kg/day generated from different ward shown in figure 3.

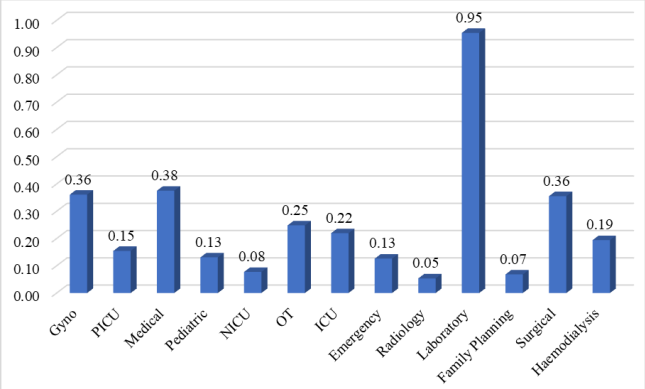


**Figure 3:** The average rate of Syringe in kg/day from different ward

### Saline Bottle:

The saline bottle is container that hold a mixture of sodium chloride and water has number of uses such as treatment of electrolytic imbalance, cleaning of wounds, removal and storage of contact lenses and so on. In the Narayani hospital, Gyno ward generated maximum volume 1.64 kg/day of saline bottles and minimum 0.01 kg/day in NICU. Some of the ward such as Radiology and Laboratory there were no any production of saline bottles. Similarly, the interview with ward In-charge of PICU, Pediatric, NICU and Family planning generation of saline waste in maximum volume in winter season then summer. In winter, the high rate of patients recorded with various kinds of diseases. The figure 4, showed average rate of Saline Bottle in kg/day from different ward.

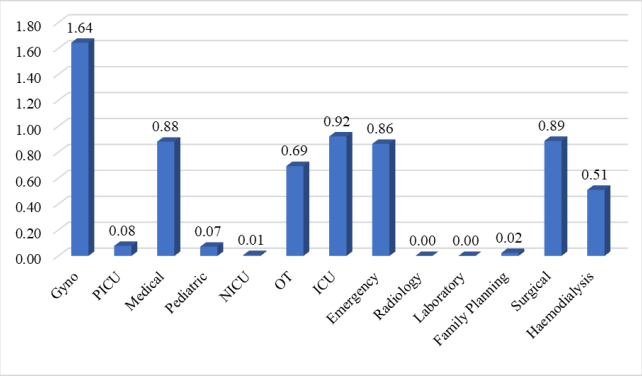


**Figure 4:** The average rate of Saline Bottle in kg/day from different ward

## Gloves:

Medical gloves are personal protective equipment used to protect from the spread of micro-organisms, infectious materials, radioactive materials and chemicals that may potentially cause infection or illness during medical procedures and examinations.

The study showed maximum volume of gloves generated from Haemodialysis 0.56 kg/day and 0.53 kg/day from Operation Theater. In the NICU less amount recorded as 0.01 kg/day. The maximum average number of patients 16 per/day recorded in Haemodialysis increased maximum amount of gloves generation. On the other hand, NICU the newly born baby recorded as 6 per/day and according to Preece et al., 2020 latex gloves are the fact of irritating allergic reaction even in 6% of the worldwide population reduced in maximum generation of gloves. The Figure 5 showed average rate of Gloves generation in kg/day from different ward.

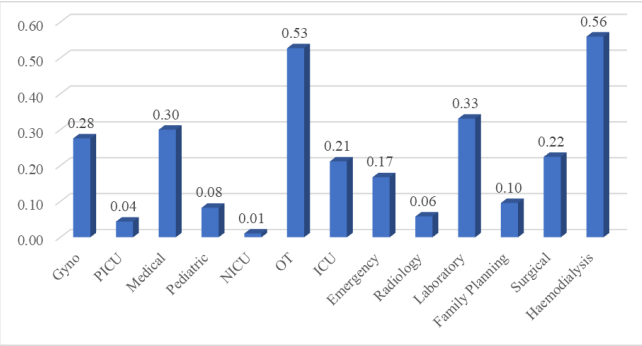


**Figure 5:** The average rate of Gloves in kg/day from different ward

## Cardboard Box:

The cardboards are generally produced as byproduct of material used to package gloves, syringe, medication and pharmaceuticals. According to study, the high volume recorded 2.01 kg/day from Operation Theater followed by Haemodialysis 0.98 kg/day. Some of the ward such as Family planning 0.10 kg/day, PICU 0.11 kg/day and Radiology, NICU had zero generation showed least production. The Figure 6 exposed average rate of Cardboard box generated in kg/day from different ward.

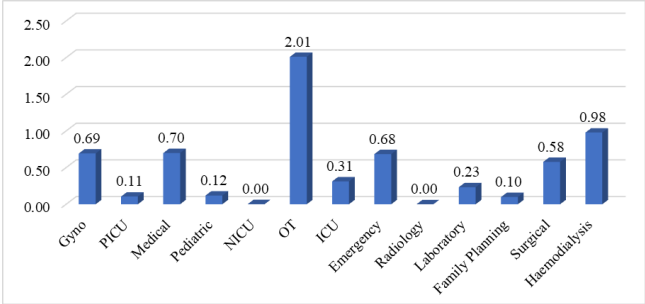


**Figure 6:** The average rate of Cardboard box in kg/day from different ward

## Plastic Wrapper:

Plastic wrappers are mainly generated from syringes, gloves, catheters, medication bottles and other medical items. From figure 16, the Gyno ward generated maximum volume of plastic wrapper 0.095 kg/day and minimum 0.014 kg/day from family planning. The Radiology and NICU wards had zero production of plastic wrapper. The figure 7 showed average rate of Plastic wrapper production in kg/day from different ward.

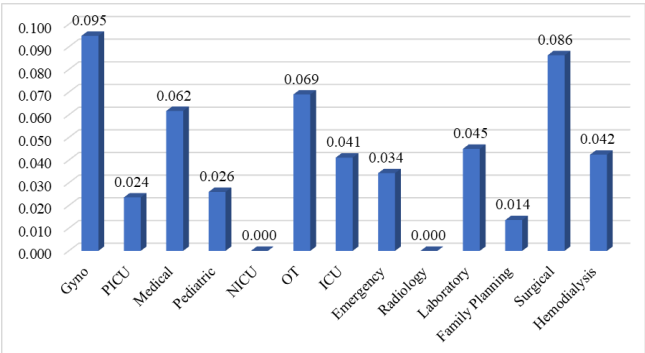


**Figure 7:** The average rate of Plastic wrapper in kg/day from different ward

**Intravenous Set (IV set):**

The intravenous set is primarily used to deliver various fluids, medication, nutritional support, blood transfusion and removal of fluids from the body. Generally, haemodialysis wards the average number of patients 16 recorded maximum rate of intravenous set 16.94 kg/day along with medical and gyno ward 0.26 kg/day simultaneously.

In the family planning wards 0.01 kg/day generation of average number of patient 3 per/day showed low and volume increased in winter season with increase in number of patients. Similarly, in surgical ward, the average number of patients recorded 28 per/day transferred in medical ward along with intravenous set revealed minimum generation of intravenous set 0.01 kg/day also. In laboratory and radiology ward there was no any production of intravenous set. The figure 8 showed average rate of Intravenous set-in kg/day from different ward.

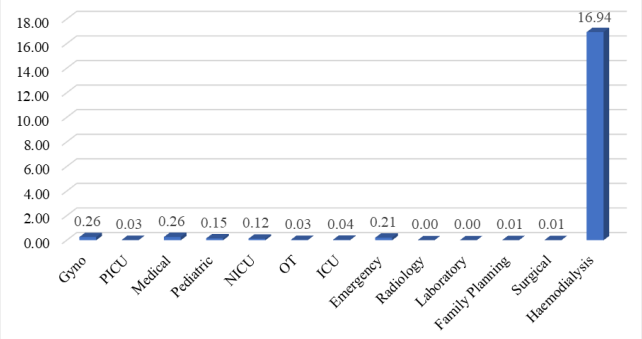


**Figure 8:** The average rate of Intravenous set-in kg/day from different ward

**Cotton Gauge:**

The cotton gauge is a purely cotton made material used for cleaning the wounds, injury, cuts and for absorbing body fluids and liquids. The study showed maximum rate of cotton gauge generated from Operation theater 1.63 kg/day followed by gyno 0.48 kg/day. Whereas, the minimum volume 0.04 kg/day recorded in Laboratory, Pediatric and PICU. The figure 9 showed average rate of Cotton Gauge generation in kg/day from different ward.

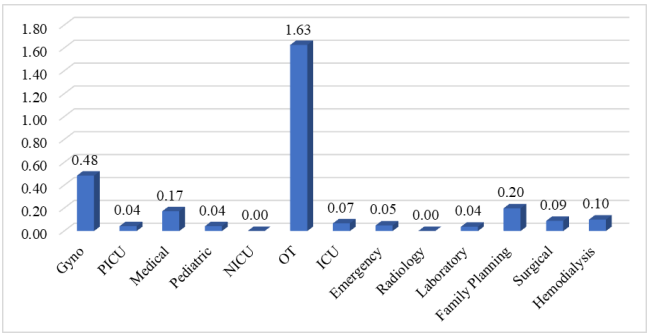


**Figure 9:** The average rate of Cotton Gauge in kg/day from different ward

***Volume of Different Kind of Bio-medical Waste***

There are various kinds of biomedical waste generated from hospital such as Vials, Syringe, Saline Bottles, Gloves, Cardboard, Plastic Wrapper, Intravenous sets, Cotton Gauge, Body parts, fluids and liquid waste. According to the study, there are 36 hospitals with 2500 beds in Metropolitan city in which Narayani Hospital is one, there Intravenous set were maximum volume 6.59 tons/year and Vials 2.63 tons/year of biomedical waste generated and in other metropolitan hospitals 54.92 tons/year and 21.89 tons/year respectively.

Similarly, the plastic wrapper 0.20 tons/year followed by Cotton gauge 1.04 tons/year in Narayani hospital and 1.64 tons/year and 8.65 tons/year in entire hospital of metropolitan city recorded as the least. The figure 10 showed average volume of different kinds of biomedical waste generated from Narayani Hospital in tons/year and figure 11 presented average volume of different kinds of biomedical waste generated from Metropolitan City Hospitals in tons/year.

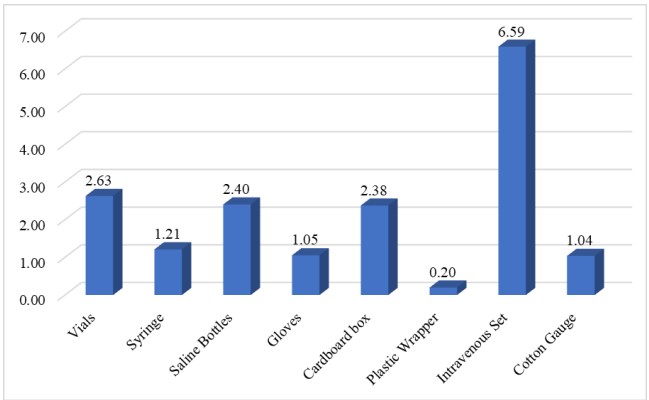


**Figure 10:** The average volume of different kinds of Biomedical waste generated from Narayani Hospital in tons/year

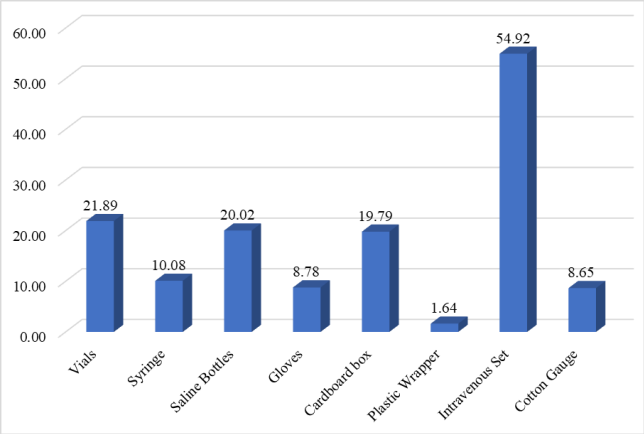


**Figure 11:** The average volume of different kinds of Biomedical waste generated from Metropolitan City Hospitals in tons/year

### *Biomedical Waste Generated from the Department*

As the hospital is the largest hospital with 9 ward with 300 beds and serving 24,643 and 2, 75,625 patients monthly and annually. Each of the wards has fluctuated in number of patients so that generation rate and types of biomedical waste fluctuated. According to the study, the high rate of biomedical waste generated from Dialysis ward 19.62 kg/day followed by Operation theatre 5.74 kg/day and Gyno 4.72 kg/day. Similarly, Radiology recorded as 0.18 kg/day lowest generation rate followed by NICU 0.26 kg/day and Family Planning 0.60 kg/day. The generation of biomedical waste from different wards kg/day is mention below in figure 12.

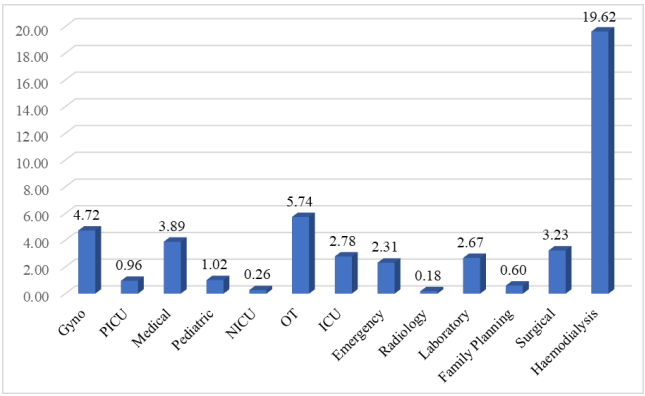


**Figure 12:** The average volume of Bio-medical waste in kg/day from different ward

### *Biomedical Waste Collection and Transportation Practices*

In Nepal, According to guidelines (DoHS, 2014) for biomedical waste collected in designated storage area and transported in closed vehicles on a regular basis before treatment and removal. The collection and storage areas should be located away from patient rooms, laboratories, hospital function/ operation rooms or any public access area (DoHS, 2014).

The study survey in Narayani hospital showed, biomedical and organic waste from different wards collected in three kinds of dustbin (Red, Blue & Green Color). Some of the high toxic and contaminated waste such as syringe and vials collected in dustbin (Red color) wrapped with polyethene bag and remaining such as saline bottles, cotton gauge, cardboard box, plastic wrapper, intravenous set directly kept in dustbin (Blue color) and organic waste in green color dustbin. The removal of body parts and placenta collected in polyethene bag and not transported outside from hospitals. The body fluids, chemical waste and wastewater from different wards are directly discharged into drainage of the metropolitan city and similar practices followed by entire hospitals of the metropolitan city in collection of solid and liquid biomedical waste.

In case of transportation, the biomedical waste collected manually by three staff everyday two times morning and evening in a day by the staff in separated dustbin and polyethene bags from each ward and transported to storage center by trolly.

Besides this, the hospital has their own biomedical waste management center is managing their waste inside the hospital and those has not management facility handover their biomedical waste to Green Hospital waste management center of metropolitan city. The collected waste in polyethene bags in different hospitals, storage their waste in back yards or separate storage place from there metropolitan vehicle collected waste manually and transported in semi-closed vehicle to Green Hospital waste management center.

### *Biomedical Waste Segregation Practices*

The process of separating waste at the site of generation and keeping it apart for management, collection, temporary storage, and transportation is known as waste segregation. The most crucial stage in the effective management of biomedical waste is the segregation of waste at the point of generation, which is the fundamental principle of safe and effective waste reduction. During the study, 50 respondents were questioned and found that 74 percent responded to segregate biomedical waste in ward and remaining 26 percent segregated in management centre.

In the Narayani hospital biomedical waste such as Vials and Syringe segregated in the ward at same time of generation by medical staff and remaining such as saline bottle, cardboard box, plastic wrapper, intravenous set, cotton gauge and organic waste collected in dustbin without segregation. In the hospital, collected waste segregated in management center by staff manually everyday and kept in a separate storage shell. The remaining non-recyclable and organic waste items transferred in temporary disposal site to handover the metropolitan for final disposal.

The interviewed with 50 respondents (Patients and their associate, stakeholder, medical staff and workers) in various department for biomedical waste segregation practices in the hospital and 74% respondent (patients and their associated people) responded that do not have the idea regarding the segregation of biomedical and non-biomedical waste and through their organic and inorganic waste in mixing with biomedical waste. Only 26% respondent (medical staff and worker) were more conscious in segregation practices of biomedical waste. In the other hospitals of metropolitan, there is no any segregation practices and hospital waste along with organic, inorganic and biomedical waste directly handover to Green Hospital waste management center of metropolitan city.

### *Recycling of Biomedical Waste*

The recycling means converting waste materials into new product by adding various process according to their nature. In the hospital various kinds of biomedical and inorganic waste generated that can be recycle such as plastic bags, slime bottle, gloves, water bottles, cardboards, intravenous set, cottons gauge, vials (glassware, glass tube and slides) and syringes after certain process. During the study, 0.05 tons/day, 0.36 tons/week, 1.56 tons/month and 18.74 tons/year of recyclable biomedical generated from the Narayani hospital represented in figure 13.

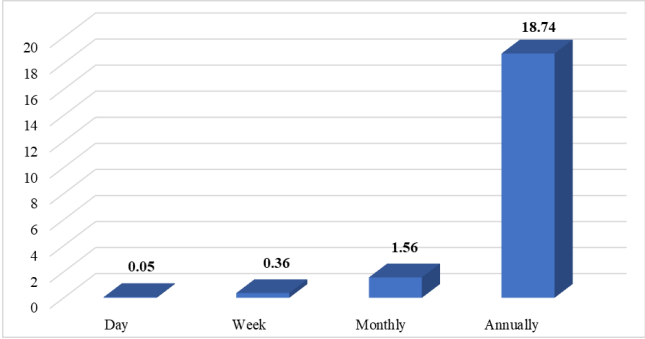


**Figure 13:** Generation of recyclable bio-medical waste from Narayani hospital in tons.

Similarly, from the entire hospital of the Birgunj Metropolitan city, 0.43 tons/day, 3.00 tons/ week, 13.02 tons/month and 156.19 tons/year of recyclable biomedical waste generated. The figure 14 represented generation of recyclable bio-medical waste from entire hospital of Birgunj Metropolitan City in tons.

During the study, 38 percent of respondents responded to agree for recycling of waste. The liquid waste such as fluids, waste chemicals and wastewater had no any process of recycling and discharge directly in drainage. On the other hand, the removal of body parts and placenta used for production of bio-gas but in other hospital body parts and placenta dumped or buried in backyards.

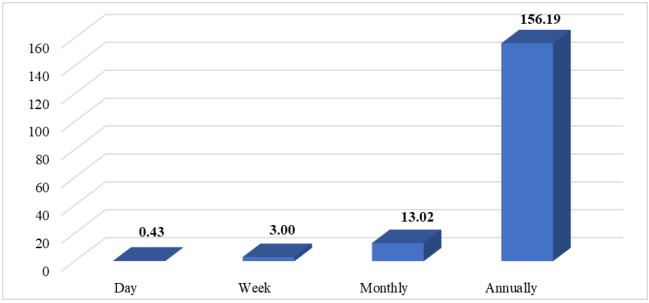


**Figure 14 :**The generation of recyclable bio-medical waste from entire hospital of Birgunj Metropolitan City in tons.

### *Disposal and Management of Biomedical Waste*

The improper management of the biomedical waste is one of the biggest problems and arise various kind of human health, biodiversity and environmental issues in the hospital and metropolitan city. As the Green Hospital waste management center of metropolitan came in operation there is vast changes in the management and disposal of biomedical waste. Similarly, management center also provided its contribution in the management practices of organic and inorganic waste of Narayani hospital. However, the Narayani hospital has its own biomedical waste management center with modern technology-based auto-clave machine.

During the study, it was found that 0.05 tons/day and 0.43 tons/day volume of biomedical waste generated everyday in Narayani hospital and from other 35 hospitals of Birgunj Metropolitan City. The biomedical waste segregated and storage in shell and after auto-clave sell to vender from management center of Narayani hospital and similar, process is followed by metropolitan city for remaining hospital in Green Hospital waste management center.

The indoor and outdoor 50 responded were questioned regarding the disposal and management approach of biomedical medical waste and found that 88 percent respondents to collect waste in dustbin and 12 percent in Polyethene bags. Similarly, 12 percent respondents to incineration, 2 percent composting, 2 percent reuse, 38 percent recycle, 40 percent dumping and 6 percent do not know, advised to follow the biomedical waste management approaches.

The biomedical waste management inside the Narayani hospital and services provided by metropolitan city were inquired from 50 respondents responded that 42 percent good, 46 percent satisfactory and 12 percent poor management of biomedical waste experienced inside hospital and in metropolitan city. At the same time, only 8 percent of staff were involved in selling of recyclable waste outside to vender and 92 percent were not involved in such activities.

During the study entire hospital (35 hospital) of metropolitan city, handover the body parts and placenta to Green Hospital waste management center to dumped in landfill site. However, body parts and placenta are managed by production of bio-gas in Narayani hospital.

So far, the entire hospitals are managed their liquid waste such as body fluids, chemical along with wastewater directly discharge into drainage without any methods of treatment. From the study, among 50 respondent's 80 percent of medical, non-medical staffs, patients and their associate and other visitors did not show eco-friendly behavior and 20 percent have positive response in waste management system.

Biomedical waste may contain potential pathological organisms (Alagoz et al., 2008) which if improperly managed may be a risk to healthcare staffs, public and environment (Shine et al., 2008). During study, most of the respondents in 50, 48 percent of respondents were not but 52 percent were found environmental issues such as foul smell, soil pollution, spreading of waste by dogs and jackal and files problems. At the same time of study, 72 percent responded did not experienced any health issues and 28 percent were recorded as fever, cold, headache and diarrhea.

## Conclusion and Recommendation

### *Conclusion*

The study concluded that biomedical waste management system is satisfactory in Narayani hospital of Birgunj Metropolitan City. The segregation, collection, transportation, storage and disposal practice of the biomedical waste was found satisfactory. The mixing collection of organic, inorganic and medical waste were might be due to lack of proper training and instruction, carelessness of patients, visitors and staffs about waste segregation system.

The hospital administration, medical and non-medical staffs had also not given priority to effective waste disposal and management. Manual transportation of uncovered bucket and dustbin practiced by the sanitary staffs that may cause splitting of waste, foul smell, transmission and

contamination of waste by vectors is hazardous to human health. Health care waste should be transported within the hospital and other facility by means of wheeled trolleys, containers or carts that are not used for any other purposes.

The biomedical waste such as vials, syringe, saline bottles, gloves, cardboard box, plastic wrapper, intravenous and cotton gauge found to be well segregated in Narayani hospital. Rather than, Narayani Hospital and other hospital of Birgunj Metropolitan City biomedical waste segregated in Green Hospital waste management center and finally sold to vender. The remaining waste were disposed in the absence of a special health care waste treatment facility. Therefore, hospitals should develop health care waste management plan strictly and training package for waste management should be developed for all hospital staffs including sweepers.

***Recommendations***

**Strategy associated:**

a. The Central Government as well as Local government should implemented policy of biomedical waste management and practices strictly the policy for the effective biomedical waste management in the hospital and other medical center.

b. The local government not only implemented the policy rather than established the local level waste management committee for the proper inspection and guidance for proper disposal and management of biomedical waste.

c. Besides the legal implementation, the financial and technical support should be also given by the government for the effective and efficient biomedical waste management system.

**Improvement level:**

a) The different color code dustbin should be placed inside and outside the wards, department and waiting places along with sign and symbol of types of waste for effective and efficient collection of segregated biomedical waste from every part of the hospital.

b) The hospital should conduct weekly or monthly or yearly awareness activities to their medical and non-medical staffs and also appointed a staff for guiding the local visitor for the proper collection of biomedical waste.

c) The hospital should follow the 3R (reduce, re-use & re-cycle) policy for the biomedical waste disposal and management.

d) The high rate of using plastic should be prohibited and instead of it the cotton or degradable bags should be encouraged to use.

e) The sanitary staff should wear the protective equipment for safe collection, handling, segregation and disposal of biomedical waste.

f) Nanostructured photo catalysts, due to their non-toxicity, low cost and high absorption efficiency can effectively degrade pollutants making them suitable for the treatment of biomedical waste management.

g) The educational program in campus and university is significantly enhance healthcare workers knowledge and practices regarding biomedical waste handling.

h) Innovative approaches are being explored to response biomedical waste materials such as plastic and glass into construction practices, promoting a circular economy and reducing environmental impacts.

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