

Annual Pattern of Biomedical Waste Generation and the Seasonal Variation

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Abstract— Waste generation in a healthcare facility depends basically upon a number of factors including but not limited to the number of patients treated, the total bed occupancy rate and the type of diseases treated. These three aspects are controlled by many sub factors but in this case study we have studied the seasonal variation, average temperature and disease outbreak in the area where the health care facility under study is located and the way in which they influence the amount of medical waste generated. Data on medical waste generation at the largest health facility of a hilly town of Himachal Pradesh a northern state of India was collected by observational approach, formal personal interviews, informal dialogue and site visits for analysis between August 2011 and August 2014. It was found out that the waste generated is directly related to the average temperature and varies with the seasonal variations. It was further found out that the waste generated at the health care facility was segregated and treated in accordance to the guidelines laid down by the Central Pollution Control Board of India under the Biomedical Waste (Management & Handling) Rules, 1998.

Index Terms— Biomedical waste, disease outbreak, health care facility, months, seasons, segregation

1 INTRODUCTION

The increase in population worldwide especially in economically developing and third world countries has a far and wide implications on our environment and generally most of the consequences this ever increasing population has are indirect and they go unnoticed until or unless they accumulate and erupt as a major problem worldwide. More the population more is the number of people falling ill therefore to provide healthcare facilities to this massive population the number of healthcare institutes have risen exponentially. Many new health care institutes both in public and private sector have mushroomed in recent years in every nook and corner of the heavily populated countries like in India with and without much concern over the hazards of the healthcare waste generated and its proper management.

Medical waste is defined as any solid or liquid waste that is generated from treatment of human beings in hospital or clinic, from clinical diagnosis and pathological testing and from medical research [1] and although medical wastes represent a relatively small portion of the total waste generated in a community, medical waste management is considered an important issue worldwide [2] because when managed ineffectively, infectious hospital wastes in developing countries can compromise the quality of patient care and create significant occupational, public, and environmental health risks [3]. Hazards associated with waste produced by health care establishments, and the increased potential for infection and injury, have been frequently described in literature worldwide [4] as medical waste may play an important role in the transmission and intensification of diseases [5], [6] and is a growing concern in developing countries [7] as in developing countries, medical waste has not received adequate attention [8] and is generally disposed together with the domestic waste [9] unlike as in developed countries where technologies like autoclaving and incineration are used for treatment and final disposal of medical waste. WHO estimated that in 2000, around 23 million

people were infected with Hepatitis B, Hepatitis C and HIV worldwide due to injections using contaminated syringes in health care facilities. In March 2008, 420 people in Gujrat, India contracted hepatitis B following medical care delivered with previously used syringes, which later were acquired through black market trade of unregulated health care waste [10]. Further investigation found evidence from 2004 study conducted by the Indian Clinical Epidemiology Network suggesting that more than 30% of the 3-6 billion injections administered each year in India were done with used equipment, a practice reported in more than 10% of the health facilities nationwide. Therefore to curb this menace of illegal waste trade for recycling in India the Central Pollution Control Board has laid down strict guidelines under the Biomedical Waste (Management & Handling) Rules, 1998 [11].

Most studies have been focused on quantification of medical waste generation and only a few have addressed the environmental and behavioural context in developing countries [12] therefore in this study we have gone a step back in medical waste management and generation and have studied and analysed the factors affecting the waste generation in a health care facility. Waste generation in a healthcare facility depends basically upon the number of patients treated, the total bed occupancy rate and the type of diseases treated. These three aspects are controlled by many sub factors but in this case study we have studied the annual pattern of waste generation and the seasonal variation and how it influences the amount of medical waste generated.

2 MATERIALS AND METHODS

2.1 Site and Facility Selection

Shimla, formerly known as Simla the state capital of Himachal Pradesh, a northern state of India lies at an average altitude of 2397.59 meters above mean sea level at 31.1033°N and

77.1722°E. The city stretches nearly 9.2km from east to west and is actually spread on a ridge and its seven spurs. The area of the city is about 25km² and the population as per 2011 census is 169,758. Shimla is draped in forests of pine, rhododendron and oak and experiences pleasant summers and cold, snowy winters.

Shimla features a subtropical highland climate under the Köppen climate classification. The climate is predominantly cool during winters and moderately warm during summers. Temperatures typically range from -6°C to 31°C over the course of a year.

As per Indian Meteorological Department (IMD) [14] classification, seasons in India are classified as

1. Winter Season (January to February)
2. Summer Season (March to May)
3. Monsoon or Southwest Season (June to September)
4. Post-monsoon or Northeast Monsoon Season (October to December).

However, for the study of climate of Himachal Pradesh (Shimla), seasons are classified as

1. Winter Season (December to March)
2. Summer Season (April - May)
3. Monsoon or Southwest Monsoon Season (June to September)
4. Post-monsoon or northeast Monsoon Season (October - November).

For the present study one of the largest health facility of the state was selected. There are a total of 2068 allopathic public health institutions in the state of Himachal Pradesh for over a population of 1.60 lakh people.

The state of Himachal Pradesh has a fairly extensive network of public health institutions. In addition to the rest, there are two teaching hospitals, two leprosy hospitals, two TB hospitals, two medical colleges and three dental colleges making the total bed capacity in the public sector 8747.

IGMCH Shimla, one of the biggest and most important healthcare institutes of the state was chosen for the case study. Indira Gandhi Medical College & Hospital Shimla came into being in 1966 at Snowdown that was the residence of Lord Kitchner (1873-74) the erstwhile Commander -in Chief of British - Indian Army. It has got 30 departments with existing bed strength of 778 beds along with 58-day care or observation beds. The average number of IPD Patients is 709 and thus the average percentage of bed occupancy is 93%, while the daily average number of OPD Patients is 1296.

2.2 On-site visits, Personal interviews, Desktop study

health facility under study was visited many times during the

study period from August 2011 to August 2014 in different seasons and different months for data collection by formal personal interviews with the personnel responsible for the health care waste management, its record keeping, and also with those who are responsible for checking if the norms and guidelines are being followed while management and handling of the healthcare waste or not.

Informal dialogue was also undertaken with the personal actually handling the waste, with those who are responsible for its collection and safe storage, those who are actually treating and disposing it on site and also with those who are responsible for its transportation and final treatment and disposal at the Central Treatment Facility along with a site visit to the Central Treatment Facility was undertaken to analyse the status of waste disposal there.

During the site visits, photographic data was also collected, using a digital camera, as an observational approach of data collection at various steps of medical waste life cycle i.e. at the point of generation, segregation, collection, transportation, on and off site treatment and final disposal and this collected photographic data was interpreted and illustrated to analyse the research findings [12].

The data thus collected was verified against the waste management records of the medical establishment and Municipal Corporation.

The data for average daily and monthly temperature was collected through an exhaustive desktop study from NASA and Indian Meteorological Department.

The data for disease outbreak in the region was collected from the website of Integrated Disease Surveillance Programme (IDSP) [13], being maintained and controlled by National Centre for Disease Control (NCDC), Directorate General Health Services, Ministry of Health and Family Welfare, Government of India.

2.3 Data Analysis

At first the average monthly biomedical waste generation rate from the data collected for four years was calculated. A Pearson product - moment correlation coefficient was computed to assess the relationship between the average medical waste generated daily at the healthcare facility and the average daily temperature of the site at which the facility is located.

3 RESULTS

3.1 Waste Generation and Influencing Factors

The daily average waste generated at the healthcare facility under study is 76.3 kg. A positive correlation was found between the average waste generated and average daily temperature, $r = 0.951$, $n = 6$, $p = 0.002$. Also the average waste generated was recorded highest for the month of September where in the year 2009 the waste generated was 37.53% more than the monthly average. Also in regard of the seasons the monsoon and the post monsoon season recorded an average waste generation higher than the total average 76kg/day.

Waste Segregation

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In IGMCH, Shimla the waste generated is segregated at the point of generation itself in the color-coded containers as discussed in the table 1.

3.2 Treatment Practices and Final Waste Disposal

The study found that different waste categories are handled, treated and disposed off differently as in compliance to the guidelines mentioned by the Central Pollution Control Board, Ministry of Environment and Forests, Government of India as is compiled in table 2.

4 DISCUSSION

4.1 Waste Generation Rate

The total amount of hospital waste generated in a healthcare facility depends upon various factors. This study have found that it not only depends upon major factors like the total number of patients treated in the hospital in a day but is also significantly associated with the environmental factors like seasonal variations and average daily temperature as the climatic conditions of a place are widely responsible for the outbreak of various types of disease directly and indirectly. Data for disease outbreaks was collected from the Integrated Disease Surveillance Project (IDSP) [13], Government of India, Ministry of Health and Family Welfare in association with the World Bank and a peak was observed in the total amount of waste generation, everytime a disease outbreak was reported in the state since it's the state's biggest and major healthcare facility and patients from all over the state are referred here for a proper treatment.

In Figure 1, highest peak for waste generation is observed for the month of September 2009 and also for that month acute diarrheal disease outbreak is being reported at Shimla. Also from figure 1 it can be seen that on an average peaks for the monsoon and post monsoonal seasons are higher than the rest. This seasonal rise in the waste generated can be owed to the increased number of patients suffering from diseases like asthma and respiratory ailments that get triggered during the harvesting seasons. Infectious diseases, diarrhea, dysentery are prevalent between June to September due to contamination.

Therefore if the seasonal variations, disease outbreaks and such other environmental factors are kept in mind beforehand by studying the trends and relationships, the regulatory authorities can effectively be prepared in advance to deal with the extra waste generated and hence the accumulation of waste in the premises and storage units can be reduced.

4.2 Segregation, Treatment and Final Disposal

The waste generated in a healthcare facility is considered hazardous due to its infectious nature but according to UNEP [15] only 10% of the total waste generated at a healthcare facility is infectious and that can further be reduced to 1-5% with proper segregation at the sources. Keeping this in mind the guidelines for biomedical waste management were laid in the country and main emphasis was put on the segregation of waste at the point of its generation in special color coded bags and containers as men-

TABLE 1
WASTE SEGREGATION IN COLOR-CODED CONTAINERS AT THE POINT OF GENERATION, IGMCH, SHIMLA

Category	Type of Waste	Color of the container
Sharps	Needles, Broken glass, Suture needles, Lancets, Blades, Scalpels	Blue
Disinfected and mutilated plastic	Blood bags, IV sets, Tubing, Urine bags, Syringes, Catheters, Gloves	Blue
Infectious waste	Microbiological and biotechnological waste, Blood soaked bandages, Soiled dressings, Cotton swabs	Red
Body parts and anatomical waste	Human tissues, Organs, Body parts, Animal Waste, Placenta	Yellow
General Waste	Non-infected plastic, Cardboard, Packaging material, paper	Black

tioned in table 2. The waste thus collected is transported to the storage site for its treatment. The yellow bags are outsourced to the municipal corporation's central treatment facility in special vehicles where it is incinerated. The red bag waste is at first shredded and then is autoclaved at 121°C for 30 minutes in healthcare facility itself and is then sold to a local vendor for recycling. The blue bag and container waste mainly consists of the needles and syringes; those are at first mutilated at the source by the handler or operator with the help of a needle cutter and then are disinfected chemically by treating it with 1% bleach solution. It

is finally disposed off in a burial pit present within the premises of the healthcare facility only.

5 CONCLUSION

This study found that the amount of waste generated depends

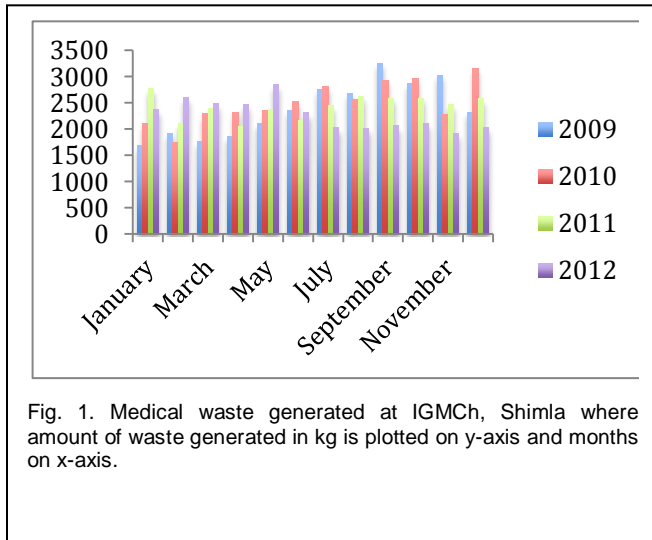


Fig. 1. Medical waste generated at IGMCh, Shimla where amount of waste generated in kg is plotted on y-axis and months on x-axis.

upon a number of factors including several environmental parameters. The waste generation at the facility has been found more than average in the monsoon and post monsoon seasons because of more people falling ill in those months since the conditions are favourable for the microbial growth and spreading of the infections. Also the healthcare facility under study does follow the guidelines and rules laid down for the effective management of biomedical waste only upto a certain limit. Though due to constant efforts of higher authorities and regular inspections the amount of waste generated has been reduced and it's recycling has also been started but still many improvements are required at the grass root level. Because IJSER staff will do the final formatting of your paper,

ACKNOWLEDGMENT

This study was supported and funded by the INSPIRE Fellowship scheme of the Department of Science and Technology, Government of India. We also thank the supportive staff and office bearers at the Municipal Corporation Shimla and IGMCH Shimla for their help in showing around the campus and providing the data.

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TABLE 2
CATEGORY WISE WASTE TREATMENT, IGMCH, SHIMLA

Bag	Treatment
Yellow	Outsourced for incineration
Red	Shredded and autoclaved at the facility
Blue	Needle destroyer, 1% bleach solution, pit
Black	Municipal stream

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