Assessing the Impact of Hospital Waste Management on Workers Health: A comparative study of Public and Private Hospital in Islamabad

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PIDE2015FMPHILENV11

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2017

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CERTIFICATE

This is to certify that this thesis entitled: **"Assessing the Impact of Hospital Waste Management on Workers Health: A Comparative Study of Public and Private Hospital in Islamabad".** submitted by Ilyas Saleem Khattak is accepted in its present form by the Department of Environmental Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in **Master of Philosophy in Environmental Economics**.

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ACKNOWLEDGMENTS

Up and above anything else, all praise and glory be to ALLAH; The Almighty. After the Almighty ALLAH, to the greatest of his blessings, the Prophet Muhammad (S.A.W); forever a source of guidance for humanity.

The author sincerely acknowledges all type of help, assistance, consideration and engorgements provided by all the persons, institutions and organizations in completion of this study of human importance. The author is particularly, obliged and highly indebted to the kind, able and continuous guidance and support provided by my supervisor Dr. Muhammad Nasir. I am also grateful to the overall guidance provided by Dr. Rehana Siddique, Head of the Environmental Economics Department and my parents, brothers and colleagues for their support and encouragement.

I am very thankful for the love, support and prayers of my mother throughout my life. I really appreciate the unconditional support and guidance of my father on each and every step of my life, without his firm belief in me I would never be able to achieve this goal.

Ilyas Saleem

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ABBREVIATION AND ACRONYM

MWCs	Medical Waste Collectors
HIV	Human immunodeficiency virus
HBV	Hepatitis virus B
HCV	Hepatitis virus C
IPD	Inpatient Department
OPD	Outpatient Department
PAK EPA	Pakistan Environmental Protection Act 2005
WHO	World Health Organization
Nosocomial infections	Hospital acquired infection
PIMS	Pakistan Institute of Medical Sciences
SI	Sharp Injury
PE	Protective Equipment
HMW	Hazardous Medical Waste

ABSTRACT

Waste is generated by any medical treatment activity. The type, quantum and process of waste generation and its disposal may be different because of various procedures undertaken in different departments of hospitals, clinics and medical laboratory. The present study is a comparative case study to investigate the impact of hazardous medical waste on the acute health symptoms of medical waste collectors in two major hospitals as representative of public sector and the private sector in Islamabad. The study was undertaken by physical visits, observations, interviews with hospital waste management team and information gathering from the waste collectors through structured questionnaire (sample survey). The results show that the probability and frequency of illness of various diseases is significantly higher in waste collectors in PIMS hospital compared to those in SHIFA hospital. Moreover, the probability of sharp injuries is also higher in PIMS. The study attributes these injuries to the lack of training as well as the unavailability and bad quality of protective equipment in PIMS. In addition, the study finds considerable variation in the methods, processes, cost and technology used in the waste collection and disposal system in both the hospitals. The hospital waste disposal, particularly the hazardous one, can be properly managed to minimize damage and ensure safety of all those exposed to such waste, especially the workers involve in its collection and disposal process.

Key words: Medical Waste Collectors, Hospital Waste Management, Sharp Injury, Hazardous Waste, Environmental Safety

KEY TERMS

Medical Waste: Waste generated in hospital, clinics, research and bio-medical laboratories in the process of diagnosis, treatment or immunization of human beings or animals.

Hazardous Medical Waste: Waste generated in the process of diagnosis, treatment or immunization of infected person.

Medical Waste Collector: Persons involved in collection, segregation, transportation to storage and disposal of medical waste generated by hospitals.

Training: Activities to improve staff knowledge, awareness and skills about best practices and technologies used in collection and disposal of medical waste and overall waste management system of a medical entity.

Technology: Methods and equipment's used in collection, segregation and disposal of medical and waste.

Waste Treatment: Cleaning processes involved in collection, segregation and disposal of medical waste.

Sharp: All kinds of needles, syringes, scalpels, infusion sets, saws and knives, blades, broken glass and any other item that could cut or puncture (treated as waste after use).

Sharp Injury: Any type of injury caused by a sharp, including, but not limited to, cuts, abrasions, or needlestacks.

Blood or Body Fluids: Liquid blood elements or other regulated bodily fluids, or articles contaminated with blood or bodily fluids released during medical treatment, diagnosis or research.

Protective Equipment: Specialized clothing or kit worn or used by medical waste collectors for protection against any hazard, damage or danger. Protective equipment includes special uniform, gloves, mask, goggle, footwear, etc.

Infectious Waste: Residue of medical treatment, laboratory work, surgeries and autopsies contaminated by any type of pathogens such as bacteria, viruses, parasite or fungi and cultures from in the shape of waste from infected patients, discarded or disposable materials and equipment which have been in contact with such patients.

Waste management: Includes all practices, processes and procedures applied and adopted by any organization for waste segregation, waste collection, waste transportation, waste storage, waste disposal and waste minimization and reuse.

Nosocomial Infections: Hospital acquired infections

CHAPTER-I

INTRODUCTION

1.1 Overview of the Chapter

This chapter is divided into six sections. In the first section, the background of the study is discussed. Section two contains a brief review of the state of waste disposal in the sample hospital to enunciate the problem statement which is given in section three. The objectives, limitations and significance of the study is given in Sections four, five and six, respectively.

1.2 Background of the Study

Waste is generated in any type of medical procedure at hospitals, clinics and laboratories. The hospital waste is broadly classified into two main categories i.e., municipal and medical waste. The municipal waste, also referred as non-hazardous waste, includes all types of residue material produced from kitchen, administrative offices and maintenance of hospital buildings and other infrastructure. The municipal waste is collected and disposed by the municipal authorities. The quantum of municipal waste (non-hazardous) produced by hospital ranges between 75% to 90% (WHO 2014). Medical waste referred as hazardous waste is one of the dangerous type of waste generated during the medical processes and activities. The collection and disposal of medical waste, usually contaminated (hazardous), carry high potential of injury and infection to all those associated with it, particularly, the Medical Waste Collectors (MWCs). According to WHO (2014), this type of waste regarded as “hazardous”, although constitute 10 to 25% of the total waste risky to general public and MWCs due to its negative impact on health and environment.

Medical waste collectors (MWCs) at their work place are facing many risks in the shape of nosocomial infections through airborne, blood borne and through direct contact with infectious waste. Exposure of MWCs towards blood borne pathogens is matter of great concern and invited increased attention since the Human Immune Deficiency Virus (HIV) disease became viral. In less developed countries, exposure towards pathogens and its health impacts are rarely monitored, despite the facts that millions of MWCs experience skin injury with a contaminated sharp object each year with risks that causes illness, disability and death. In the hospitals of Pakistan about 54% of MWCs are reported suffered at least one sharp injury within 6 months (Kumar et al., 2010). Mostly, hospital administration and para medical and medical staff / doctors seldom comply with the standard practices of medical waste disposal (devised by Pak EPA) exposing doctors, nurses, MWCs and even fellow patients and visitors to various infection. In order to prevent nosocomial infections, all type of medical waste should be properly collected, segregated and disposed (Mathur et al., 2012).

Safe disposal of the infectious (hazardous) medical waste is the prime responsibility of the hospital management. In most of the hospitals and other medical treatment related laboratories/facilities, etc. the medical (infectious) waste is mixed with the municipal waste at many stages of its disposal, either due to negligence or due to inability to finance the heavy cost of collection and disposal of such waste. This is resulting in compromises in the management of hospital infectious waste disposal which can impose serious health hazards not only to the patients but also to the health service providers. Open dumping and burning of medical waste, increases the risk of spreading infections. These are some of the important reasons in occupational health and for worker's safety as an important component of hospital management plans. The main objective of proper management of hospital waste is to minimize the chances of

risks for human health and environment both within and outside healthcare facilities. At the point of generation, waste segregation preferably into hazardous and non-hazardous, reusable and non-reusable components needs to be ensured as first step (Johannessen *et al.*, 2000). Similarly, rare use of safety equipment and lack of training of MWCs also lead to inadequate and improper handling of waste which poses serious environmental consequences and negative impact on the public health (KHAN et al., 2013).

According to international estimates of hospital waste, 0.5kg of infectious waste is produced per bed. Different studies in Pakistan estimated that on average around 1.35 kg to 2.07 Kg of waste is produced per bed per day out of which 0.1 to 0.5 kg is considered as infectious waste (Arshad *et al.*, 2011). Using the estimation averages, the 7,761 major health institutions (1,201 Hospitals, 5,829 Dispensaries, 731 Maternity & Child Health Centres) produces 246,694 kg of total waste per day, out of which 61,683 kg or 25% is infectious waste. The area/province wise distribution of major health institutions with number of beds and waste production estimates are given in table 1. Adding 675 Rural Health Centers and 5464 Basic Health Units, the total number of health institutions comes to 13900 with total number of 140322 beds during the year 2016 in Pakistan which produces 25609 tons of waste annually. In Islamabad, the federal capital, there are 95 major health institutions, comprising 9 hospitals, 83 dispensaries and 3 M&CH Centres. The total waste generated by these institutions is estimated at over 5000 kg/day (waste generated at rural/basic health units is not included). The waste collection, segregation and disposal practices vary from institution to institutions, rarely found in conformity with the international WHO guidelines/standards and the guidelines of the Pakistan Environmental Protection Agency.

Table 1: Waste by Major Health Institution in Pakistan (2016)

Area/Province	Hospital (No's)	Dispensaries (No's)	Maternity Centers	Bed	Waste (Kg/day)	
					Infectious	Non-Infectious
Federal	9	83	3	2523	1262	3785
Punjab	368	1325	280	57648	28824	86472
Sindh	427	2912	221	33744	16872	50616
Khyber Pakhtunkhwa/FATA	270	915	131	21908	10954	32826
Baluchistan	127	567	96	7541	3771	11312
Total	**1201**	**5829**	**731**	**123364**	**61683**	**185011**

Source: Pakistan Bureau of Statistics and authors own estimation. Based on international average estimates @ 2kg/bed (infectious o.5 kg/bed and non-infectious 1.5 kg/bed)

The cost involved in waste disposal and its management may be of two types, i.e. direct cost specifically incurred on its disposal and indirect cost in the shape of cure of diseases and environmental degradation caused by improper waste disposal. The later may not be easily quantifiable. However, if adequate financial resources are allocated for health care waste management it will save a lot of resources beard by the society on morbidity, mortality and environmental damages. Apportionment of essential budget for hospital waste would ensure effective and sustainable hospital waste disposal management system. Majority of the hospitals and health care institutions do not maintain proper/separate accounting and budgeting documents to ascertain the cost incurred in managing wastes disposal activities. Albeit many hospitals due to paucity of financial resources attempt to find cost effective but more reliable treatment and disposal method for the waste they generated (Lee *et al.*, 2004). Proper segregation at collection stage of waste into infectious and non-infectious would lead to reduction in the treatment costs. Various technological solution such as shredding

and sterilization of the infectious waste before its disposal with municipal waste is already used in some of the hospital while majority of them uses the conventional incineration technologies.

Cost effectiveness of various technological solution of waste disposal vis-à-vis the environmental safety aspects are of paramount importance in any hospital waste management system. Consideration of not only the capital but operational cost of hospital waste management is of equal importance, particularly for long term sustainability of the system. Capital costs are one-time fixed investment incurred on construction of building, purchase of land and installation and procurement of incineration plant, vehicles and equipment required for waste disposal. Operating cost includes labour wages, consumable items, fuel costs, utility bills and depreciation or other routine maintenance cost. The analysis of capital and operating cost differential of various available technology options enable hospital management to opt for cost effective solution in selecting waste disposal technology/system.

1.3 State of Waste Management in the Case Study Hospitals

Two major hospitals, the Pakistan Institute of Medical Sciences (PIMS) and the SHIFA International Hospital has been selected for the study to represent the public and private sectors, respectively. According to the Ranking WEB of Hospital, the SHIFA International hospital is ranked 4th in Pakistan and 3760 in the world while the PIMS is ranked 7th in Pakistan and 5911 in the world. The PIMS, a public-sector hospital, has presently 1200 beds capacity with anticipated increase to 1800 beds in the next two years. The total waste produced in PIMS is about 2400 kg/day out of which 600 kg is infectious (0.5kg/bed/day) and remaining is non-infectious waste. The SHIFA International Hospital (SIH) a private-sector hospital is in operation since June 26,

1993. The Hospital has 600 beds with quality care and OPD facility in different specializations is one of the major private hospital in Islamabad. The total waste produced in SHIFA hospital, based on the average criteria of estimation is thus about 1200 kg/day out of which 300 kg/day is infectious.

The SHIFA International Hospital Complex has established its own incineration plant. The PIMS also has used to have its own incineration facility which has presently been disbanded and non-operational. In PIMS, the waste is segregated and collected at ward level and dumped/stored in a temporary container, from where the same is transported by a private company to its waste disposal plant (incineration facility) situated some 50 km away from near Fateh Jhang. Both the institutions claim that the Pak-EPA (Environmental Protection Act 2005) rules and WHO guidelines for waste disposal are followed to the possible extent with efforts to use proper technology and management plan for hospital waste disposal. They are also cognizant about the impact of training of waste collectors and the required safety measures which make them less vulnerable to the infectious diseases. According to Pakistan Environmental Protection Act 2005 Hospital should confirm that sanitary staff and sweepers are not involved in waste segregation, collection and disposal and that they only handle waste bags and containers in the correct manner. Hospital should ensure that emergency procedure is available at all times and that all staff members are aware of the action to be taken by them; investigate, record and review all incidents reports regarding hospital waste management and record the quantities of waste generated by each department on a weekly basis.

1.4 Problem Statement

Various types of waste generated by hospitals in Islamabad is increasing in quantum over the years. Besides a threat to public health and environment, it is risky for the health personnel who handle these wastes. The workers who are involved in segregation, collection and disposal of the waste generated by different departments of hospital are facing serious occupational hazard because of their exposure to infectious human blood, body fluids and sharp injuries. The issue becomes more serious due to lack of proper attention by the concerned authorities in implementing Pak-EPA rules and WHO guidelines for hospital waste disposal in public and private hospitals in Islamabad. In addition, lack of awareness among workers, basic training and use of protective devices and proper incineration technology made MWCs more vulnerable to health hazards.

Due to mismanagement of medical wastes generated from hospitals, nosocomial infection is caused by viral, bacterial, and fungal pathogens. The MWCs are also exposed to other potential risks which include physical injuries because of sharp needles, surgical blades and other disposable surgical instruments. Such injuries can cause serious diseases such as HIV and hepatitis virus B and C (WHO 1999). The general situation of medical waste management in health institutions of Islamabad is poor as all type of wastes are collected, stored and disposed of improperly. Waste carts full off hazardous and non-hazardous waste are left open in corridors and walkways. Cases of MWCs exposure to infectious diseases caused directly or indirectly by improperly managed hospital waste is on the rise which warrants assessment of its impact on health of MWCs for remedial actions.

1.5 Objectives of the Study

The objectives of the research are to:

i. Examine the impact of hospital waste management on the health of medical waste collectors (MWCs) involved in the waste disposal process.

ii. Analyze the hospital waste management practices, cost effectiveness and environmental safety of the technology used by sample hospital in public and private sector in Islamabad.

1.6 Significance of the Study

The study is of great significance in identifying the risks and impacts on the medical waste collectors who are exposed to various health problems and diseases which otherwise goes unattended. Analysis of hospital waste management system comprising collection, treatment and disposal of waste, particularly, the hazardous medical waste is of great importance from environmental and public health points of view. The study aims to investigate the negative impacts on the public health, particularly, on the health of workers involved in segregation, collection, treatment and disposal of medical waste. The study will also contribute to the literature by comparing the cost effectiveness of different hospital waste management practices and technologies, besides highlighting health and environmental safety issues involved. The study will suggest measures for improvement in the hospital waste management and disposal system, with particular focus on impact of hazardous / infectious waste on the health of those workers involved in the collection, treatment and disposal of hospital waste.

1.7 Research Gap

The literature review finds many research gaps in estimation of waste, methods of disposal, cost and impacts on health of workers and other people involved in the disposal of waste. Different studies use the average estimates for waste per bed/patient on the basis of international averages. In Pakistan, very few studies undertaken so far in the respect also uses the same average estimates and no effort has been made to estimate the real hazardous waste per type of hospital and type of patient. The present study, particularly, in the case of PIMS has tried to estimate per patient/bed hazardous waste in different wards/departments such as maternity, burn centre, children hospital, cardiology centre and general hospital, etc. Thus, the study is a step forward in the right direction to reduce the research gap in the estimation of waste to some extent. However, further intensive research is needed to estimate hospital and patient wise waste to provide better yardstick for devising collection and disposal methods by the hospital management.

CHAPTER-II

LITERATURE REVIEW

2.1 Overview of the Chapter

Medical waste is generated while delivering health care services to patient in hospitals, clinics and laboratories. The infectious medical waste directly affects the nearby community and the workers involved in collection, segregation and disposal process and the environment. The environmental and health impacts of hospital waste is widely discussed and thus abundant of literature is available in this filed. This chapter review, highlight and discuss the theoretical and practical issues involved in hospital waste management, its treatment and disposal from various perspective.

2.2 Hospital Waste - Types, Magnitude and Management

Hospital waste, also referred as health care waste or bio medical waste has been differently defined by various author's according to its types, magnitude and its health and environmental impacts. Hospital waste is divided into two broad categories of wastes, i.e domestic type of waste usually referred as municipal waste and medical waste. The medical waste is further characterised as infectious and non-infectious waste. Medical waste is that waste which is generated in the process of patients diagnose, treatment or surgery for cure. Infectious waste is a part of medical waste which is generated as a result of contact with an infected patient and the residue material used in his treatment (Altin *et al.*, 2003). The waste generated during diagnosis, treatment or immunization of human beings or animals is usually referred as biomedical waste or simply medical waste (Babu *et al.*, 2009). The term health-care waste includes all the waste generated within health-care facilities, research centres and

laboratories related to medical procedures (WHO 2014). According to PAK-EPA (Hospital Waste Management Rules 2005) Hospital waste is defined as the waste which include both risk waste (infectious) and non-risk (non-infectious) waste. Waste which is contaminated by any type of pathogens like viruses, bacteria, fungi or parasite or equipment which were used for infected patient are called infectious waste. Non-infectious waste includes paper, cardboard, packing, food from kitchen and the like.

The total medical waste in Pakistan, on the average is estimated in the range of around 1.35 to 2.07 kg/bed/day. The term waste per bed and waste per patient is used sometimes interchangeably in various studies. Due to lack of segregation process and collection by unconcerned hospital staff resulting in many infectious diseases and also if it is not dispose properly it will degrade the environment (Kumar *et al.*, 2013). Domestic waste (non-hazardous) produced by hospital ranges between 75% to 90%. It includes administrative, kitchen and residual wastes of maintenance work related to hospital buildings, etc. The rest 10–25% of waste is considered as infected and thus hazardous to cause various health risks and environmental risks to general public and HCWs (WHO 2014). Now a days the major issue is non implementation of bio safety rules as some of the hospitals dispose their waste improperly (Mathur *et al.*, 2012). If the waste is properly segregated like (infectious, Kitchen, etc.) then the operational cost and investment on the incineration plant will decreased (Altin *et al.*, 2003). The awareness and education about the health and environmental risks of handling infectious hospital waste should be the prime concern of any health care institution. Proper education of staff, worker, patient and community as whole with standard disposal including storage and transport system should be a key component of any waste management plan (Babanyara *et al.*, 2013). Hospital waste management includes four steps. These steps if followed accurately will achieve effective management which

include low operational cost. The steps are segregation, storage, onsite/off site treatment and final disposal (Shreedevi). Lack of incineration facility in hospital will give free hand to scavengers to collect the infectious waste which will risk their health as well as of community (Kumar *et al.*, 2013). The study further estimates that total amount of hospital waste produced in Pakistan is 250,000 tons per annum which require proper treatment before disposal to ensure safety to the health and environment of all concerned and involved in this activity (Kumar *et al.*, 2010).

A study conducted in Peshawar, the capital of the Khyber-Pakhtunkhwa province in Pakistan, revealed that limited facilities for waste disposal like incineration, burial and burning are available. According to the study disposal of waste by burial is the most common method constitute about 87% of the hospital waste disposal while the rest 13% is burned in the open air. The method of incineration is used in 33% of the surveyed hospitals, however, no proper facility for disposal of radioactive waste was noted. In some cases about one third of the radioactive waste is generated in the hospitals are picked up by the supplier while the rest of the dangerous waste is left with no proper disposal mechanism (Amin *et al.* (2013).

2.3 Hospital Waste - Effect on the Health of Workers

Various types of health workers are involved in collection, segregation and final disposal of hospital/medical waste. Such workers are directly exposed to various negative effects, particularly of infectious hospital waste (Alemayehu, 2015; Babanyara *et al.*, 2013). The waste products generated by hospitals are reservoir of viruses and pathogens microorganisms, which can give rise to infections and cause contamination (Soliman *et al.*, 2007). Different studies have identified various health related risks and effects on the worker's health directly and indirectly involved. Like a study done by

Altaf *et al.* (2002) said that Infectious waste cause different type of infections and diseases because of pathogens and viruses present in the waste. Akter *et al.* (2002) done a study in Bangladesh found results after interviewing some of the workers were suffering from TB, malaria, hepatis B and C, diarrhoea and skin infections The pathogens present in infectious waste cause diseases like HBV, HCV, Human immunodeficiency virus and infections like skin, respiratory and gastro infection (Moro *et al.*, 2007; Prüss‐Üstün *et al.*, 2005). If the disposal of hospital waste is not properly managed, there are chances of certain high-risk practices such as reuse of nonsterile needles and syringes with high risk of transmitting disease. The WHO estimates that about 8-16 million cases of HBV infection, 2.3 to 4.7 million cases of HCV and about 0.16 million cases of HIV infections occur mainly due to the use of unsafe injections globally.

The diseases and infections are transmitted through sharp injuries from needles and other sharp instruments used in operations contaminated with infectious human blood or through wounds which are uncovered and exposed to infectious waste (Pandit *et al.*, 2008). The percentage of workers who were injured with needle stick was 58.7% in Eastern Ethiopia, and in India 52.2% workers were injured by needle stick (Alemayehu, 2015; Pandit *et al.*, 2008). According to WHO (2014) Pathogens and viruses present in the infectious hospital waste can enter human body through different routes for example cut in the skin, by inhalation, ingestion and through mucous membrane. If the infectious waste is not managed properly, the microorganisms present in the waste can be transmitted to human body by direct contact, through air or by different vectors and poses serious threat to both workers and environment (Soliman *et al.*, 2007). Approximately, 0.327 million, 2.1 million, and 0.926 million MWCs are annually exposed to sharp injuries contaminated with HIV, Hepatitis B (HBV) and

Hepatitis C (HCV) virus, respectively (Prüss-Üstün et al., 2005). In case of an accidental needle stick from an infected patient, there is 5-30% chance for the recipient to be infected with hepatitis B and 3% for hepatitis C infection. The probability of risk of HIV infection is relatively less (around 0.3%) in cases of contaminated needle stick injuries (Organization, 2002). The high prevalence of hepatitis B and C infection, particularly, among the health care workers is commonly associated with the unsafe disposal of contaminated needles and syringes. A study conducted in Karachi, the capital of the Sindh province in Pakistan, about 20% of the sanitary staff of and medical centre were found infected by hepatitis B mainly due to unsafe disposal of medical waste (Mujeeb *et al.*, 1994). Similarly, cognizant to avoid the risk about 60% of the janitors and sanitary staff in the medical care institution were immunized against common communicable diseases (Amin *et al.*, 2013).

To maintain satisfactory hygiene essential component is safe disposal of medical waste. The waste generated should be collected in puncture proof, waterproof and animated bag showing infectious sign on it. The recommended method for disposal of sharp items responsible for causing injury are tamper-proof and puncture-resistant containers. The soft (liquid) wastes may be disposed in thick-walled plastic sacks capable of protection against penetration by sharps or spillage of fluids (Blenkharn *et al.*, 2008). Use different coloured coded bags/containers for different type of waste generated (WHO 2014). According to Pakistan EPA rules 2005 hospital should not store its waste for longer than twenty-four hours in its premises either it should be disposed with incinerator or other treatment device. A study carried out in Bahawalpur, one of the major city in southern Punjab province of Pakistan, the medical waste management practice observed in 48 hospitals (24 public and 24 private sector) reveals that the case of public sector about 50% hospitals segregate medical waste from other

waste stream while in case of the private sector only 17% do the segregation of waste before disposal. The overall segregation practices, like separate area for segregation proper containers for segregation, colour coding for different types of waste and use of protective measures by waste collector was relatively found better in the public sector health facilities as compared to the private sector, probability due to affordability of cost of waste disposal (Badar *et al.*, 2014).

Due to unplanned and mismanagement of hospital waste risks general public, HCWs, patients and environment. Open dumping and uncontrolled burning of hospital waste increases the risk of spreading infections. The issue of safe disposal of hospital waste, particularly, the infectious and hazardous waste is of prime concern in Pakistan as in most of the cases proper waste disposal management system is not in vogue. There is lack of awareness and education about the health and environmental risks involved in improper waste disposal and its economic and social consequences beard by the society as a whole. It is commonly observed that the without observing the risk, the hospital waste is either dumped at community waste sites 'kuchra kundis' or sold directly to the dealers of the junk 'kabaris', i.e., usually disposed with municipal waste without segregation. The situation turns more dangerous when scavengers driven by extreme poverty and ignorant of health risks are seen involved in sorting and handling the infected materials at community waste sites including syringes, infusion and blood bags to sale it to junk dealers who provide a potential market for recycling business. Plastic industry is the major buyer of used syringes, infusion and blood bags for recycling which again unhygienic. Anything (waste) left is either taken for final disposal by municipal authorities in open trucks or burned in a smouldering fire, polluting the environment. It can also be observed that straw dogs, cats and even birds in search of their food, found easy to gather at the community waste sites that further

causes dispersal of the infectious materials in the open (Altaf *et al.*, 2002). The common method of open burning or through incineration by the hospital located in the densely populated urban area poses a risk not only to the workers involved in such disposal activities but to all the population residing nearby due to the chemical exposure including halogenated hydrocarbons such as dioxins and furan generated from the combustion of biomedical waste (Soliman *et al.*, 2007). For these reasons, HCWs safety should be the first priority of hospital waste managements (Johannessen *et al.*, 2000). Awareness, education and continuous supervision and monitoring of hospital waste disposal is required at each level to tackle the issue. The hospital administration should prepare proper waste manmgnet plan and ensure its implementation to avoid the health and environmental hazards faced by the workers involved in disposal and the community as whole (Kumar *et al.*, 2015). Almost all the hospitals need to make proper management plan to handle and dispose off the waste (Akter *et al.*, 2002). Due to non-segregation of infectious waste from the general wastes results potential risk to HCWs and the general public. Healthcare wastes are not properly managed and do not comply with Environmental Management Act, Public Health Act, and WHO recommended guidelines. By the provision of education and proper training to HCWs will built a strong base of knowledge among them which will protect their self's as well as patients and the environment (Kuchibanda *et al.*, 2015). Time has come to prioritize talking problems associated with proper disposal of hospital waste through awareness about the health hazards, adequate training in waste management disposal systems and provision of sufficient financial and human resources by all the public and private sector hospital administration (Babanyara *et al.*, 2013).

CHAPTER-III

CONCEPTUAL FRAMEWORK OF THE STUDY

3.1 Overview of the Chapter

The process of development of the conceptual framework of the research study is explained in this chapter. The chapter highlights various aspects of the framework in discussing the causes and interrelationships of the waste disposal system and the impact and consequences on the health of the workers involved in this process.

3.2 Causes and Consequences of Hospital Waste

Major reasons which cause these hazards are not following infection control procedures, not using proper equipment and not following the proper procedures of collection, transportation, storage and disposal. Recycled products are also posing serious health risks not only to workers but also to the consumers who are using them (Punjab Health Sector Reforms Support Project). Lack of awareness among the HCWs handling the waste is becoming a major problem. mainly non-Muslims workers handle the waste majority of them are not proper trained with low level of knowledge regarding protective measures, waste types and steps of handling the waste (MUSTAFA *et al.*, 2008).

The first and essential step to minimize the process of infection transmission is training and capacity building of HCWs. Training of workers lead to knowledgeable workforce, which will reduce the ratio of infection. Informed workforce can also help the visitors and patients in maintaining good hygiene. Proper segregation practice prevents risk waste to get amalgamated with non-risk waste. Waste stored in piles at different places attract different vectors, e.g. mosquitoes and flies. It can also cause

environmental degradation, unpleasant smell, and growth of insects like mosquitoes and flies, rodents and worms; diseases like typhoid, cholera, Tuberculosis, Hepatitis A, B and C are transmitted to HCWs through injuries from sharps contaminated with human blood (Muduli *et al.*, 2012). HCWs, patients and surrounding communities are associated with health hazards generated by healthcare facility operation.

Two types of technologies viz, incinerator based and non-incinerator based are used for hospital waste disposal. The incinerator is a type of furnace for burning waste material at a very high temperature until it becomes ash. During the process various pollutants (acid gases like hydrogen chloride and sulphur dioxide, carbon monoxide, nitrogen oxides and hazardous dioxins and furans, metals like lead, mercury, and cadmium) are released into the air. These emissions of pollutants have serious adverse consequences on worker health, public health and the nearby environment. Negative effects of dioxins on human health are cancer, immune system disorders, diabetes, birth defects, and other health effects. Medical waste incinerators are a main source of dioxins and mercury in the environment (Non-Incineration Medical Waste Treatment Technologies 2001). After final treatment of infectious waste material, the residual waste is disposed with municipal waste. In less developed countries where disposal technologies for treating the waste are not available use direct landfilling or it is openly burnt around the facility grounds.

There are six elements through which infectious disease can be transferred. These are Infectious agent, reservoir, portal of exit, mode of transmission, entry portal and susceptible host. For occurrence of the disease each element should must be present similarly a good waste management system can prevent the occurrence of the disease and will help in breaking the chain of these elements.

3.3 Disease/infections from waste - its Channel and Symptoms

The total waste generated in hospitals generally consists 10-25% infectious waste such as sharps instrument (needles, scalpels, blades, knives, saws, broken glass and pipettes), blood and other body fluids. The infection and diseases are transmitted through the used dressings, bandages, swabs, gloves, masks, gowns and other materials contaminated with blood or other body fluids. The disease/infection channel and symptoms are depicted in table 2.

Table 2: Disease/Infection Channel and Symptoms

Disease/ Infection	Channel	Symptoms
Gastro infection	By ingestion	Diarrhea, Nausea, Vomiting Headache, Low-grade fever
Respiratory infections	By inhalation	Cough, Fever Nasal breathing, scratchy or sore throat
Eye infection	Through infected hands touching eyes	Redness or small red lines in white of eye Tears, Swollen eyelids
Skin Infection	Cut in skin, puncture or abrasion	Rash and itchy, dry or cracked skin or skin allergy
AIDS	Body or blood fluid, infected sharps, etc.	Fever, Chills, Rash, sweats at night, aches in muscles, Sore throat, Fatigue, swollen lymph nodes, Mouth ulcers
Hepatitis	Body or blood fluid, infected sharps, etc.	Nausea and Fatigue, less appetite, pain in belly, a mild fever, skin or eyes yellowness
Back Pain	Non-availability of equipment	Chills & fever, weight loss and weakness in legs
Headache	Spent frequent time at waste disposal site	Dullness, head ache, tightness or pressure across forehead or on the sides and back of head, Neck and shoulder muscles tenderness

Sources of Symptoms:

http://www.mayoclinic.org/diseases-conditions/viral-gastroenteritis/basics/symptoms/con-20019350
http://www.medicinenet.com/upper_respiratory_infection/article.htm
http://www.medbroadcast.com/condition/getcondition/eye-infections
http://www.healthline.com/health/skin-disorders
https://www.aids.gov/hiv-aids-basics/hiv-aids-101/signs-and-symptoms/
http://www.webmd.com/hepatitis/ss/slideshow-hepatitis-overview
http://www.spine-health.com/conditions/lower-back-pain/lower-back-pain-symptoms-diagnosis-and-treatment
http://www.mayoclinic.org/diseases-conditions/tension-headache/symptoms-causes/dxc-20211470

3.4 Cost of Waste Collection and Disposal

Consideration of not only the capital but operational cost of hospital waste management is of equal importance, particularly for long term sustainability of the system. Capital costs are those which are accrued only one time and operational cost are costs incurred in the management of hospital waste (WHO 2014). Capital cost include waste treatment technology, vehicles, construction of waste storage site, and room or building for treatment machine. Operating cost includes labour wages, consumable items, fuel costs, utility bills and depreciation or maintenance cost. The capital and operating cost differential analysis of various technologies is undertaken to recommend cost effective solution for waste disposal.

Table 3: Cost Component of Waste Disposal System

Capital Cost	Operating costs
Treatment plant incinerator	Training
Cost of Equipment	Safety equipment and Uniforms
Bag holders located at all sources of waste	Disposal cost after treatment
Land cost	Utilities (fuel, water, electricity)
Building Construction Cost	Maintenance and parts replacement

3.5 Technologies used in waste Collection and Disposal

The technologies used in waste collection and disposal are categorised into two types, i.e., incinerated based technologies and non-incinerated technologies. Non-incinerated technologies are further classified according to technology price, waste amount, and size. The processes involved in non-incineration are chemical, thermal, irradiative and biological process.

3.6 Processes and Procedures in waste Collection and Disposal

Different process and procedure is employed in the disposal of different type of waste. For instance, body wastes are destroyed either by incineration under high temperature from 800 to 900 degrees centigrade or buried under the soil. The process of incineration at high temperatures results in emission of gasses into the air. The pollution control measures are required by deploying proper equipment not only for measurement of the pollutant but also to reduce the pollutants before their entry into the open air. The incinerator of adequate size, capacity and type are required according to the type and quantity of the waste generated in a particular hospital. In case of inadequate burning, or incomplete burning process, or inadequate retention period some arsenic, mercury, lead besides some dioxins or furans particles are evaporated in to the air.

The procedures for chemical disinfection or sterilization is done through the use of autoclave, irradiation or microwave equipment. The residue in the shape of ash is disposed at secure landfill. In rare cases, after complete disinfection, some or major parts of residual wastes is recycled such as thick plastics is recycled and re-use in manufacture of arterial bags, tubs and syringes. A lot of waste is generated in the shape of un-used, partially used or expired pharmaceutical. Such redundant pharmaceutical is considered as a type of waste need a proper procedure for its disposal. Such waste is to be properly disposed either through incineration, or through land fill by the institutions themselves or in some cases are return to the manufacturer for disposal/destruction through chemical or incineration methods by them. Various methods and process including but not limited to incineration, stabilization, neutralization etc. are employed for the disposal of chemical wastes. Some parts of such waste are segregated according to their recycling potential and compatibility and the rest is disposed. Another type of

waste generated during the medical process is wastewater. Such liquid waste requires treatment through anaerobic digestion, composting and then incineration processes. However, in such cases proper temperature level is required to ensure destruction of pathogenic microorganisms.

Medical therapy and diagnosis by radioactivity process are common developed countries where the disposal process is divided into two categories. These are called open sources and sealed sources. In the open source, radiochemical substance is derived from direct use and in the case of sealed source indirect use of the substance is involved which is sealed in the apparatus or the equipment unit. While the sealed sources are secure as the substance (isotopes) is returned to manufacture where they recycled or destroyed as per their standard procedure. The radioactive waste in the case of open sources disposal require careful process and procedure. However, such wastes are not commonly found in the hospitals where the technology and equipment that generate these wastes are not in use. In any case, such wastes, if generated, should be stored safely until the radioactivity has decline to acceptable levels. After that the residue may be disposed with general sanitary landfill or another specified site. The disposal process and methods are summarized in Table 4.

Table 4: Disposal Process by Type of Waste

Type of Waste	Items	Disposal Process
A. Infectious or Risk Waste		
Sharp Waste	Broken glass and any other items such as Needles, Syringes, Scalpels, Infusion sets, Saws and knives, Surgical blades that can cut and puncture	Autoclaving Incinerate
Human body Waste	Body tissues and organs, body parts, (unborn vertebrates), blood and other body fluids	Incinerate
Pharmaceutical Waste	Expired, unused or partially unused pharmaceutical products, spilled or contaminated pharmaceutical products, surplus drugs, vaccines or sera, discarded items used in handling pharmaceutical such as bottles, gloves, masks, tubes, etc.	Incinerate
Genotoxic Waste	Drugs and outdated material. Vomiting or urine from patients treated with cytotoxic drugs or chemicals. Contaminated materials from the preparation and administration of the drugs such as syringes, vials, etc.	Chemical Treatment,
Chemical Waste	The residual chemicals released during the diagnostic or experimental work, cleaning processes, housekeeping and disinfecting procedures. It also includes mercury waste such as from broken clinical equipment spillage. Waste from discarded batteries.	Chemical Treatment
Radioactive Waste	Include liquid, solid or gaseous waste contaminated with radio nuclides generated from outside analysis of body tissue/fluid or during body organ imaging and tumours localizations during investigations and therapeutic procedures	Safe storage till the radioactivity is vanished or reduced to satisfactory levels and then disposed in landfill
B. Non-Infectious or Non-Risk Waste		
Office Waste	Paper and cardboard, Packaging, etc.	Incinerate, Re-use if not contaminated
Kitchen Waste	Left-over food, fruit and vegetable peelings	Landfill

Source: WHO (2014), http://www.aboutcivil.org/hospital-waste-types.html#seg and authors own observation in selected hospitals.

CHAPTER-IV

DATA COLLECTION METHODOLOGY

4.1 Overview of the Chapter

The data collection process and methods used in the research study is explained in this chapter. The study area, sample size and other required parameters including the econometric model for the research study are elaborated in this chapter.

4.2 Study Area

The study area selected for this research is Islamabad – the capital city of Pakistan with total area of 906.50 square kilometres having population of 1.365 million (2015). The 10th largest city in Pakistan, Islamabad is located 33.43°N longitude and 73.04°E latitude at the foot of the Margalla Hills. This well-planned city replaced Karachi as capital during 1960s. The present bed capacity with future projections of major hospitals in the public and private sector located in Islamabad, besides several clinics, dispensaries and other small health facilities are given in table 5.

Table 5: Health facilities in Islamabad Bed Capacity

Sr. No.	Major Hospitals	Capacity (Nos. of Bed)	
		Present	Projected
1	Pakistan Institute of medical sciences	1200	4000
2	Federal Government Services Hospital	500	1000
3	National Institute for Handicapped	200	400
4	National Institute of Health	50	100
5	Capital Hospital	500	1000
6	KRL Hospital	500	1000
7	PEAC Hospital	50	100
8	Pakistan NAVY & PAF Hospital	1000	1000
9	NORI	100	200
10	SHIFA International Hospital	600	1000
11	MAROOF International Hospital	100	200
12	Kulsum International Hospital	200	500
13	Quaid-e-Azam International Hospital	400	500

14	Other Small Health Facilities - Ali medical Center - International Medical - Ali Hospital - Surgical Center - Darul Shifa - Haider Clinic - Islamabad Private hospital - Different Private Clinics - CDA, FGSH Dispensaries	500	1000
	Total Number of Beds	**5900**	**12,000**

The Pakistan Institute of Medical Sciences (PIMS) one of the major public-sector hospital and the SHIFA international a major private sector hospital is selected for the comparative study of public and private sector. PIMS is located in sector G-8/3 of Islamabad. Objectives of PIMS are to provide a tertiary level patient care and serve as referral hospital and also to conduct teaching and training of doctors and other health workers at various level in the field of medicine and surgery. Since its opening in 1985, PIMS has been expanding its services and equipment to meet the growing healthcare needs of human community. SHIFA International is located in sector H-8/4 of Islamabad. SHIFA International is a tertiary care hospital established in 1989.

4.3 Sample Size and Data Collection

A survey of various health care facilities in Islamabad was carried out during the last week of November, 2016. In the capital city Islamabad, there are over 20 hospitals in the public and private sectors (datil given in table 5). According to the bed capacity PIMS is the only major hospital having more than 1000 bed facility. About 10 hospitals comes under level-I i.e. 200 to 500 bedded capacity. Three hospitals with 100 bed capacity comes under level-II. The rest of the hospitals are level-III hospitals with 20 to 50 bedded capacity each. The Pakistan Institute of Medical Sciences complex comprises three major hospitals viz, the Islamabad hospital (over 500 bed capacity), the

Children hospital (242 bed) and the Maternity and child health center (140 bed capacity) is selected to represent the public-sector hospital. The SHIFA International Hospital with 600 bed capacity having almost all the medical departments is selected to represent the private sector hospitals. The number of medical waste collector, the quantity and type of waste generated, the process of waste collection, segregation and disposal is another criterion for selection of the representative of the public and private sector hospitals for the study. Around 150 medical waste collectors are engaged for collection, segregation and disposal of hospital waste in the PIMS and about 300 workers in SHIFA are involved the waste disposal process would form the main target group for sample selection. Various investigation methods such as interviews, questionnaire, filed visit were employed to gather required information on various aspect of the respondents such as personal, social, employment related gender, diseases, and exposure to other health hazards of respondents involved in waste disposal activities. On the basis of the literature review, the existing state of waste disposal management system including processes, technologies and training/safety of workers involved in the selected hospitals are examined.

The data collected from 120 MWCs - 60 each from PIMS and SHIFA International hospitals is analysed with the help of econometric model. These MWCs were selected randomly. A questionnaire was developed for obtaining real time information from the sample respondents. The questionnaire was divided into two parts one is of about medical waste collector's health and other is for hospital waste management. Structured and semi structured interviews with the hospital administration/ management and other respondents were also employed to gather real time information.

4.4 Econometric Specification of the Model

In order to estimate the impact of Hospital waste on Workers health; the following regression model is used:

$$\mathbf{WH} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1}\mathbf{A} + \boldsymbol{\beta_2}\mathbf{LPT} + \boldsymbol{\beta_3}\mathbf{H} + \boldsymbol{\beta_4}\mathbf{EDU} + \boldsymbol{\beta_5}\mathbf{PE} + \boldsymbol{\beta_6}\mathbf{SI} + \boldsymbol{\beta_7}\mathbf{Exp} + \boldsymbol{\beta_8}\mathbf{VS} + \boldsymbol{\mu}$$

4.4.1 Description of Variables

In the above model, **WH** is the workers' health as a dependent variable. The dependent variable will take value 1 if the respondent experienced at least one of the diseases (mentioned in table in last one year attached in questionnaire in appendix). For the binary response (i.e. if the disease occurred or not), linear probability model was used. For the case where we ask about the frequency of disease occurrence (i.e. the number of times the responded was affected by the disease in last one year), Negative binomial regression model was used. For robustness, we estimated the model for each of the disease. In the second model, we estimated the impact on numbers of times the respondent experienced the disease. The independent variables are as follows:

A = This variable shows the age of the medical waste collectors. The variable age is in years. Age expected to have a significant impact on the worker's health. Workers health is affected more as the worker is old age.

LPT = This variable shows weather or not professional training received by the workers. It also shows the type of training and duration of training received. In training received 1 was given to "yes: and 0 was given to "no".

H= This variable indicates the association of worker with the hospital. If worker is from public hospital, which is PIMS, then 1 is assigned and 0 is assigned to the worker of private hospital which is SHIFA international.

EDU = This variable shows that how much is the worker educated. Education is divided into four categories; 0=illiterate, 1=primary, 2=middle, 3=matric and above as follows.

PE = This variable shows the availability, its use, and quality of protective equipment to workers. Worker were asked about five protective equipment their availability, use and quality. The responses were binary with 1=yes and 0 otherwise.

SI = This variable shows weather workers were injured with sharp injuries yes=1 or no=0. It was further elaborated into different sharps and injury occurrence.

EXP = This variable shows the duration of exposure of workers to waste. It was estimated in hours.

VS = This variable shows the vaccination status of workers (yes=1 or no=0)

CHAPTER-V

RESULTS AND DISCUSSION

5.1 Overview of the Chapter

This chapter concludes the results of the regressions used for the analysis of impact of hospital waste on worker's health. Before the results and interpretation, we presented and discussed the descriptive statistics and analysis of data.

5.2 Descriptive Statistics

Descriptive statistics analysis is used to demonstrate various aspects of the respondents with regard to their demographic characteristics including age, education and length of service, besides the level of exposure to diseases and the extent of impact on the health of workers due to morbidity/illness. A total of 120 MWC's were the respondents in this study where 60 from PIMS Hospital and 60 respondents from SHIFA International Hospital were interviewed. Table 5.1 shows various aspects of the demographic characteristic of the respondents. The comparison of respondents by gender between the sample respondents from the two hospital reveals that while male workers predominates (80%) over female workers in PIMS, in SHIFA no female workers is employed as waste collector. The reasons behind this trend is that in PIMS, the employment of workers is on permanent basis by observing the official quota. In the case of SHIFA, the employee's status is contractual. The average age of waste collector workers in the PIMS is over 40 years and in the SHIFA hospital it is 35 years. The education level of waste collectors in both the hospitals are quite different. About 50% of the respondents in PIMS are illiterate, 23% have primary, 10% have middle and 15% have matric level education. The education level in the case of SHIFA hospital is

better with only 20% illiterate, 33% have primary, 30% middle and 15% have matric or high level of education. The average length of service of the waste collectors in the PIMS hospital is 18 years and in the case of SHIFA it is about 8 years due to contractual nature of the job.

The incidence and status of prevalence of various diseases observed during the study shows that the prevalence of worker illness of any kind of disease is highly significant in PIMS hospital as compared to SHIFA International Hospital. The chances of illness of waste collection workers of PIMS hospital is 31% more as compared to the workers of SHIFA International hospital. The incidence of diseases analysis reveals high incidence in Skin, TB, Hepatitis C and Back pain of the symptom of illness in the case of PIMS waste collectors/workers than SHIFA hospital, probably due to comparatively better management of waste.

In addition, to the probability of illness, the frequency of illness in the last one year is also significantly higher in PIMS. The incidence and frequency of diseases along with other socioeconomic and demographic characterises of health workers in the two hospitals are provided in table 6 and table 7, respectively.

Table 6: Demographic and Service Characteristics of the Respondents and Analysis of Incidence of Morbidity Status of the Respondents

Variable	PIMS Mean and (S.E)	SHIFA Mean and (S.E)	Difference
Demographic and Service Characteristics of the Respondents			
Gender	0.816	1.000	-0.183***
	(0.050)	(0.000)	(0.050)
Age	41.08	35.13	5.95***
	(0.958)	(0.735)	(1.208)
Education (Illiterate)	0.516	0.216	0.300***
	(0.065)	(0.053)	(0.084)
Education (Primary)	0.233	0.333	-0.100
	(0.055)	(0.613)	(0.082)
Education (Middle)	0.100	0.300	-0.200***
	(0.302)	(0.059)	(0.071)
Education (Matric & above)	0.150	0.150	0.000
	(0.046)	(0.046)	(0.065)
Length of service	18.40	6.850	11.55***
	(0.826)	(0.254)	(0.864)
Analysis of Incidence of illness status of the Respondents			
Worker Illness (1=Yes)	0.516	0.200	0.316***
	(0.065)	(0.052)	(0.083)
Gestro (1=Yes)	0.150	0.083	0.067
	(0.046)	(0.035)	(0.058)
Respiratory (1=Yes)	0.33	0.33	0.000
	(0.023)	(0.023)	(0.016)
Ocular (1=Yes)	0.100	0.050	0.05
	(0.039)	(0.028)	(0.048)
Skin (1=Yes)	0.150	0.000	0.150***
	(0.046)	(0.000)	(0.046)
TB (1=Yes)	0.066	0.000	0.066**
	(0.032)	(0.000)	(0.032)
Hepatitis C (1=Yes)	0.083	0.000	0.083**
	(0.035)	(0.000)	(0.035)
Back Pain (1=Yes)	0.116	0.000	0.116***
	(0.041)	(0.000)	(0.041)
Arm (1=Yes)	0.066	0.050	0.016
	(0.032)	(0.028)	(0.043)
Typhoid (1=Yes)	0.016	0.000	0.016
	(0.016)	(0.000)	(0.016)
Observations	60	60	

Note*** shows that the results are highly significant at 1% level, ** shows that the results are highly significant at 5% level of confidence. Parenthesis shows Standard Error

T-test used for calculation. Dependent variable was Hospital.

Table 7: Frequencies of Incidence of Illness Status of the Respondents

Variables	PIMS Hospital	SHIFA Hospital	Difference
Worker Illness (Frequency)	1.883	0.516	1.366***
	(0.324)	(0.135)	(0.351)
Gestro (Frequency)	0.616	0.216	0.400*
	(0.204)	(0.098)	(0.226)
Respiratory (Frequency)	0.066	0.083	0.016
	(0.046)	(0.059)	(0.075)
Ocular (Frequency)	0.200	0.116	0.083
	(0.081)	(0.067)	(0.106)
Skin (Frequency)	0.300	0.00	0.300***
	(0.104)	(0.00)	(0.104)
TB (Frequency)	0.066	0.00	0.066**
	(0.032)	(0.00)	(0.032)
Hepatitis C (Frequency)	0.116	0.00	0.116**
	(0.053)	(0.00)	(0.053)
Back Pain (Frequency)	0.333	0.00	0.333**
	(0.135)	(0.00)	(0.135)
Arm Pain (Frequency)	0.033	0.00	0.033
	(0.033)	(0.00)	(0.033)
Typhoid (Frequency)	0.150	0.100	0.050
	(0.074)	(0.061)	(0.096)
Sharp Injury	0.500	0.116	0.383***
	(0.065)	(0.041)	(0.077)
Observations	60	60	

*** shows that the results are highly significant at 1% level, ** shows that the results are highly significant at 5% level of confidence. Parenthesis shows Standard Error. T-test was used.

The frequencies of incidence of various diseases are depicted in Table 7. As results in Table 6 show that overall disease ratio was higher in PIMS as compared to SHIFA hospital, so for the conformation that these diseases to worker were from waste, frequencies of diseases are also calculated. In Table 6 four diseases were having higher probability in PIMS same are the results when we calculated the frequencies. So, these two table conclude that with no training, treatment, and technology workers are more vulnerable to diseases in PIMS as compared to SHIFA International. PIMS workers are also having 38% more probability of sharp injuries then SHIFA workers.

The results of the Linear probability model with regard to the probability of illness and Negative Binomial Regressions for frequency of illness prevalent among the workers are provided in is Table 8 and Table 9.

The results of linear probability model and Negative Binomial Regression for frequency of illness as summarized in those table show the incidence of relatively higher occurrence of disease in PIMS is manifestation of low level of education, age, training, and overall poor management of the process of collection, segregation, storage, disposal and transportation of the hospital waste.

The regression analysis results further prove that by controlling the demographic characteristics, the probability of occurrence / incidence of falling sick to skin disease is 13% higher in PIMS as compared to SHIFA but again it can be by chance from any other reason. Hence in order to confirm the robustness of our result we check the frequency of disease occurrence. We found that the frequency of Skin disease, TB, Hepatitis C and Back pain are significantly higher among the workers in PIMS compared to the workers in SHIFA International. But what are the channels for the affect? One possibility is that workers in PIMS are more exposed to sharp injuries and hence are more vulnerable. We confirm this claim in Table 10 (column 1). The results show that the probability of sharp injuries to workers in PIMS is 40% higher and this coefficient is highly significant.

Naturally the next question is that why the probability of sharp injuries is highest in PIMS? Is it because of the unavailability of protective equipment? Or it is because of the non-usage and bad quality of their equipment? The next columns in Table 10 and Table 11 provide empirical evidence on this situation. The results of gloves availability show that there is 11% less probability of availability of gloves in PIMS as compared to SHIFA ,10% less probability that PIMS workers are using gloves; and the probability

of the bad quality of gloves is almost 78%. Both gloves and mask are two important protective equipment in protection against hospital waste borne diseases.

The ratio of availability of mask is less significant and the use of mask is 50% less in PIMS as compared to SHIFA, 13% workers in PIMS respond that quality was not good although this response is not statistically significant. The reason behind not using of mask could be low level of education, training, and overall poor management of the process of collection, segregation, storage, disposal and transportation of the hospital waste. The availability of long shoes is 59% significantly less in PIMS; similarly, usage is also 62% less in PIMS the overall quality was not as bad. Workers who have the protective shoes but may not be using because of less training, education and proper check and balance. Uniform availability is 10 % less and usage is also 41% less in PIMS and no difference between quality was found in the two hospitals.

These results confirm that lack of protective equipment's and its bad quality along with absence of training and check and balance system leads to increase in sharp injuries among the workers in PIMS. This in turn affect their health and leave them more vulnerable. The results for the Linear probability model in respect of the probability of protective equipment and probability of sharp injury among the workers is given in these tables.

Table 8: Linear Probability Model for Probability of Illness

	Overall Illness	Gestro	Respiratory	Ocular	Skin	TB	Hepatitis C	Back Pain	Arm pain	Typhoid
Hospital	0.147	-0.056	0.035	0.080	0.135**	0.130	-0.061	0.002	-0.074	-0.009
	(0.149)	(0.089)	(0.054)	(0.078)	(0.067)	(0.081)	(0.055)	(0.087)	(0.087)	(0.012)
R-Squared	0.158	0.100	0.103	0.041	0.148	0.124	0.128	0.181	0.040	0.092
Observations	120	120	120	120	120	120	120	120	120	120

** shows that the results are highly significant at 5% level, Parenthesis shows Standard Error

Table 9: Negative Binomial Regressions for Frequency of Illness

	Overall Illness Frequency	Gestro	Respiratory	Ocular	Skin	TB	Hepatitis C	Back Pain	Arm pain	Typhoid
Hospital	0.426	-0.425	-2.723	0.573	17.821***	20.256***	16.188***	16.665***	-1.171	1.348
	(0.489)	(1.132)	(2.255)	(1.176)	(0.764)	(1.127)	(1.124)	(1.317)	(1.189)	(1.197)
Observations	120	120	120	120	120	120	120	120	120	120

*** shows that the results are highly significant at 1% level, Parenthesis shows Standard Error

Table 10: Linear Probability Model for Probability of Protective Equipment

	Sharp Injury	Glove Available	Glove Use	Glove Quality	Mask Available	Mask Use	Mask Quality
Hospital	0.399***	-0.113*	-0.206*	-0.779***	-0.0513	-0.508***	-0.139
	(0.142)	(0.636)	(0.118)	(0.114)	(0.049)	(0.132)	(0.123)
R-Squared	0.204	0.074	0.228	0.536	0.089	0.172	0.044
Observations	120	120	120	120	120	120	120

* shows that the results are highly significant at 10% level, *** shows that the results are highly significant at 1% level, Parenthesis shows Standard Error

Table 11: Linear Probability Model for Probability of Protective Equipment

	Uniform Available	Uniform Use	Uniform Quality	Boot Available	Boot Use	Boot Quality
Hospital	-0.108*	-0.416***	0.001	-0.5931***	-0.623***	0.044
	(0.057)	(0.137)	(0.099)	(0.120)	(0.092)	(0.209)
R-Squared	0.093	0.234	0.063	0.497	0.482	0.066
Observations	120	120	120	120	120	120

* shows that the results are highly significant at 10% level, *** shows that the results are highly significant at 1% level, Parenthesis shows Standard Error

5.3 Estimation of Cost on Waste Disposal at SHIFA Hospital

Cost estimates on waste disposal in terms of capital cost and operating cost incurred by the SIFA international hospital has been estimated and the details are given in Table 12 and Table 13 respectively. The total annual cost on the waste collection, treatment and disposal at SHIFA international hospital is estimated at Rs.74 million which includes capital cost of Rs. 33.8 million. The component wise details of the capital cost are given in Table 12.

Table 12: Capital Cost Estimates on Waste Disposal at SHIFA

Capital Cost Components	Rs. Million
Incinerator (300 Kg/h)	20.0
Incinerator (100 Kg/h)	6.0
Machine for Converting Liquid waste to Solid	2.0
Land (300 Acres Landfill Site) Ratwal Fathejang	3.0
Plant Building (1000 sq. ft. X Rs. 2000)	2.0
Waste Storage Room (200 sq. ft. XRs. 1000)	0.2
Bin/Container for Transport to Disposal Site	0
Trolleys for collecting Waste Bags from Wards	0.2
Equipment	0.1
Waste Collection Trucks (Outsource)	0
Weighing Machine (2)	0.05
Refrigerator for Storage of Waste (Cold Storage)	0.2
Total Capital Cost	**33.8**

The annual operating cost on the waste collection, treatment and disposal at SHIFA international hospital is estimated at Rs.40.2 million. The component wise details of the operating cost are given in Table 13.

Table 13: Operating Cost Estimates on Waste Disposal at SHIFA

Capital Cost Components	Rs. Million
Labor (100* Rs 1000)	29.2
Bags (White, Yellow, Blue)	6.4
Uniform & Safety Equipment	0.5
Training	0.3
Maintenance / trolleys cleaning	0.5
Utilities (fuel, water, Electricity)	0.5
Transportation	1.8
Waste Disposal after Treatment	1.0
Total Operating Cost	**40.2**

5.3.1 Estimate of Cost on Waste Disposal at PIMS Hospital

The PIMS hospital do not maintain separate inventory of waste disposal costs on various components. The hospital permanent staffs, sanitary workers collect the waste and carried to a temporary installed container from where the waste is transported to the final treatment and disposal place at Morgah, Islamabad. The transportation, treatment and disposal of waste is outsourced to a private firm. The firm is paid charges @ Rs.26 /Kg for a fixed quantity of 200 kg per day. The total average monthly bill on this account comes to about 0.150 million and the annual estimates comes to Rs. 1.800 million. Another Rs. 2.0 million is added on account of wages of waste collector workers, equipment (trolleys) and other miscellaneous (protective and training) cost, etc. The total cost on waste management thus comes to Rs. 3.8 million which seem under estimated as compared to the annual operating cost at SHIFA at about Rs. 40.2 million. The actual average quantity of waste estimated at site on different days of week at PIMS is 1700 kg and @ of Rs. 26/kg the cost will come to about Rs. 16 million. The PIMS is in process of introducing new technology of shredding, sterilization unit for environmentally safe disposal of hazardous waste of the hospital at an approximate cost of Rs. 200 million.

5.3.2 Unit Cost Analysis of Waste Disposal

The cash flow techniques are used to calculate the average unite cost of waste (Rs. /per kg) in the case of SHIFA international hospital. The present value (NPV) of the total cost, and separately for the capital cost and the annual operating and maintenance cost over the life of the project (assumed as 20 years on the basis of incinerator, the major capital asset) have been calculated. Similarly, the present value of annual quantity of waste generated and the number of beds have been calculated and the results are shown in Table 14.

Table 14: Analysis of Waste Disposal Cost at SHIFA International Hospital

Years	Capital Cost (M. Rs.)	O&M Cost (M. Rs.)	Total Cost (M. Rs.)	Waste/M.KG/ Annum	Nos. of BED
1	33.750	0.000	33.750	0.000	0.000
2	0.000	40.188	40.188	2.738	600
3	0.000	40.188	40.188	2.738	600
4	0.000	40.188	40.188	2.738	600
5	0.000	40.188	40.188	2.738	600
6	0.000	40.188	40.188	2.738	600
7	0.000	40.188	40.188	2.738	600
8	0.000	40.188	40.188	2.738	600
9	0.000	40.188	40.188	2.738	600
10	0.000	40.188	40.188	2.738	600
11	0.000	40.188	40.188	2.738	600
12	0.000	40.188	40.188	2.738	600
13	0.000	40.188	40.188	2.738	600
14	0.000	40.188	40.188	2.738	600
15	0.000	40.188	40.188	2.738	600
16	0.000	40.188	40.188	2.738	600
17	0.000	40.188	40.188	2.738	600
18	0.000	40.188	40.188	2.738	600
19	0.000	40.188	40.188	2.738	600
20	-3.375*	40.188	36.813	2.738	600
Present Value of Capital Cost (M. Rs.)			29.142		
Present Value of O&M Cost (M. Rs.)			216.601		
PV of Total Cost (M. Rs.)			245.743		
PV of Waste (Million Kg)			14.754		
NPV of Bed (Nos)			3234		

*Salvage value assumed @ 10% of the capital cost
Results @15% Discount Rate/Opportunity Cost of Capital for private sector investment

5.3.3 Calculation of unit cost

The cost per kg of waste disposal at SHIFA International is given in Table 15. The cost has separately been calculated as capital cost per kg and operating and maintenance cost per kg by dividing the present value of the present value of the total waste.

Table 15: Unit Cost of Waste Disposal at SHIFA

Total Cost Rs Per KG	Rs. 16.65
O&M Cost Per KG	Rs. 14.68
Capital Cost Per KG	Rs. 1.98

The unit cost analysis in case of PIMS hospital is not undertaken as the required data was not available / maintain in PIMS. The cost estimates, however, can be sued as a best approximation for calculation overall cost of waste disposal by using incineration based technology.

The cost analysis reveals that for 600 bed capacity hospital the total waste disposal capital cost while using incineration based technologies is about Rs. 33.2 million and the annual operating cost comes to Rs. 40.8 million. While average unit cost @ 15% cost of capital is Rs. 16.65 per kg/bed/day. If we use the average estimate of 2 kg of waste generated per bed per day, then the total cost of waste disposal would be Rs. 33.30 per hospital bed per day. It means that charging Rs.33.30 per bed/day would recover the investment cost incurred by the hospital on its waste manmgnet and disposal.

5.3.4 Technologies used in waste Collection and Disposal

At the SHIFA international hospital both incinerated and non-incinerated type of technologies is used for waste disposal through their oven management. In the case of PIMS, the waste disposal activity is treated casually and entrusted to a private firm on fixed terms and condition.

5.3.5 Processes and Procedures in waste Collection and Disposal

The process and procedures in waste collection, storage, treatment and disposal at SHIFA international hospital is relatively more systematic as compared to PIMS hospital. In SHIFA infectious waste is 100% incinerated with the two 300kg/h and 100kg/h incinerators installed within the hospital then the ash is stored in a separate room for the land fill which is situated in Fathjhung Rathwal where they have acquired round about 700 to 800 acres of land. Non-Infectious waste is delivered to sub-contractors which includes kitchen waste, office waste etc. According to officials daily 10 to 20 trucks are delivered to contractor. Infectious waste is stored in cold storage room in 2 to 8^0 C for further clarification of germs and viruses. For collection of infectious waste yellow bag is used and for non-infectious waste blue bag is used. Transportation of waste consists of two steps collection of waste from different departments then brought to weighing machine after weighing the non-infectious waste is delivered to store room and infectious waste delivered to cold storage room then this waste is incinerated. Incinerator works in two shifts for 8 hours.

On the other hand, PIMS have no proper waste disposal system the waste is brought in open trolleys to the container which is placed with in the surrounding of hospital. The containers were remained open and sometime waste is put outside the container which is increasing the chances of infections among the workers and visitors.

The infectious waste is delivered to contactor who took it daily from hospital and incinerate at National Cleaner Production Centre (NCPC). Table 16 explains the Comparison of amount of waste generated by PIMS and SHIFA International.

Table 16: Comparison of amount of waste generated by PIMS and SHIFA International

Health Institutions	Beds (Nos)	Waste Generated (Kg/day)			Waste (Kg/Bed/Day)		
		Total	Infectious	Non-Infectious	Total	Infectious	Non-Infectious
PIMS	1200	6700	1700	4000	5.58	1.42	3.33
SHIFA International	600	7500	2000	5500	12.50	3.33	9.17
Total	**1800**	**14200**	**3700**	**9500**	**18.08**	**4.75**	**12.50**

PIMS is 1200 bedded hospital the total amount of waste produced is 6700kg/day out of which 1700kg/day is infectious waste and non-infectious waste is 4000kg. Similarly, SHIFA international is generating amount of 7500kg/day out of which 2000kg/day is infectious and remaining 5500 is non-infectious. The amount of per bed/kg in PIMS 5.58kg out of which 1.42kg is infectious and 3.33kg is non-infectious. In SHIFA International the amount per bed/kg is 12.50kg out of which 3.33kg is infectious and 9.17 kg is non-infectious.

CHAPTER-VI

CONCLUSION AND RECOMMENDATIONS

6.1 Overview of the Chapter

This final chapter of the study contain discussions on the theoretical and practical implications of the study and includes conclusions and recommendations of the study.

6.2 Conclusion and Recommendation

The study finds considerable variation in the methods, processes, cost and theology used in the waste collection and disposal system in both the hospitals. Similar are the result of analysis on the impact of health of the waste collectors.

The STATA statistical software package 2013 was used to estimate the results. For finding the overall frequency of diseases, negative binomial regression was used. Similarly, for the diseases wise results we tried logit but convergence could not be achieved so we used liner probability model regression. The study also concludes that hospital waste disposal, particularly, the hazardous one be properly managed to minimize and ensure safety of all those exposed to such waste, especially, the workers involve in its collection and disposal process.

The results show that sharp injury status was higher in PIMS hospital compared to SHIFA International Hospital, MWC's are at high risk of acquiring blood-borne diseases such as Hepatitis C and Skin Infections. Similarly, the results of training received showed that none of the worker was trained by the concerned departments and overall poor management of the process of collection, segregation, storage, disposal and transportation of the hospital waste increases the ratio of infectious diseases in

PIMS. On the other hand, SHIFA International hospital is having a separate training department which organizes weekly training for 20 to 25 persons and special training is also given to the workers by foreign experts which have reduced the ratio of sharp injuries and other infectious diseases among the Medical waste collectors as suggested by our results.

Results have shown that protective equipment unavailability, quality and use was not up to the mark in PIMS hospital as compared to SHIFA. Considerable number of injuries occurred because of lack of training on the use of protective equipment and non-availability. In order to reduce the ratio of infectious diseases, sharp injuries, exposure to waste and blood and body fluid, training and education on treatment and disposal, training on safety and training on the use of protective equipment should be provided. Moreover, the up-to-date technological advancement and application of guidelines provided by national and international standards should be ensured. Proper incinerator system should be introduced for the disposal of infectious waste in order to reduce the pilferage of infectious waste and early disposal of infectious waste to reduce the infections caused by waste leftover for many days.

The cost analysis reveals that for 600 bed capacity hospital the total waste disposal capital cost while using incineration based technologies is about Rs. 33.2 million and the annual operating cost comes to Rs. 40.8 million. While average unit cost @ 15% cost of capital is Rs. 16.65 per kg/bed/day. If we use the average estimate of 2 kg of waste generated per bed per day, then the total cost of waste disposal would be Rs. 33.30 per hospital bed per day. It means that charging Rs.33.30 per bed/day would recover the investment cost incurred by the hospital on its waste manmgnet and disposal.

Proper management of Health care waste system should be introduced to reduce the impact of hospital waste not only on the workers but also to the surrounding community. Keeping in view the continues growth in provision of hospital facilities in the country, prioritization of efforts talking problems associated with proper disposal of hospital waste through awareness about the health hazards, adequate training in waste management disposal systems and provision of sufficient financial and human resources by all the public and private sector hospital administration is required. The importance and severity of public health and environmental issues involved in the disposal of hospital waste suggest continuation and extension of further research covering all the health facilities (hospitals, clinics, medical and bio-labs) and the infectious diseases and their impact on all medical care staff (doctors and nurses) as well as patients and general public (community aspect) for through investigation.

6.3 Limitation and Scope of the Study

Due to time and cost constraints, the study is restricted to the analysis and comparisons of hospital waste management to assess its impact on health of MWCs in two major hospitals in Islamabad i.e. the Pakistan Institute of Medical Sciences (PIMS) in the public sector and SHIFA International Hospital in the private sector. However, these two hospitals are good representative of public and private sector hospitals in Islamabad.

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Appendix

S.NO: _____

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS ISLAMABAD (PIDE)

Dear Sir/Madam

We are conducting research on "Impact of hospital waste management on waste collectors". You are requested to spare few minutes to fill the questionnaire. The research is purely for academic purpose and the responses given will be kept **Confidential**. Your honest response and cooperation is highly appreciated!

A: Demographic information of respondent

Q1: Gender: **a.** Male ☐ **b.** Female ☐

Q2: Age (year): _____

Q3: Education: **a.** Illiterate ☐ **b.** literate ☐**,** Specify **_____**

Q4: Length of Service (year): _____

B: Health status of the respondent

Q5: Exposure to waste (daily hours): **a.** 1-3 ☐ **b.** 4-6 ☐ **c.** 7-10 ☐ **d.** more than 10 ☐

Q6: Have you experienced any of the following diseases in the last one year:

S.No	Name of disease	(Yes/No)	Number of times	Cost incurred	leaves taken
1	Gastroenteric infection				
2	Respiratory infections				
3	Ocular (eye) infection				
4	Skin infections				
5	T. B				
6	Viral hepatitis A				
7	Viral hepatitis B and C				
8	Back pain				
9	Arm pain				
10	Any other. Please specify:				

Q7: Have you ever been injured by any sharp object in waste in last one year?

a. Yes ☐ **b.** No ☐

Q8: How did the injury occurred?

a. Item left on/near disposal container ☐ **b.** Putting item into a disposal container ☐

c. After disposal, stuck by item while opening of disposal container ☐

d. Item piercing side of disposal container bag or inappropriate waste container ☐

f. Other ☐ Specify _____

Q9: With which sharp material you got injured?

a. Needle stick ☐ **b.** Lancet ☐ **c.** Glass ☐ **d.** Others ☐ specify_____

Q10: Which part of your body was injured?

a. Hand ☐ **b.** Foot ☐ **c.** Other body part ☐

Q11: Have you received any training on hospital waste management?

a. Yes ☐ **b.** No ☐ (***If the answer is No, then move to Q15)***

Q12: What type of training have you received?

a. Training on treatment and disposal ☐ **b.** Training on safety ☐

c. Training on the use of protective equipment ☐ **d.** All of them ☐

Q13: When was the last time you have received the training?

a. 1month ☐ **b.** 3months ☐ **c.**6months ☐ **d.**1year ☐

Q14: What was the duration of the received training (Week) _____

Q15: Are protective equipment's available to you? **a.** Yes ☐ **b.** No ☐

Q16: Do you have and use the following protective equipment's? and of which quality?

Equipment	**Available (Y/N)**	**Use (Y/N)**	**Quality (Good/Bad)**
a. gloves			
b. goggles			
c. uniform			
d. apron			
e. mask			
f. boot			

Q17: Have you given any vaccination before joining or between the job?

a. Yes ☐ **b.** No ☐

S.NO: _____

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS ISLAMABAD (PIDE)

Dear Sir/Madam

We are conducting research on "Impact of hospital waste management on waste collectors". You are requested to spare few minutes to fill the questionnaire. The research is purely for academic purpose and the responses given will be kept **Confidential**. Your honest response and cooperation is highly appreciated!

Structured Questionnaire for Hospital Management

Q1: Type of Hospital

a. Specialist □ b. General □ c. University (training/provincial) □ d. Regional/District □

Q2: No of Beds _____ **Q3: No of Departments _____**

Q4: Waste management System: a. Own incinerator □ b. Outsource □

Q5: How much waste is generated in your hospital daily: _____ (kg)

Q6: How much infectious waste is generated daily: _____ (kg)

Q7: How do you dispose the waste?

a. Open burning/ Land fill □ **b.** Incinerate □ **c.** Non-incineration tech □

d. Chemical disinfection □ **e.** Outsource □

Q8: How many workers are involved in waste disposal: _____

Q9: How much you spend on waste disposal? Budget Rs. _____ /month

Q10: Do you have waste management committee? **a. Yes □** **b. No □**

Q11: What type of training is provided to the waste collector?

a. Training on treatment and disposal □ **b.** Training on safety □

c. Training on the use of protective equipment □ **d.** Any other □ Specify: ___

Q12: What precautionary and protective measures provided by the hospital?

Q13: Annual Expenditure on Training and Precautionary measures?