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Economical Benefit Resulting From Waste Minimization in Hospitals (Case Study: Shahid Akbar Abadi Hospital)

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Abstract. Nowadays, hospital wastes are dangerous for human health in developing countries. Construction waste is becoming a serious environmental problem in many large cities in the world (Chen et al., 2002). Hospital wastes because of its production nature usually have high potential to damage environment. Minimization in production process of hospital wastes can decrease wastes and it has economical profits. Goal of this study to find methods to minimize the special hospital wastes, therefore we introduce different part of a pilot hospital (Akbar Abadi hospital) and checking statics status produce and segregation stages for special wastes. After doing research, biochemical laboratory part because of having sn and solphore compounds in wastes of consumed kit is important part of hospital for minimize special hospital wastes. By changing technology and usage of new equipment (Ecom and Auto analyzer) in biochemical laboratory producing special wastes caused by using kit like sugar, cholesterol, Triglyceride, Ore, Uric acid, SGOT-SGPT-ALKP, Calcium and Phosphorus ,can be minimize equal to 55 and 83 liters wastes in a year, and economical profits of these equal to 61,259,600 and 41,164,400 rials in a year. In hormonology laboratory with use of automatic washer, amount of produce wastes equal to 19,800gr in year and economical profit of it is equal to 17,786,000 rials in year.

Keywords: Dispelling hospital wastes, Minimization of wastes, Spectrophotometer, Ecom and Auto Analyzer.

1. Introduction

According to research conducted by the World Health Organization (WHO), between 75 to 95% of produced residuals in hospital or health units have no risk. These residuals are produced by administrative and housekeeping activities, and the remaining 10 to 25% are considered dangerous which refers to the industrial side products and hospital wastes, home, business centers, training centers for health, safety, human property and environmental risk. They are wastes including infectious, pathological, sharp, medicinal, Genotoxic, chemical materials and also containing heavy and radioactive metals.

The selected method is based on the waste disposal technology of the country, the climate and consideration of all conditions for using a suitable method with the highest efficiency and least pollution.

The aim of this study is investigation of the economical efficiency of the minimization of hospital waste production and knowledge of various sectors and the status of statistical production and waste separation in Shahid Akbar Abadi Hospital located in Tehran. Currently, 2 major methods of processing and managing hospital waste are used, which include: saving method in the source and burning garbage.

According to World Bank 2005, the current production of hospital wastes in Iran has reciprocal trend with respect to the estimates of WHO for developing countries. (Dehghani2008) found that the amount of waste produced in the teaching hospitals of Tehran University of Medical Sciences is 4.42kg/bed/day. In other words, about 75% of wastes are hazardous and of 25% are normal. Based on the same report, it is unlikely that instruction of segregation and separation in the origin has enough efficiency. Another important

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point is that the production of hospital waste in Tehran is estimated about 2 to 3 times higher than other developing countries located in Middle East and Africa. Each active hospital bed produces a figure around 2.5 to 3 kg of waste per day. While in other cities such as Cairo and Beirut, it is about 1.1 to 1.3 Kg.

The significance of this study is to address a point that has not already considered; the economic aspects and making profit and calculating values of decreased hospital costs and comparing different modes of utilizing different devices and its impact on reducing current hospital costs and the more profitability. This can be an incentive tool for managers and official's heads of hospitals and organizations and encourage them to use advanced equipment and devices.

2. Materials and Methods

This research has been conducted in "shahid Akbar Abadi" hospital and maternity located southwest of Tehran in the summer of 1386. Hospital is belonged to the Government and it is first class. Number of approved hospital beds are 320, which currently has 213 active beds. Hospital building has 4 floors and consists of 7 sections. The number of employees is equal to 260.

Data collection of hospital waste has been done by frequent field visits and taking list of materials from the drug store located in the hospital which will be distributed to all sectors and it is based on the random removal of wastes and their separations and also interview with the hospital staffs in different sectors.

The average daily hospital waste outlet in "Shahid Akbar Abadi" is 603 Kg which 315 Kg of them are infectious, hazardous and sharp wastes and 288 Kg are the regular home residuals. Amount of weight and volume and density of the produced wastes in this study are approximately 220.09 tons, 5.15 m^3/day and 130 kg/ m^3 respectively. 52% of the produced wastes are infectious and 48% are common and home residuals.

In addition, according to the classification done by (WHO, 1983) it was found that 61.1% of wastes are household and 38.9% are hazardous. (Hassn, 2008) showed that the amount of household wastes in Bangladesh is 77.4% and other 22.6% are hazardous wastes.

Infectious wastes are: operating room wastes, delivery room, treatment, ICU part, NICU part, the dressing room, pathology department, laboratory, isolation room, expired drug, textiles and clothing contaminated with blood, gas and cotton used for dressing, laboratory samples and related culture environment, plastic materials including nylon, gloves, urine bag, Infusion Set, sickroom parts, needles and razor.

Plastic wastes makes up 19% of hospital wastes and this high unexpected percentage is due to the overuse of non-recyclable trash instead of recycling and reusing for different purposes. These results are contrary to findings of (Abdulla, 2008) and (Bdure, 2007) in Jordan hospitals. (Dehghani, 2008) reported in Iran hospitals that the plastic contents are 24%, 27%, 29% respectively. Glass makes up over 18.7% of hospital wastes which is due to the high number of serum and empty vial. Plastic wastes have the highest percent of 2.5% which are observed in hospitals with dialysis services; including rubber filters, rubber tubing and rubber gloves.

3. Results

3.1. Ordinary Waste minimization practices in the "Shahid Akbar Abadi" hospital

3.1.1. Radiology Section

In Radiology Sectors, Radiology films due to have silver are separated and sold separately. Additional fixation solution also is not discarded and will be sold. These section's wastes are chemical wastes and they are in the group of infectious wastes. Their approximated weights appear 2 Kg daily.

3.1.2. Food wastes

Bread is removed from the food wastes and sold separately. 3 Kg of common wastes per day are including bread. Overally, 5 Kg of wastes has been reduced daily in the "Shahid Akbar Abadi" hospital.

3.2. Wastes minimization in the "Shahid Akbar Abadi" hospital

3.2.1. Plastics Waste, paper and paperboard, glass, metal, cotton

The approximated weight of these wastes comprises about 156 Kg every day. This group can be sold. The proper separation in the origin in addition to reducing wastes and increasing environmental beneficial effects have economic exploitation. This work takes place in the semi-functional. These materials are sent to landfill due to lack of proper separation from the remaining wastes.

3.2.2. Minimization measures in the laboratory

Using Device called the Auto analyzer and auto metal system instead of manual methods in bio-chemistry and Hematology laboratories reduces consumption of laboratory kits and also the number of cleaning pipes and increases water savings. Overally, the benefits of this machine in minimization are; reduce the purchase of materials and laboratory kits, full use of older material and kit, regular control on drug use and laboratory kits before reaching their expirations, full use of all materials in kits containing materials and laboratory glass

3.2.3. Drug minimization measures

In this section by regular inspecting on medicines and also checking their expiration dates, we can significantly decrease the production of this type of wastes.

3.3. Minimization measures in bio-chemistry lab

If you use an Ecom machine instead of Spectrophotometer, the average consumption of solution and kits will be reduce to half. Due to the availability of cyanide and sulfur compounds in solution and kits and also entering of these wastes directly into urban sewage, minimization of consumption in this section is very important. Auto analyzer machine is new and modern system. By using this machine, the consumption of materials and laboratory kits will be reduce to half of what it is for Ecom machine. Other advantages of this device is to reduce personnel required for the lab work which in turn reduces the risk of personnel's contacting with cyanide and sulfur material and their related illnesses. Also, answer to the testing sample for Ecom device is equal to 4 or 5 days. By using the auto analyzer system this time is reduced to 1 day.

Table 1 - cost of kits consumption for Spectrophotometer, Ecom and Auto Analyzer

Type of machine	Cumulative daily tests	The volume of consumed kits(cc)	Cost of each kits (Rial)	Cost of consumed daily kits(Rial)	volume of consumed monthly kits(cc)	Cost of consumed monthly kits(Rial)	volume of consumed annually kits(cc)	Cost of consumed annually kits(Rial)
Spectrophotometer	153	306	14,840	411,720	9,180	12,351,600	110,160	148,219,200
Ecom	153	153	14,840	205,860	4,590	6,175,800	55,080	74,109,600
Auto Analyzer	153	76.5	14,840	102,930	2,295	3,087,900	27,540	37,054,800

Table 2 - current cost of Spectrophotometer, Ecom and Auto Analyzer

Type of machine	Cost of purchasing (Rial)	Cost of Depreciation(Rial)	Cost of maintenance(Rial)	The annual cost of wages(Rial)	Cost of consumed annually kits(Rial)	Cumulative cost(Rial)
Spectrophotometer	20,000,000	4,000,000	2,000,000	48,000,000	148,219,200	222,219,200
Ecom	35,000,000	35,000,000	350,000	48,000,000	74,109,600	160,959,600
Auto Analyzer	10,000,000	10,000,000	10,000,000	24,000,000	37,054,800	181,054,800

3.4. Hormone minimization measures in the Biology Laboratory

In Hormone Laboratory Studies, average of 55 tests in day is performed. For each test a vial of volume of 5 CC of distilled water is consumed. The average annual amount of distilled water in the laboratory is 100,375 cc. Boxes containing vial of distilled water are in fifty and price of 30,000 rials, so the cost of annually consumed distilled water is equal to 10,245,000 rials. Now for operators and identifying operations, ten employees in this laboratory are used which their average wages in the year are 48,000,000 rials. Costs of the current system equals to 60,045,000 rials per year also, vial containing distilled water are made from

plastic and each weight is equal to 1 gr. Thus, the amount of waste produced annually is equal to 19,800 gr. By using automatic washing machines which costs approximately 15,000,000 rials one can use gallons of distilled water instead of vials of distilled water. Volume of each gallon equals to 5,000 CC and its cost is equal to 30,000 rials.

Table 3 - Cost of consumed distilled water, daily, monthly and annually in using the automatic washing systems in the Hormone Laboratory Studies in Shahid Akbar Abadi Hospital

Cost of each CC of distilled water(Rial)	Cost of daily consumed distilled water(Rial)	Cost of monthly consumed distilled water(Rial)	Cost of annually consumed distilled water(Rial)
6	1,650	49,500	594,000

By using automatic washing machine, we can use one staff. Useful lifetime of the device equals to 15 years and the ratio of depreciation expense is equal to 10%.

Table 4 - cost of using automatic washing machine

Cost of purchasing distilled water (rial)	Cost of purchasing machine(rial)	Cost of annually depreciation (rial)	Cost of maintenance(rial)	Cost of wage(rial)	Cumulative costs(rial)
594,000	15,000,000	1,000,000	1,500,000	24,000,000	42,094,000

Considering the difference in cost calculations and change of IT systems in Hormone Laboratory Studies, by using Automatic washing system in addition to minimization of plastic wastes, it causes economic benefits as well.

4. Conclusion and Discussion

1. Spectrophotometer is used in bio-chemistry laboratory for diagnostic testing of kits, which due to being old device, its intake kits and special wastes due to consumption of fine kits, in day, month and year is equal to 306 cc, 9,180cc, and 110,160cc respectively.

2. In the case of using the device called Ecom in the Bio-Chemistry Laboratory, amount of waste from small consumable kits in day, month and year is 153cc 4,590cc 55,080cc respectively.

3. Auto analyzer as a new device available for analysis in bio-chemistry laboratories, reaches the amount of waste from small consumable kits on the day, month and year to 76.5cc, 2,295 cc and 27,540cc respectively.

4. Using the Ecom device instead of Spectrophotometer device in bio-chemistry Laboratory reduces the special wastes production or consumption of kits in 55,080 cc.

5. Using the Auto analyzer device instead of Spectrophotometer device in bio-chemistry Laboratory reduces the special wastes production or consumption of kits in 82,620 cc.

6. Total current annual cost of the Spectrophotometer, Ecom and Auto analyzer is equal to 222,219,200, 160,959,600 and 181,054,800 Rials respectively.

7. Cost of special waste reduction from consumable kits by application of Ecom and Auto analyzer devices in the bio-chemistry laboratory is equal to 61,259,600 and 41,164,400 Rials respectively.

8. Using Ecom and Auto analyzer device causes 27% and 19% annual benefit to the current situation respectively.

9. Total cost of operations in the current system of Hormone Laboratory Studies is 59,880,000 rials. By using the technology of automatic washer, these costs reduced to 42,094,000 rials which is equivalent to 17,786,000 rials of cost reduction in consumption of distilled water and the cost of personnel.

10. Using the automatic washer in Hormone Laboratory Studies causes minimization of 19,800 gr in plastic wastes production.

According to calculations in Table 1, volume of the residual resulting from the use of laboratory kits by Spectrophotometer equals to 110,160 cc which is equivalent to 110.16 liter/year. By using the Ecom device

instead of Spectrophotometer amount of waste reduction is equal to 55,080cc (55.08 liters per year) and by using the auto analyzer device instead of Spectrophotometer amount of waste reduction is equal to 82,620 cc (82.62 liter per year). The cost reduction resulting from the using of Ecom device instead of Spectrophotometer in kits consumption is 75,423,600 rials and using the auto analyzer device instead of Spectrophotometer is 1,044,787,850 rials in year.

in the next stage, for the current estimation of the cost of these three devices, including initial cost of purchasing of the device, the annual depreciation expense, maintenance costs annually, the annual cost of staff, salary costs, cost of consumables kits annually we use the below method:

Using the Spectrophotometer and Ecom machines require hiring 2 people master in Laboratory and average wage of 20,000,000 rials per month per person, whereas by using the auto analyzer device one staff can perform the diagnosis and operator work. Also the useful lifetime of Spectrophotometer, Ecom and auto analyzer is 5, 10 and 10 years respectively and annual depreciation coefficient is 10%. According to the results, the amount of total annually profit, including costs of kits consuming and payroll of personnel by using Ecom compared to Spectrophotometer equals to 62,004,200 rials in the year and the auto analyzer compared to Spectrophotometer device equals to 42,708,350 rial per year. Over ally by using Ecom and auto analyzer in bio-chemistry laboratory 27% and 19% of total annual costs reduces respectively, and causes economic benefit with a reduction in special waste laboratory.

5. Suggestions

The following solutions to remove obstacles to make progress in hospital waste management are recommended:

1. More accurate monitoring and controlling of hospital waste separation process by the ministry of health and medical education and environmental protection agency.

2. Materials management in a way that the 3 primary criteria of using less, reusing and recycling to be considered.

3. Review reasonably related laws to facilitate the process of reducing the danger of hospital waste and removing their problems.

4. Review the laws in the process of the hospital waste separation at source and related definitions to prevent from confusion of officials responsible for hospital waste separation.

5. Participation of private sector's specialists in the process of hospital waste management.

6. Domestic and foreign investment to import modern technology in the country by public and private sector.

7. Meetings with managers and officials for a closer relationship and familiarity with available scientific and practical solutions.

8. Helping of the University to improve the implementation of the plans and suggests new scientific recommendations.

9. Advertising extensively by the public media for more awareness of the public.

10. Using new technology capable of reducing waste in different parts of the hospital, especially areas with potential of production of hazardous wastes.

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