

was specialized series of action to take exact and correct information from waste generation to waste disposal point. The knowledge to put waste separately, from its point of generation was consider in full consideration in which hospital are graphically represented. Waste collection in drum of different coloured coded are internally lined, separation of waste in infectious and non-infectious bin, disinfection of waste from its generation point, needle cutter and coloured coded transportation drum used in three hospitals was recognised. In hospital only infectious and non-infectious waste considered. All general waste put in non-infectious bin at storage sites while all type of infectious waste put in infectious drum transported to disposal site without any disinfection. All infectious waste incinerated with plastic cover, bags and plastic sealed.

2.5 Status Evaluation of Existing Incinerator with Reference to Standards

Hospital incinerator was visited with incharge of incinerator. Incinerator that used for incineration of infectious waste. Firstly, the type of incinerator was observed. The incinerator designed, burning capacity, no. of burners, loading system, type of paint, chimney plate thickness, electricity provided or fuel, no. of blowers, fly ash, emission of gases control, dust and smell, gas filtering system, chimney height and scrubber all these specifications were observed. All these observations were under concern only to check the grade performance efficiency of incinerator. All specifications were compared with standards to check which hospital's incinerator has good performance efficiency according to standards.

2.6 Comparative Analysis of Hospital Waste Incinerator

In this step comparative analysis of incinerators were conducted. Which hospital had better efficiency not according to standards but with reference to each other. In this phase different specifications of incinerator were compared. The best working incinerator and the least working incinerator was distinguished.

2.7 Strategies for Modification and Improvements

In this step different strategies for modification and improvement in waste handling to waste disposal method was prepared. Incinerator design according to type of waste with secure working condition, ash stabilization and emission control device was provided. Separation of waste, with proper storage condition and protected transferring of waste to disposal point with disposal alternatives according to waste type was given.

3. RESULTS AND DISCUSSION

The existing scenario of waste management in Allied hospital, DHQ and Govt. General hospital Faisalabad are canvass in different steps.

3.1 Initial Survey at Allied Hospital

In Allied hospital Faisalabad, initially it was concluded waste management was followed. Waste generated was separated by ward staff. Temporary collection of waste was held with in ward area. To collect general waste, white coloured drums were used, that were labelled with non-infectious waste. To collected VIALS (Sharp waste) and blood bags red coloured drum was being used. Yellow coloured drums were used for infectious waste (drip set, and syringes). It was founded all drum was coloured coded, covered and inside plastic lining was also provided.

Separate needles collector with small yellow basket whose top and inside lining was provided. Before dispose of the needle, needle cutter was provided in every ward to cut the needle from its body. It was concluded that each ward has its separate needle cutter. But it was concluded that every bed contained only basket that was uncovered to collect all type of waste that generate by patients or patient's attendant. Each basket emptied after 8 hrs that was placed beside patient bed, and after 8 hrs waste of wards was transferred to main collection area by the help of sweepers. Now, the waste management of Allied hospital has introduced that after 8 hr, end of one shift, waste of ward was weighted and signed by head nurse present in ward. It was assessed that the total weight of waste figure varies from ward to ward even the weight of non-infectious and

infectious waste was also different, mostly general waste had high weight. It was founded that waste wrapped, sealed and labelled before transferring it to the main collection point.

PPE while dealing with patient plays an important role as in less shifting of diseases, pathogens and microorganism. It was concluded that for every member of hospital there must have PPE and training on each condition would be given for the health and safety of medical staff [3].

In outdoor department all kind of waste put in same bin, no waste separation done at source of generation specially in dental department. On daily basis huge number of patients comes at outdoor department, so number of patients increase it means the amount of waste generated high.

Incinerator area of Allied hospital was at back side of hospital. A separate place where all infectious waste was burned on daily bases. Here infectious waste not separated from other less infectious waste as when infectious waste mix with less infectious waste in result large quantity of infectious waste produced because hospital waste is heterogeneous in composition [11]. General waste sends towards the general collection site that was than disposed of with any disinfection. General waste first stored with in hospital area than transfer to the filth depot of Municipal Corporation. General waste disposed far away from the population area. The machinery or vehicle used to transfer general waste to the disposed point are un covered and never ever cleaned. Municipal Corporation carry the general waste on daily basis. But It was concluded that Allied hospital has proper building and management plans to control waste according to the algorithms followed in Allied hospital.

3.2 Initial survey at DHQ Hospital

In DHQ hospital waste management plan was not working properly. Generally, the walls and floor was in poor condition but inside some ward the condition is little better. Outdoor was very congested. In DHQ hospital the waste management plan was follow on generation and separation at source point than waste collection, transfer and disposal method was not properly working. It was concluded that separation of sharp waste (VILAS) red drum was not available they put sharp waste in infectious yellow coloured drum In some wards HIV positive infectious waste put separate from other infectious waste. It was concluded very good step of segregation of HIV positive and negative result.

Community wellbeing and local atmosphere can be secure on bases of waste collection, transportation and final disposal of MWM that can be regulated if all step is followed according to standards [12]. It was concluded that besides the infectious waste the proper handling of general waste was also not followed in DHQ hospital. Medicine cardboard was thrown anywhere around the hospital area, inside wards and outside the wards.

Status of incinerator was also thoroughly observed. At day time the incinerator was not in working condition because of high chances of pollution. At day times around the area of incinerator, the people walk on road more, the chances to inhale in polluted atmosphere are high at day times, beside that at night time few people walk on road so less chances for people to inhale in polluted environment as no. of people less, than low no. of chances to inhale polluted air. So, it was decided by hospital members that incinerator should work only at night times. Only at night shift incinerator was used to burn waste.

3.3 Initial survey at Govt. General Hospital

Govt general hospital was thoroughly observed by the permission of MS of hospital. He introduced me to the chief sanitary officer that give me all necessary information related to waste management. Hospital had small facility to deal with patients. Only 50 beds were present in hospital. Hospital had small infectious control plan to separate waste at point of generation. Hospital has waste management committee. As number of patients small, then quantity of waste that produced was small. Hospital had white, yellow and red coloured drum to separate infectious, sharp and general waste. Needle cutter was also used to cut needles.

Hospital has good record keeping data on daily basis. Waste was covered and then weighted. But in hospital safety measure to protect from the infectious or hazardous waste were less. Hospital staff was without gloves, mask and other safety measure. It was found that general waste was put at back side of hospital, while infectious waste was not inside the hospital boundary. It was concluded that infectious waste was carried by ERRAR company on daily basis. But hospital had yellow room to store the infectious waste.

It was assessed that hospital was over all clean because of small building was in working condition and small no. of patient visit daily. But full attention was given to admitted patients. Hospital has small X-rays department and small laboratory. All departments were small in space it means that it has small area, one department has capacity of maximum of 7 beds. The waste collection bags and all instruments, medicine, synergies were within that small space. It was founded that all room were congested but was neat and clean.

3.4 Preparation of questionnaire from all stakeholders

This contained the result about knowledge and information of hospital staff related to waste handling. From all hospital questionnaire was filled. The difference between the filled questionnaire and actual practices represent graphically. According to the questionnaire the results shown in graphic form.

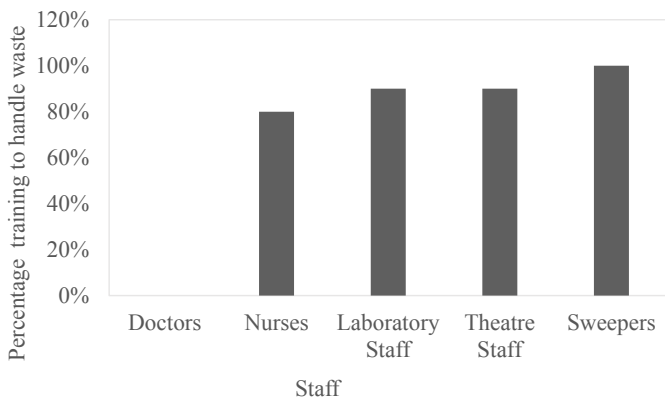


Figure 1: Training to handle waste in different hospitals

It was concluded that waste handling was maximum at Allied hospital. Wards were neat and clean. Waste segregation was high for doctors during training while doing operation they do not follow the instructions for infectious and non-infectious waste handling and put waste in the same bin. It was founded that handling of waste was worst at DHQ hospital. Number of patients were very high in the hospital. A lot of surgeries and operation held in 1 day so amount of waste produced was high. When large amount of waste produced than segregation was also very difficult.

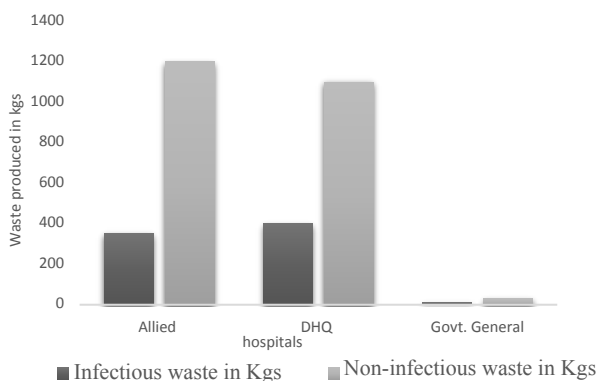


Figure 2: Generation of waste at hospitals

It was concluded that waste generated at Allied and DHQ hospital was about 1500kg. Govt. General hospital has small facility to attend patients so, infectious waste produced was 0-1.5 kg while non-infectious waste produced about 20-30 kg.

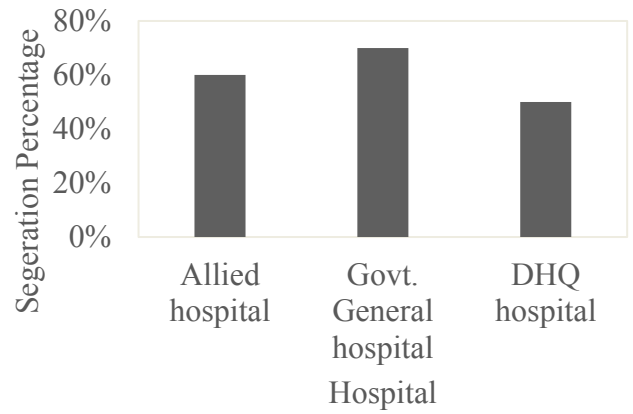


Figure 3: Segregation of waste at hospitals

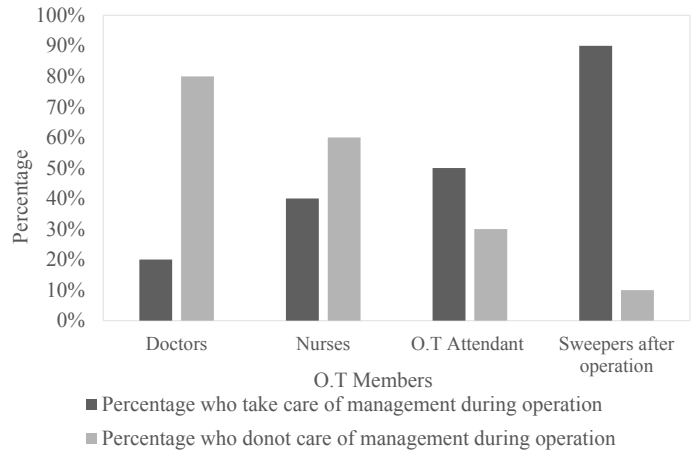


Figure 4: Segregation of waste by operation theatre members

Figure 4 shows members of O.T that manage waste segregation in operation theatre. Doctors took care of waste segregation at least level while sweepers in O.T take care of waste management at peak level. Once operation was completed than sweeper pour all waste on floor cut the sharp waste, puncture and separate the infectious waste from non-infectious waste. It was founded that there 10 members out of 17 were hurt by the medical waste contact [13].

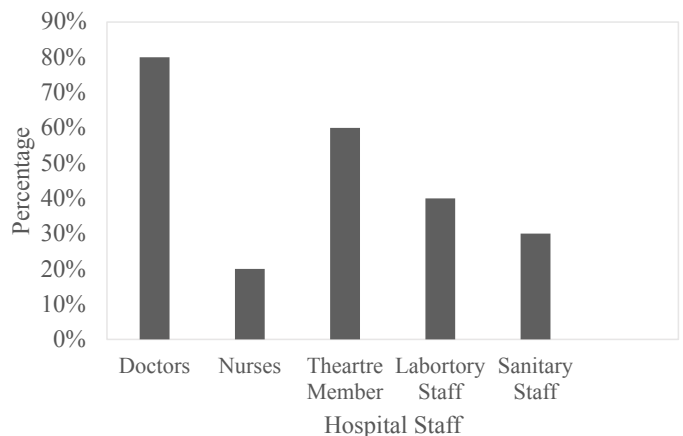


Figure 5: Hospital members that use protective measures

Figure 5 shows that nurses least deal with PPE and doctors are members that deal wear PPE maximum. Sweeper only wear PPE when they deal with waste generally during cleaning floor walls, ward and patients cabinet they not wear PPE.

3.5 Performance Evaluation Existing Scenario of Purposed Study Sites

3.5.1 Waste Type

In each hospital every type of waste produced but its weight varies from

hospital to hospital according to number of patients present in ward. Different type of waste produced that was

1. Non-infectious waste (General and Recyclable)
2. Infectious waste (Biological and Sharp)

3.5.2 Waste Quantity that Created

The quantity of waste that created in each hospital varies. As Govt. General hospital has minimum number of patients so daily waste produced was minimum. It was assessed that daily waste produced in Govt. general hospital in three shifts from 0g to 1.5 kg per ward and 5-10 kgs of infectious waste. In DHQ total biological waste produced was about 10 kg per day and infectious waste from 350 -400 kg and non- infectious waste produced 1100 kg per day. Total waste produced about 1500 Kgs. In Allied hospital 20% waste is infectious waste and 80% non-infectious. It was founded in Allied hospital minimum no. bed in Peads ICU was 5 and max number of beds in Ortho unit that was 72 and Medical emergency has 260 patient's capacities and after recovery they refer towards related ward. As no. of bed high, automatically waste generated was high.

3.5.3 Waste Storage

It was disclosed that in Allied hospital waste was stored in different coloured coded bins as follow:

Yellow bin: Infectious waste

White bin: Non- Infectious waste

Red bin: Sharp waste

It was ascertained in DHQ waste collected in coloured bin (no red coloured bin was used).

Yellow bin: Infectious waste

White bin: Non-Infectious waste

It was determined that in Govt. General Hospital waste was collected in bin as used in Allied hospital, yellow for infectious, white for general and red bin for blood bags, sharp waste.

3.5.4 Waste transportation

It was detected that in Allied hospital after 8 hr waste collected from each ward and transported to the temporary disposal point. Before transportation waste was sealed, covered and weighted and mentioned on plastic cover in which all waste put. It was realized that for transportation of waste yellow and blue coloured trolley used. For transportation of infectious and general waste yellow coloured uncovered trolley used while for laundry transportation blue coloured trolley used. The non-infectious waste was then filth depot far away from the hospital boundary with help of Municipal Corporation. Infectious waste was incinerated with in the hospital.

It was observed in DHQ hospital blue coloured trolley was used to transport waste and dirty linen. No separate trolley was present there to transport general or infectious waste separately. All type of infectious and non-infectious waste was transported by same trolley.

In Govt. General hospital general waste was transported by sweepers to the collection point. No trolley was used for transportation purpose. Infectious waste was transported with help of ERRAR company sweepers. They took infectious waste from each ward and with the help of special vehicle infectious waste was transported to the main compony area where waste was disposed and incinerated.

3.5.5 Waste Treatment

It was concluded that in Allied hospital, waste was disposed without any treatment. No necessary treatment was applied. Same condition was observed in other two hospitals. Only needle cutter was providing to cut needle and it was not a treatment, but it was considered as precaution for disposal of used needle.

3.5.6 Waste Disposal

It was concluded that in Allied hospital non-infectious waste was first temporary disposed with in area of hospital but far away from patients reach then disposed to filth area with help of Municipal Corporation. Infectious waste was incinerated and ash produced in result of burning was land fill away from the hospital area. It was figure out that ash

produced from risk waste will dispose in land fill which was designed by local council.

It was assessed in DHQ hospital general waste was collected in non-infectious waste store site and then disposed with help of Faisalabad Waste Management Company. Infectious waste was sent for incineration and for sharp waste, sharp cutting machine used and then tiny particles were landfill. It was revealed that in outcome of incineration ash was also land fill without any necessary treatment.

It was founded that in Govt. General hospital non-infectious waste was disposed with help of Faisalabad Waste Management Company while infectious waste was disposed with help of ERRAR Company. It was concluded that no incinerator was present inside the hospital for infectious waste burning, only yellow room was present with in the hospital building (no separate place).

3.6 Status Evaluation of Existing Incinerator with Reference to Standard

It is funded that Incinerator was provided in each hospital for complete burning and to reduce the volume of infectious waste. In Allied hospital incinerator was visited by incinerator supervisor that give all necessary information about incinerator working efficiency. it was concluded that incinerator was in working condition at day time. Violation of rule that incinerator only work at night time.

At DHQ hospital incinerator work only at night shift during day timings it remains out of working conditions. DHQ hospital used natural gas for combustion of waste in incinerator, 1 cycle required 60 minutes to complete the process once it started. 4 cycles per day are required to incinerate waste produced per day. DHQ hospital has combustion type incinerator with capacity of 100kg/hr equipped with cyclones and I.D fan to make atmosphere friendly.

It was founded that Govt. General hospital has no incinerator. To burn incinerator hospital deal with compony that burn infectious waste of all hospital. The company send his man to collect all infectious waste in special vehicle to carried waste from hospital to the burning point. The team man visit hospital twice a day and collect infectious waste.

3.7 Comparative Analysis of Hospital Waste Incinerator

Woking condition of DHQ hospital incinerator was in good condition. As first step was segregation of waste before waste incinerated. All sharp waste was convert into small pieces by machine than disposes of separately from other waste. Other waste like biological waste, infectious waste and medical waste was incinerated at night times. Specifications of waste satisfactory but gas emission control device was not present so a lot amount of smoke produced and cover area around it. Smoke has very bad smell and has disease in it. 3 blowers are provided in DHQ incinerator according to primary and secondary chamber, wet scrubber and chimney are also provided to control dust. While blower, burning capacity, use of fuel, loading system and electricity was according to standards. Induced fan also provided in the DHQ incinerator to throw away flue gases and flue gases cleaning system. While in Allied hospital all sharp waste put in incinerator and burnt In Allied hospital incinerator work in day time and emit gases. Some specifications thickness of plates, paint, burning capacity, use of fuel, loading system and electricity was matching standards. No gas emission control device attaches to incinerator. Both incinerator has no emission control device. It was concluded that settling of ash means dispose of ash without any treatment. Ash disposed without sedimentation process.

3.8 Strategies for Modification and Improvements

According to the situation of all hospitals in Faisalabad the first thing that need planned waste management team perform their duties with full responsibility. It was founded that HWM team consist of head of institution, head of every department (medical store, general store, services, theatres, accidents and emergency director, infectious control officer, the pharmacist, the radiology officer), chief nursing staff, hospital supervisor, drug controller officer, public health technologist and hospital engineer.

3.9 Personal Hygiene

According to the condition of hospital it was recommended that for controlling the infectious effect on health, the following steps must take for staff. Staff must wear neat and clean dress. Nails trimmed 1/4 inches, wear gowns for handling infectious linen and infectious instruments even for waste. Visitor must wash themselves effect on health after contact with patient so that no transmission of infection come across. To hold contaminated equipment must wear disposable gloves. Equipment must be clean, dry and stored in orderly manure. Cleaning, sterilization and disinfection solutions must available permanently in every ward. Equipment's must be rinsed before sterilization or washing. Staff must use safety equipment.

3.10 Covered bin around each bed

Each bed must have two bins, one for general waste or for food waste, other for infectious waste which should be covered. As if bin would be covered it will transfer less infection.

3.11 Dirty room in separate ward

In every ward dirty room must be present for temporary storage of waste. As yellow bag for anatomical waste (body parts), general waste put in white bags and after all dirty room must clean on daily basis. Dirty room must be clean with disinfected chemical. Sterilization solution used within 24 hr after that time that solution must be wasted.

3.12 Waste treatment and final disposal

Type of waste matter a lot on the treatment and disposal method to reduce its infectious affect. According to the type of waste different treatment must be used like disinfection (that is removal of spores as an exception with removal of all pathogens) with chemical, halogen, alcohol and plasma. Auto calve (machine use for moist heat above normal atmosphere) sterilization (exclusion of all life). Steam sterilization (high pressure steam to remove microorganisms) and incineration (to decrease the volume of waste and kill all pathogens). Chemical disinfections contain aldehydes (formaldehyde, paraformaldehyde and glutaraldehyde), halogen based (chlorine and iodophors) sometimes, phenol, alcohol and other odourless colourless and nonrotating chemicals are used which are called quantity ammonium compounds.

Sterilization may be dry heat, gasses, liquid and radiations. Low temperature plasma in which air as working fuel in result it emitted uneven arrangement of nitrogen oxides and required low amount of energy than other system. Incineration used for final burning of hospital waste. According to research objective the design of low cost incinerator is not a big deal but the hazardous effect of not proper handling of waste is of major concern. If a low-cost incinerator is installed in hospital but it does not have any wet scrubber as the cost of wet scrubber is high or emission control device than the whole area around it will affected. And to reduce hazardous effect from environment is more effort able than installing an incinerator of good quality

Every hospital should design the hospital waste incinerator according to the consideration of standard and its maintenance efficiency and working must be up to dated. Incineration is only option for disposal as in Pakistan harmless disposal methods are limited. All infectious waste must have burned within 24hrs. Ash in result of burning have different infectious substances with in it so, secure land fill of ash is also of major concern. For that purpose, non- combustible container must be used [13].

For maintains, operation and working of incinerator highly qualified incinerator operators are required in each hospital according to current situation. As in current scenario no hospital has high qualified incinerator operator. As it was conformed that if incinerator operator was not present than hospital requirement is to have substitute for reducing the hazardous effect of waste or the second option is to agreement with district capability for incinerator. Incinerator operator have all information regarding health and care of environment is not alarming by the operation of the

incinerator and operator precisely trained over World-wide operation of incinerator that contained heat recovery and flue gases scrubbing knowledges [14].

4. CONCLUSION

It was concluded that current scenario of hospital waste management of Allied hospital was better than all other hospitals, while waste management at DHQ hospital was at bad-tempered level and in Govt. general hospital management was good tampered according to the rules of waste management of Pakistan

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