



Analysis of solid waste generation in hospitals of Kathua Town (J&K), India

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Abstract

The present paper deals with the seasonal variations in the generation of solid waste in hospitals of Kathua Town. The dangerous waste generated by hospitals has become a serious hazard which threatens public life, so variation in the qualitative and quantitative composition of waste was worked out seasonally. The study also includes the observations on the separation of recyclable solid waste at source so as to evaluate net solid waste generation per day that needs disposal. In the last some recommendations are given in this paper.

Keywords: *Infectious waste, Radioactive waste, Biodegradable waste, Non biodegradable waste, Recyclable waste, Biomedical waste*

Introduction

Hospital waste is broadly defined as any solid or liquid waste that is generated during diagnosis, treatment or immunization of human beings or animals or in research activities pertaining there to, or in the production or testing of biological samples or material. In India, the waste generated during the process of patient care is also referred to as biomedical waste. The discharge of hundreds of tones everyday of such an unregulated and untreated toxic waste into the environment creates an imbalance in the composition of the environment. This highly infectious waste can create serious pollution problems and may prove to be a source of varying type of health hazards. The waste generated by the hospitals includes wide variety of hazardous substances like solvents, chemotherapy waste, anesthesia gases, radioactive waste, intravenous drips, used bandages, cotton plasters, stools and urine collection bags, nasal gastric tubes, syringes, needles, scalpels, blades, rubber catheters, suction catheters, urinary catheters, gloves *etc.* Careless dumping of infectious waste like living or non living pathogens, human body tissues, solid cotton, dressing linen, blood soaked bandages, laboratory culture stocks, waste of experimental animals used in research,

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waste generated by veterinary hospitals, colleges, animal houses and livestock and other medical waste outside hospitals and nursing homes were checked under a legal provision. Many times used syringes, blood bags, gloves and other items which should ideally be disposed off after they are chemically disinfected are sold back into the market. Even used cotton after being washed and fluffed is stuffed in quilts and sold. Rag pickers gather unsegregated medical waste and sell it in the market. Reports pertaining to recycling of disposable medical items have been published from different parts of the country from time to time. Human lives are put at risk, when it involves recycling of dangerous and toxic medical waste products (Agarwal, 2000). Many hospitals and nursing homes dump untreated infectious medical waste in municipal dumping grounds. Infected medical waste can cause fatal diseases like AIDS, meningitis, hepatitis B and C, liver failure, tuberculosis and brain fever. Most of them even throw them out on the road sides. Heavy metals like mercury and cadmium are present in significant quantities in these hospital (medical) wastes which are extremely toxic even in small quantities. In view of its hazardous nature and serious environment threats, biomedical waste requires special handling, especially in view of the available new technologies for its disposal in a scientific

manner. Hospital waste, which constitutes relatively a small fraction of urban municipal waste (1.5 to 2.0 percent), is proving to be a big menace. Due to increase in medical facilities in recent years, the medical waste also increases many folds and the subject is of great concern for the Public and the Government.

Study area

The sites of study area were hospitals of Kathua Town. Geographically Kathua district lies in South-East of the state. It is situated 32.17' to 32.55' North latitude and 75.32' to 75.76' East longitude, spread over an area of 2651 sq. kms constituting 1.9 % of the total area of the state. Town has population of over 40000 as per 2001 estimates. Kathua, the site of present study is about 85 kms from Jammu city on Jammu-Pathankot National Highway. The two main rivers of the district are Ravi and Ujh which are two major contributors to the prestigious Ravi-Tawi Irrigation –complex. The significance of the study area, Kathua is important because it is situated near Lakhanpur, which is the Gateway of India to Jammu Kashmir state.

Materials and Method

The study was conducted in the hospitals of Kathua Town during two years *i.e.* 2007-2008. The average solid waste generation per capita per day along with standard deviation was calculated by taking 08 samples from the study area per three months period for two years. During each sampling the total solid waste generated by the patient and his attendants during the period of 24 hours was collected in a polythene bag of 10 kg capacity and weighed. The qualitative and quantitative composition of biodegradable and non biodegradable waste per capita per day was calculated. The quantity of various recyclable/reused like plastic ware (glucose bottles, spirit bottles, H₂O₂ bottles *etc.*), glassware (savlon bottles, betadine bottles *etc.*) which were separated by sweepers to be sold to Itinerant Waste Buyers (IWB) or Small Enterprises Middle man (SEM) at weekly or monthly intervals were recorded to calculate average separation and net generation of solid waste. The per capita per day values of solid waste separation and net generation in hospitals during eight seasons of the study period were compiled to find the average per capita per day

separation and net generation at hospitals. There were about 250 medical beds in Kathua town and finally per capita was multiplied with total number of medical beds.

Results and Discussion

The analysis of solid waste generation in two years revealed that average solid waste generation/capita/day decreased from January-March to April-June, increased from April-June to July-September and it again decreased from July-September to October-December, during first year as well as in second year of study period. The biodegradable solid waste generation also exhibited the same trend, but non-biodegradable wastes did not followed a specific trend during course of study. The average qualitative composition of various biodegradable and non-biodegradable solid wastes in different seasons of two years study period has been tabulated in Table-1a- 1d.

The data generated over two years study revealed that average/capita/day solid waste generation ranged from 0.510-5.919 kg with an average value of 2.217 ± 0.344 kg. The average separation of recyclable wastes to be sold to waste buyers at source ranged from 0.022-0.350 kg with an average value of 0.087 ± 0.031 kg/capita/day. The net average/capita/day solid waste generation in the study area was observed to be ranged from 0.415-5.773 kg with an average value of 2.130 ± 0.342 kg/capita/day (Table-2). As per record of BMO office Kathua, there are 250 medical beds. Taking this value same at present, the total solid waste generation/day in the hospitals in the Kathua Town comes to be 0.55 tones/day, of which 0.02 tones/day is separated at source to be sold to waste buyers by hospital's authority themselves without the involvement of municipality and net solid waste generation/day in the study area was calculated to be 0.53 tones/day (Table-2), of this 0.32 tones/day was the biodegradable, 0.16 tones/day non-biodegradable and 0.05 tones/day inert material. The generation of average potential recyclable solid waste/capita/day was to be 0.555 kg (0.14 tones/day *i.e.*, 25.54 % of gross average value of 0.55 tones/day). This included average recyclable non-biodegradable solid waste/capita/day was to be 0.555 kg (0.14 tones/day *i.e.* 25.54 % of 0.55 tones/day) which included plastic ware 0.380 ± 0.157 kg, glassware 0.175 ± 0.048 kg (Table-3). Presently on an average 0.040 ± 0.037



kg/capita/day of plasticware and 0.047±0.017 kg/capita/day of glass ware out of 0.380±0.157 kg/capita/day of plastic ware and out of 0.175±0.048 kg/capita/day glassware respectively were actually collected at source to be sold to waste buyers. Thus the recyclable waste was observed to be separated from the generated potential recyclable waste on a total 3.64 % *i.e.* 0.02 tones/day @ 0.087 kg/capita/day was observed to be separated at source. Net recyclable material /day was observed to be 84.14 % *i.e.* 0.12 tones @ 0.467 kg/capita/day (Table-3). Banerjee and Bagchi, (1999), Basu,(1998) and Goudar and

Subramanyam, (1996) also suggested various methods of solid waste management. Thus the awareness of hospital's authorities regarding the sale of various reuses, recyclable waste can decrease the waste load to maximum of 25.54 % (0.14 tones/day @ 0.555 kg/capita/day) without the involvement of the municipality services. In the last but not the least I would like to say that we all must follow the triple 'R' policy *i.e.*, REUSE, REDUCE and RECYCLE policy in order to overcome this problem, as this problem will become more acute with better medical facilities in coming years.

Table-1a: Seasonal variations in average solid waste generation (kg/capita/day) in Hospitals of Kathua Town

Wastes	(January-March, 2007)			(April-June, 2007)		
	Average solid waste (kg/capita/day)			Average solid waste (kg/capita/day)		
	Gross solid waste (G)	Recyclable solid waste (r)	Net solid waste (G-r)	Gross solid waste (G)	Recyclable solid waste (r)	Net solid waste (G-r)
Biodegradable	1.214±0.599 [0.7912-6.18] (48.46)	-	1.214±0.599 [0.791-2.618] (48.46)	0.861±0.293 [0.220-1.454] (43.55)	-	0.861±0.293 [0.220-1.454] (43.55)
Paper	0.098 (3.91)	-	0.098 (3.91)	0.144 (7.30)	-	0.144 (7.30)
Cloth ware	0.491 (19.61)	-	0.491 (19.61)	0.419 (21.18)	-	0.419 (21.18)
Cotton	0.113 (4.53)	-	0.113 (4.53)	0.104 (5.25)	-	0.104 (5.25)
Wood	-	-	-	0.022 (1.10)	-	0.022 (1.10)
Food/garbage	0.511 (20.41)	-	0.511 (20.41)	0.172 (8.72)	-	0.172 (8.72)
Non-biodegradable	0.975±0.560 [0.461-1.400] (38.92)	0.070±0.06 [0.051-.099] (2.79)	0.905±0.496 [0.410-1.300] (36.13)	0.880±0.410 [0.267-1.000] (44.51)	0.053±0.041 [0.022-0.096] (2.68)	0.827±0.386 [0.246-0.904] (41.83)
Plastic ware	0.644 (25.71)	0.040 (1.58)	0.604 (24.13)	0.515 (26.06)	0.017 (0.85)	0.498 (25.21)
Metallic ware	0.108 (4.32)		0.108 (4.32)	0.172 (8.71)	-	0.172 (8.71)
Glass ware	0.168 (6.70)	0.030 (1.21)	0.138 (5.49)	0.147 (7.43)	0.036 (1.83)	0.111 (5.60)
Rubber	0.031 (1.23)	-	0.031 (1.23)	0.032 (1.61)	-	0.032 (1.61)
Egg shell/bones	0.024 (0.96)	-	0.024 (0.96)	0.014 (0.70)	-	0.014 (0.70)
Inert material	0.316±0.209 [0.110-0.991] (12.61)	-	0.316±0.209 [0.110-0.991] (12.61)	0.236±0.085 [0.143-0.419] (11.94)	-	0.236±0.085 [0.143-0.419] (11.94)
Total	2.505±1.100 [1.415-4.761] (100)	0.070±0.064 [0.051-0.099] (2.79)	2.435±1.090 [1.091-4.714] (97.21)	1.977±0.621 [0.630-2.451] (100)	0.053±0.041 [0.022-0.096] (2.68)	1.924±0.615 [0.601-2.376] (97.32)



Table-1b: Seasonal variations in average solid waste generation (kg/capita/day) in Hospitals of Kathua Town

Wastes	(July-September, 2007) Average solid waste (kg/capita/day)			(October-December, 2007) Average solid waste (kg/capita/day)		
	Gross solid waste (G)	Recyclable solid waste (r)	Net solid waste (G-r)	Gross solid waste (G)	Recyclable solid waste (r)	Net solid waste (G-r)
Biodegradable	1.544±0.476 [0.281-3.180] (63.80)	-	1.544±0.476 [0.281-3.180] (63.80)	1.433±0.516 [0.619-3.390] (60.57)	-	1.433±0.516 [0.619-3.390] (60.57)
Paper	0.220 (9.10)	-	0.220 (9.10)	0.159 (6.73)	-	0.159 (6.73)
Cloth ware	0.532 (22.00)	-	0.532 (22.00)	0.594 (25.10)	-	0.594 (25.10)
Cotton	0.151 (6.26)	-	0.151 (6.26)	0.134 (5.65)	-	0.134 (5.65)
Wood	0.010 (0.40)	-	0.010 (0.40)	-	-	-
Food/garbage	0.630 (26.04)	-	0.630 (26.04)	0.546 (23.09)	-	0.546 (23.09)
Non-biodegradable	0.716±0.259 [0.272-1.110] (29.59)	0.089±0.030 [0.041-0.146] (3.68)	0.627±0.233 [0.255-0.970] (25.91)	0.740±0.284 [0.215-1.319] (31.28)	0.150±0.044 [0.080-0.350] (6.34)	0.590±0.247 [0.143-0.999] (24.94)
Plastic ware	0.314 (12.97)	0.039 (1.62)	0.275 (11.35)	0.291 (12.32)	0.123 (5.21)	0.168 (7.11)
Metallic ware	0.140 (5.79)	-	0.140 (5.79)	0.201 (8.50)	-	0.201 (8.50)
Glass ware	0.210 (8.66)	0.050 (2.06)	0.160 (6.60)	0.188 (7.95)	0.027 (1.13)	0.161 (6.82)
Rubber	0.032 (1.34)	-	0.032 (1.34)	0.050 (2.10)	-	0.050 (2.10)
Egg shell/bones	0.020 (0.83)	-	0.020 (0.83)	0.010 (0.41)	-	0.010 (0.41)
Inert material	0.160±0.053 [0.044-0.219] (6.61)	-	0.160±0.053 [0.044-0.219] (6.61)	0.193±0.074 [0.056-0.283] (8.16)	-	0.193±0.074 [0.056-0.283] (8.16)
Total	2.420±0.711 [0.610-4.440] (100)	0.089±0.030 [0.041-0.146] (3.68)	2.331±0.681 [0.574-4.363] (96.32)	2.366±0.708 [0.510-3.910] (100)	0.150±0.044 [0.080-0.350] (6.34)	2.216±0.669 [0.415-3.590] (93.66)



Table-1c: Seasonal variations in average solid waste generation (kg/capita/day) in Hospitals of Kathua Town

Wastes	(January-March, 2008)			(April-June, 2008)		
	Average solid waste (kg/capita/day)			Average solid waste (kg/capita/day)		
	Gross solid waste (G)	Recyclable solid waste (r)	Net solid waste (G-r)	Gross solid waste (G)	Recyclable solid waste (r)	Net solid waste (G-r)
Biodegradable	1.933±0.613 [0.860-4.490] (69.81)	-	1.933±0.613 [0.860-4.490] (69.81)	0.965±0.277 [0.342-1.671] (53.31)	-	0.965±0.277 [0.342-1.671] (53.31)
Paper	0.317 (11.46)	-	0.317 (11.46)	0.129 (7.10)	-	0.129 (7.10)
Cloth ware	0.773 (27.91)	-	0.773 (27.91)	0.384 (21.19)	-	0.384 (21.19)
Cotton	0.210 (7.60)	-	0.210 (7.60)	0.094 (5.19)	-	0.094 (5.19)
Wood	0.058 (2.10)	-	0.058 (2.10)	0.040 (2.22)	-	0.040 (2.22)
Food/garbage	0.574 (20.74)	-	0.574 (20.74)	0.319 (17.61)	-	0.319 (17.61)
Non-biodegradable	0.620±0.237 [0.285-1.415] (22.39)	0.073±0.032 [0.036-0.155] (2.64)	0.547±0.212 [0.233-1.269] (19.75)	0.590±0.117 [0.159-0.826] (32.60)	0.064±0.036 [0.022-0.109] (3.54)	0.526±0.090 [0.131-0.723] (29.06)
Plastic ware	0.122 (4.40)	-	0.122 (4.40)	0.328 (18.10)	0.026 (1.42)	0.302 (16.68)
Metallic ware	0.150 (5.40)	-	0.150 (5.40)	0.089 (4.90)	-	0.089 (4.90)
Glass ware	0.274 (9.90)	0.073 (2.64)	0.201 (7.26)	0.140 (7.76)	0.038 (2.12)	0.102 (5.64)
Rubber	0.051 (1.83)	-	0.051 (1.83)	0.026 (1.42)	-	0.026 (1.42)
Egg shell/bones	0.024 (0.86)	-	0.024 (0.86)	0.008 (0.42)	-	0.008 (0.42)
Inert material	0.216±0.064 [0.096-0.386] (7.80)	-	0.216±0.064 [0.096-0.386] (7.80)	0.255±0.071 [0.060-0.622] (14.09)	-	0.255±0.071 [0.060-0.622] (14.09)
Total	2.769±0.776 [1.644-5.919] (100)	0.073±0.032 [0.036-0.155] (2.64)	2.696±0.759 [1.613-5.773] (97.36)	1.810±0.381 [0.599-3.132] (100)	0.064±0.036 [0.022-0.109] (3.54)	1.746±0.359 [0.561-3.054] (96.46)



Table-1d: Seasonal variations in average solid waste generation (kg/capita/day) in Hospitals of Kathua Town

Wastes	(July-September, 2008) Average solid waste (kg/capita/day)			(October-December, 2008) Average solid waste (kg/capita/day)		
	Gross solid waste (G)	Recyclable solid waste (r)	Net solid waste (G-r)	Gross solid waste (G)	Recyclable solid waste (r)	Net solid waste (G-r)
Biodegradable	1.109±0.339 [0.519-2.010] (55.39)	-	1.109±0.339 [0.519-2.010] (55.39)	1.055±0.360 [0.460-2.218] (55.85)	-	1.055±0.360 [0.460-2.218] (55.85)
Paper	0.138 (6.90)	-	0.138 (6.90)	0.153 (8.11)	-	0.153 (8.11)
Cloth ware	0.325 (16.24)	-	0.325 (16.24)	0.330 (17.46)	-	0.330 (17.46)
Cotton	0.090 (4.51)	-	0.090 (4.51)	0.096 (5.06)	-	0.096 (5.06)
Wood	-	-	-	-	-	-
Food/garbage	0.555 (27.74)	-	0.555 (27.74)	0.476 (25.22)	-	0.476 (25.22)
Non-biodegradable	0.718±0.349 [0.215-1.610] (35.86)	0.110±0.083 [0.035-0.240] (5.49)	0.608±0.278 [0.173-1.393] (30.37)	0.673±0.241 [0.219-0.918] (35.63)	0.090±0.031 [0.029-0.150] (4.76)	0.583±0.233 [0.180-0.768] (30.87)
Plastic ware	0.440 (22.00)	0.048 (2.38)	0.392 (19.62)	0.383 (20.30)	0.030 (1.57)	0.353 (18.73)
Metallic ware	0.110 (5.50)	-	0.110 (5.50)	0.111 (5.90)	-	0.111 (5.90)
Glass ware	0.139 (6.93)	0.062 (3.11)	0.077 (3.82)	0.135 (7.16)	0.060 (3.19)	0.075 (3.97)
Rubber	0.022 (1.11)	-	0.022 (1.11)	0.024 (1.25)	-	0.024 (1.25)
Egg shell/bones	0.006 (0.32)	-	0.006 (0.32)	0.019 (1.42)	-	0.019 (1.42)
Inert material	0.175±0.11 [0.043-0.223] (8.74)	-	0.175±0.110 [0.043-0.223] (8.74)	0.161±0.096 [0.046-0.190] (8.52)	-	0.161±0.096 [0.046-0.190] (8.52)
Total	2.002±0.798 [0.796-3.919] (100)	0.110±0.083 [0.035-0.240] (5.49)	1.892±0.715 [0.761-3.679] (94.51)	1.889±0.641 [0.593-3.562] (100)	0.090±0.031 [0.029-0.150] (4.76)	1.799±0.623 [0.543-3.510] (95.24)



Table – 2: Average solid waste generation and separation at Kathua Town

Average solid waste	Biodegradable (B)	Non-biodegradable (NB)	Inert Material (IM)	Total = (B+NB+IM)
Gross average/capita/day at source (G) kg/day	1.264±0.354 (0.220-4.490)	0.739±0.129 (0.159-1.610)	0.214±0.054 (0.043-0.991)	2.217±0.344 (0.510-5.919)
Average/capita/day separated at source (r) kg/day	-	0.087±0.031 (0.022-0.350)	-	0.087±0.031 (0.022-0.350)
Net average/capita/day generated (G-r) kg/day	1.264±0.354 (0.220-4.490)	0.652±0.138 (0.131-1.393)	0.214±0.054 (0.043-0.991)	2.130±0.342 (0.415-5.773)
Gross average/day at source G x 250* (tones/day)	0.32	0.18	0.05	0.55
Average/day separated at source r x 250* (tones/day)	-	0.02	-	0.02
Net average/day generated (G-r) x 250* (tones/day)	0.32	0.16	0.05	0.53

* 250 medical beds as per record of BMO office Kathua

Table – 3: Average generation and separation of recyclable solid waste at source in Kathua Town

Average solid waste (kg/capita/day)	Non-Biodegradable (NB) kg.	Non-Biodegradable (NB) kg.	Total Non-Biodegradable (NB) kg/capita/day
	Plastic ware	Metallic ware	Total (kg) NB= PI+MW
Average/capita/day generated at source (R)	0.380± 0.157 (17.73)	0.175±0.048 (7.81)	0.555 (25.54)
Average/capita/day separated at source (r)	0.040±0.037 (10.52)	0.047±0.017 (26.85)	0.087 (15.67)
Net average/capita/day generated at source (R-r)	0.339±0.160 (89.21)	0.128±0.045 (73.14)	0.467 (84.14)

Figures in () is showing percentage by weight (Table-1a-1d) Figures in [] showing ranged values (Table-1a-1d)

* Metallic ware – tin boxes, scrap.

* Plastic ware – plastic bottles, buckets, scraps, plastic woven sack.

Avg. Recyclable Non-Biodegradable solid waste (kg/day) generated at source = 0.555 × 250 = 0.14 tones/day.

Avg. Total Recyclable solid waste (kg/day) at source = 0.555 × 250 = 0.14 tones/day.

Avg. Recyclable Non-biodegradable solid waste (kg /day) separated at source = 0.087 × 250 = 0.02 tones/day.

Avg. Total Recyclable solid waste (kg /day) separated at source = 0.087 × 250 = 0.02 tones /day.

Net avg. Recyclable Non-biodegradable solid waste (kg /day) = 0.467 × 250 = 0.11 tones /day.

Net avg. Total Recyclable solid waste (kg /day) = 0.467 × 250 = 0.011 tones/day.



Recommendations

Ideally, medical wastes must be segregated category wise and rendered harmless through physical separation and disinfection and disposed off in secured landfills or incinerated.

The authority must require those persons deployed for handling medical wastes must have the basic knowledge and technical skills for this specialized task.

A well directed public awareness campaign.

A strong monitoring system, which determines accountability of the polluter and of the handler of the hazardous wastes.

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