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Full Length Research Paper

Bio-medical wastes disposal and management in some major hospitals of Mysore City, India

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The disposal of biomedical wastes have been studied at various hospitals like, Krishnarajendra Hospital, Mission Hospital, J.S.S. Hospital, Basappa Memorial Hospital, Apollo Hospital and Vikram Hospital for the period of six months by analyzing the procurement lists. Various issues like quantities and proportions of different categories of wastes handling, treatment and disposal methods have been examined. The process of segregation, collection, transport, storage and final disposal methods of infectious and non-infectious wastes have also been observed. One way analysis of variance test has been carried out to determine the possible interrelationship between the wastes originating from different departments of different hospitals. The proper disposal methods have not been employed in K.R. Hospital followed by J.S.S. Hospital and Mission Hospitals when compared to other hospitals. In addition, the differences in the infrastructure were examined and the consequences for waste segregation and disposal methods were also discussed under economic and ecological aspects. For this existing problem, proposed systems of bio-medical waste management are described to improve the disposal practices. A waste management strategy has also been proposed.

Key words: Environment, hospitals, bio-medical wastes, disposal, infectious wastes, non infectious wastes, solid wastes.

INTRODUCTION

Disposal of Bio-medical wastes has emerged as a major problem in India. The public is increasingly concerned over improper disposal of hazardous wastes and bio - medical wastes are still handled and disposed together with domestic wastes, thus creating a great health risks to both the public and the environment. Hospitals are known for the treatment of sick persons but, we are unaware about the adverse effects of the garbage and filth generated by them on human health. The waste is increasing in its amount and type due to advances in scientific knowledge and has an impact on human lives (Rao and Garg, 1994). There are quite a few research reports on the Biomedical waste disposal. They include Althaus et al. (1983), Blemkhan and Oakland(1989), Brown (1993), Culicova et al.(1995), Da Silva et al. (2005), Klanowaski et al. (1993), Mubarak (1998), Patil and Shekdar (2001), Singh and Sharma (1996). Most of them have dealt with the effects and consequences of unmanaged hospital wastes in major cities. Mysore city with a large population has many private as well as Government hospitals that generate huge amounts of wastes every day. Disposal techniques are not perfect. Newer technologies are not adopted and therefore waste disposal methods have suffered leading to various problems in the city.

No rational decision on waste management is possible until the generation and composition of solid waste is known. The disposal methods, which may be conditioned by proportions is of recycled, degradable and non degradable materials (Trivedi and Raj, 1992). Hence, the present study was undertaken to know the disposal practices of bio-medical wastes, to suggest proper disposal methods and management of bio-medical wastes in six major hospitals of Mysore City viz, Krishnarajendra Hospital, Mission Hospital, J.S.S. Hospital, Basappa Memorial Hospital, Apollo Hospital and Vikram Hospital.

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Table 1. List of hospitals and bed's capacity selected for the study.

Name of the hospitals	Beds capacity
Krishnarajendra Hospital (KRH)	1050
Mission Hospital (MH)	300
J.S.S. Hospital (JSSH)	1130
Basappa Memorial Hospital (BMH)	350
BGS Apollo Hospital (APH)	250
Vikram Hospital (VH)	104

Table 2. Type of container and colour coding for hospital waste disposal.

Waste class	Type of container	Colour coding
Human anatomical wastes.	Plastic bags	Yellow
Animal waste	- do -	- do -
Microbiology and biotechnology wastes	- do -	Yellow / Red
Wastes sharp	Plastic bag - puncture proof containers	Blue / White Translucent
Discarded medicines and cytotoxic wastes	Plastic bags	Black
Solid Bio – medical waste	- do -	Yellow
Solid (Plastic) Disposable tubings	Plastic bag – puncture proof containers	Blue / White Translucent
Incineration waste	Plastic Bag	Black
Chemical waste(Solid)	- do -	- do -

MATERIALS AND METHODS

The present study was carried out in various hospitals like Krishnarajendra (Government Hospital), Mission, J.S.S., Basappa Memorial l, Apollo l and Vikram Hospital, Mysore respectively.

Average number of total waste bags generated was studied for a period of six months that is, July, August, September, October and December of the year 2009. The average generation of various infectious and non infectious waste items per hospital unit area was recorded. Observations were also made on the separation of wastes, collection of various recyclable plastic and glass wares by sweepers during sweeping.

The average number of patients per day (A), average waste per capita per day (C) and average solid waste generated per day at each source (S) at each hospital was calculated using the standard formula. Then, the average collection of recyclable wastes, that is, plastic ware (P) and glass wares (G) at each hospital was also calculated by using the prescribed formula, (Rampal et al., 2002). Besides, the net solid waste generated at dust bin (S - R) Solid waste incinerated per day and net solid waste generation at each study site was also calculated. Lastly various management approaches and guidelines were also given for the proper disposal of wastes generated from the different hospitals.

All the obtained data were analyzed using one way analysis of variance (Anova) and the overall means were compared using DMRT (Duncan Multiple Range Test) and performed after the significant F-test. The different alphabets indicated as superscripts under each column/rows were found to be significant under the Duncan Multiple Range Test.

RESULTS

The data on the bed's capacity and patients of each hospital was obtained from the hospital records that is, 1050 beds at K. R. Hospital, 300 beds at Mission Hospital, 1150 beds at JSS Hospital, 350 beds at BM Hospital, 250 beds at Apollo Hospital and 104 beds at Vikram Hospital along with type of color coding for hospital disposal (Table 1 and 2 and Figure 1).

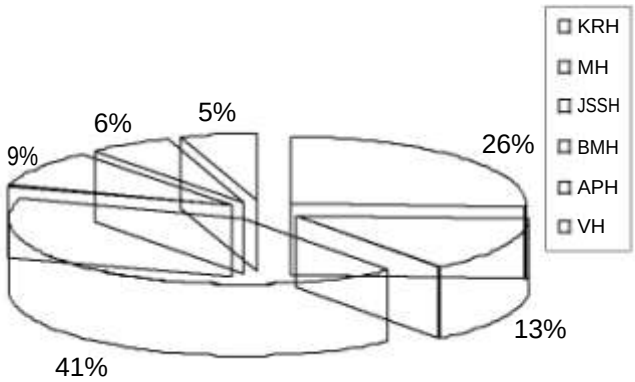

Figure 1. Average no. of patients per day in six major hospitals of Mysore.

The total number of different colors of waste bags that is, yellow bag, red bag, black bag, blue bag and white bag generated per day per month of July was observed to be 40.69 in K.R. Hospital, 14.16 at Mission Hospital, 39.51 at J.S.S. Hospital, 14.02 at B.M. Hospital, 11.51 at

Table 3. Average number of different total waste bags generated from the 6 major hospitals during 6 months - 2005 (Average total bags per day per month)

Months	Hospitals					
	KRH	MH	JSSH	BMH	APH	VH
July	40.69*	14.16*	39.51*	14.02 ns	11.51 ns	12.49 ns
August	37.42*	12.65 ns	36.30*	12.98 ns	10.49 ns	22.40** ns
September	37.09*	19.60*	64.28*	24.66**	19.44*	12.54 ns
October	57.45**	22.77**	34.66*	14.14 ns	9.98 ns	11.76 ns
November	69.44**	13.81 ns	50.73**	19.31*	20.91*	18.45*
December	39.60*	13.20 ns	22.59 ns	11.98 ns	11.87 ns	12.61 ns

** = Significant at 1% level, * = Significant at 5% level, ns = Non Significant.

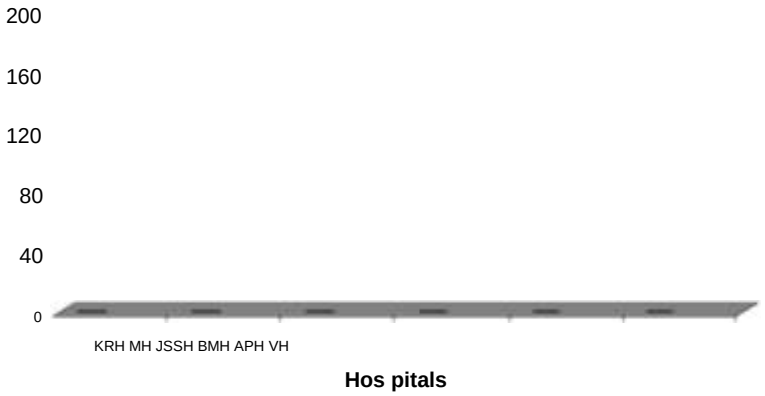

Figure 2. Average wastes generated per day in six major hospitals of Mysore city.

Apollo Hospital and 12.49 at Vikram Hospital, respectively (Table 3).

In the month of August, the total number of waste bags generated was observed to be 37.42, 12.65, 36.30, 12.98, 10.49, and 22.41, at the above hospitals respectively. Similarly, the total number of waste bags in September month was 37.09 in K.R. Hospital, 19.60 in Mission Hospital, 64.28 in JSS Hospital, 24.66 in BM Hospital, 19.24 in Apollo Hospital and 12.54 at Vikram Hospital were recorded (Table 3). It was also observed that, the average waste bags generated per day during October month was 57.45 in K.R.Hospital, 22.77 in Mission Hospital, 34.66 in JSS Hospital, 14.14 in B.M. Hospital, 9.98 in Apollo Hospital and 11.76 in Vikram Hospital study sites respectively. Similarly an average number of waste bags in the month of November was 69.44, 13.81, 35.73, 19.31, 20.91, 18.45, were observed at the above mentioned health centers respectively (Table 3). In the month December, the total numbers of waste bags were found to be 39.60 in K.R.Hospital, 13.20 in Mission Hospital, 22.59 in JSS Hospital, 11.98 in B.M. Hospital, 11.87 in Apollo Hospital and 12.61 in Vikram Hospital (Table 3). Besides, the number of individual color coding waste bags at each hospital for the period of 6 months was also tabulated in the Table 3.

The average generation of waste from all the sources or departments of K.R. Hospital (6.63 kg/bed/day), Mission Hospital (4.35 kg/bed/day), JSS Hospital (11.09 kg/bed/day), BM Hospital (4.46 kg/bed/day), Apollo Hospital (5.90 kg/bed/day) and Vikram Hospital (4.69 kg/bed/day), was observed respectively (Table 6). The total average generation per capita per day in all the health centers was observed to be 0.45 kg in KR Hospital, 0.30 kg in Mission Hospital, 0.31 kg in JSS Hospital, 0.49 kg in BM Hospital, 0.55 kg in Apollo Hospital and 0.69 kg in Vikram Hospital respectively (Table 6). On this rate, the average waste generated per day at each study site was found to be 184.5 kgs in K.R. Hospital, 63.00 kgs in Mission Hospital, 195.30 kgs in J.S.S. Hospital, 71.05 kgs in B.M. Hospital, 49.55 kgs in Apollo Hospital and 58.65 kgs Vikram Hospital respectively (Table 6 and Figure 2). An average collection of recyclable plastic wares comprising of glucose bottles, spirit bottles and H_2O_2 bottles was observed to be 9.60, 3.2, 15.61, 6.71, 3.1, and 2.2 kgs, generated at each hospitals mentioned above respectively (Table 6). Whereas, collection of

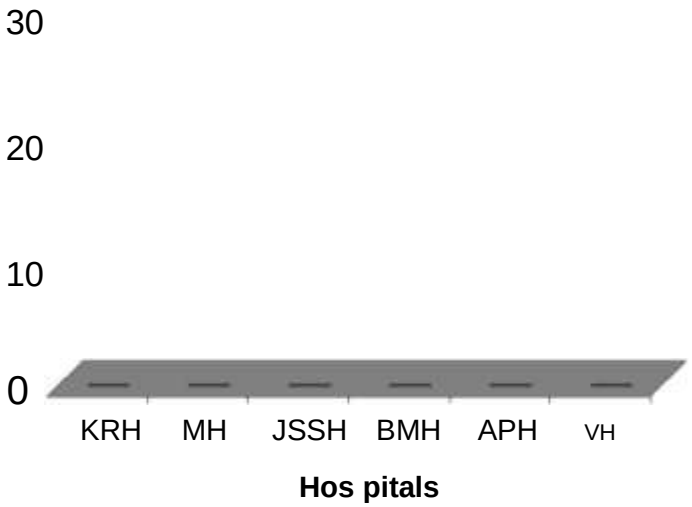

Figure 3. Average collection of recyclable wastes at hospital sources.

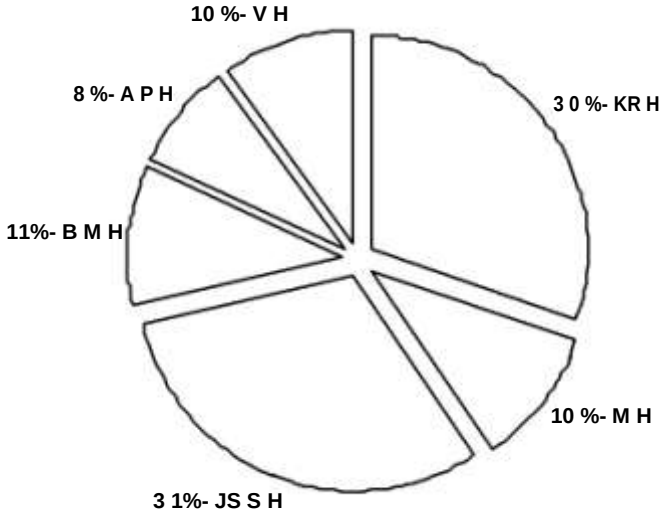

Figure 4. Net solid wastes generated at dust bin in six major hospitals of Mysore city.

Glass wares comprising of Savlon bottles, Betadine bottles and other medicine bottles, vials were observed to be 6.75 kgs/day at KR Hospital , 2.3 kgs/day at Mission Hospital, 9.66 kgs/day at JSS Hospital, 4.9 kgs/day at BM Hospital, 1.7 kgs/day at Apollo Hospital and 1.6 kgs/day at Vikram Hospital (Table 6).

Thus in total, 16.35, 5.5, 25.3, 11.61, 4.8 and 3.8 kgs/day of plastic and glass wares at each sites, KR Hospital, Mission Hospital, JSS Hospital, BM Hospital, Apollo Hospital and Vikram Hospital respectively were observed to be collected by 'Safaikarmacharis' during sweeping and these plastics and glass wastes were not in negligible amount at the Hospital dumping dust bins or sites. Sometimes, the number of disposal of above said wastes can also be changed with respect to the days and months (Table 6 and Figure 3).

The qualitative and quantitative composition of infectious and non - infectious wastes has been tabulated in the Table 7 and 8. In addition, it was also observed that, no incinerator was established at all the selected hospitals, only crude method of incineration process, that is, burning of waste in the open ground was observed Most of the wastes goes to dumping site along with municipal waste, only a few wastes are being managed by a private agency called Shri Consultants, Mysore. However, an average solid waste of 42.05kgs/day at KR Hospital, 16.35 kgs/day at Mission Hospital, 56.26 kgs/day at JSS Hospital, 13.09 kgs/day at BM Hospital, 10.23 kgs/day at Apollo Hospital and 11.01 kgs/day at Vikram Hospital was observed to be incinerated every day using crude method (Table 6 and Figure 5). So after, deduction of plastic and glass wares by safai Karmacharis and waste incinerated per day, the net generation of solid waste per day at dust bin in KR Hospital (168.15 kgs), Mission Hospital (57.50 kgs), JSS Hospital (170.01 kgs), BM Hospital (59.44 kgs), Apollo Hospital and (44.70 kgs), Vikram Hospital was observed respectively (Table 6 and Figure 4).

The percentage composition of infectious and non-infectious wastes has been shown in Tables 6 and 7 the comparative analyses were also made. The net generation of wastes was 126.10 kgs/day at KR Hospital, 41.15kgs/day at Mission Hospital, 113.74 kgs/day at JSS Hospital, 46.35 kgs/day at BM Hospital, 34.47 kgs/day at Apollo Hospital and 43.84 kgs/day at Vikram Hospital are finally disposed off from the vicinity of Hospitals thrice a week except the Hospitals like, Apollo Hospital and Vikram Hospital (Table 6 and Figure 6).

Besides, Ragpickers were also observed at various dumping sites lifting syringes, needles, surgical blades,

Table 4. Average number of individual waste bags generated from all six major hospital of Mysore city during six months - 2005 (Average no. bags per day per month).

Different bags	Months					
	July	August	September	October	November	December
Yellow Bag (YB)	23.35*	22.83*	29.39**	24.66*	31.45**	20.05*
Red Bag (RB)	6.03 ns	6.18 ns	9.26 ns	8.98 ns	15.55*	6.44 ns
Black Bag (BB)	32.95**	29.16*	27.74*	28.76*	31.46**	26.90*
Blue Bag (BLB)	12.23*	11.92 ns	15.69	14.03*	15.47*	10.50 ns
White Bag (WB)	6.80 ns	7.81 ns	22.23**	13.31*	26.12**	6.79 ns

** = Significant at 1% level, * = Significant at 5% level, ns = Non significant.

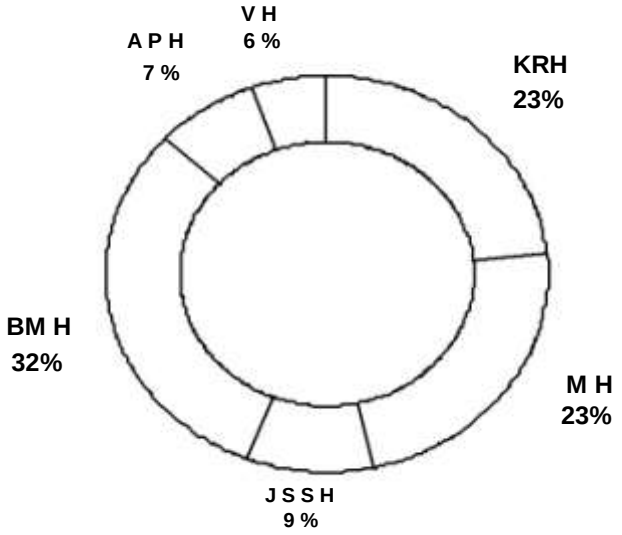

Figure 5. Solid wastes incinerated per day in all the major six hospitals.

surgical gloves, plastic bags, blood bags, urine bags etc., thereby exposing themselves to various infectious diseases. Various items collected by Ragpickers as well as Safai Karmacharis at hospitals are sold in market to be recycled for medicinal or non-medicinal use both of which are hazardous for human health.

DISCUSSION

From the results so obtained, precise conclusion cannot be drawn. However Table 8 represents a concise account of the data statistically. All the 12 Hospitals studied had varied results during the 6 months of study. Accounting for the significant results at 0.05% level on the different waste bags generated, it was observed that KR Hospital had lower disposal during October and November months ; Mission Hospital had a significant disposal only during September, JSS Hospital had during July, August and October, BM Hospital, Apollo and Vikram Hospital during November.

It is obvious that, K.R. Hospital, JSS Hospital and Mission Hospital had highest amount of disposal because these are general Hospitals and are recognized centers for accident victims. BM Hospital also a recognized centre but probably the waste management here may be good to a little extent. The reasons for such great variations may because these hospitals are located at all entrances of Mysore City. A large number of villagers also depend on the nearest Hospitals. Some Hospitals like, BM Hospital, JSS Hospital, Apollo Hospital are super specialty Hospitals, in addition to being general and therefore the number and type of patients coming into the Hospitals differs considerably, this is evident from Table 6. Total 21 types of sources of wastes generation have been shown, KR Hospital, Mission Hospital, JSS Hospital, BM Hospital, Apollo Hospital and Vikram Hospital where almost all types of diseases are treated and hence generation of waste bags are definitely high. However, the problem is not waste generation but waste management (Table 5).

Table 4 indicates the average number of waste bags generated from the six hospitals studied; it was observed that, Yellow, Blue and Black Bags shows significant waste bags for 4 months out of 6 months during the course of study. While, Red and White Bag were really not a problem. Therefore, various strategies for management of these wastes generated are to be thought off.

New strategies of management

Keeping the above fact in mind, the following management strategies are proposed to overcome the problem of improper disposal of Bio - medical wastes.

i. Segregation of bio - medical wastes should be done at the sources of generation as per the categories mentioned in the rule.
ii. The classification of Bio - medical waste with respect to

Table 5. Waste generation at various sources in 6 major hospitals of Mysore city (Generation Rates Kg/Bed/Day).

Sources	KRH	MH	JSSH	BMH	APH	VH	Mean total
Medical	16.21	11.61	27.49	12.29	10.01	7.24	14.14
Surgical	9.24	9.61	17.10	10.05	13.15	9.86	11.50
Gynae and Obstt.	3.21	8.86	8.88	9.25	9.62	6.44	11.51
Orthopaedic	8.86	4.12	10.16	5.04	5.59	5.37	6.51
Cardiac	4.51	3.61	6.10	4.02	6.67	13.21	6.35
CCU	5.10	4.71	15.21	5.35	8.91	11.04	8.38
Neurology	2. 19	1.61	3.91	2.20	4.01	3.91	2.97
Urology	2.01	1.40	3.62	2.31	3.60	4.05	2.82
ENT	14.12	6.59	13.29	5.41	4.01	3.39	7.80
EYE	9.61	5.19	11.12	4.21	3.81	4.27	6.36
Paediatric	3.62	1.69	4.67	1.42	2.01	3.71	2.85
Nephrology	2.01	0.06	12.06	2.31	2.91	2.39	3.62
Plastic Surgery	0.02	-	1.71	-	2.02	-	0.62
Skin	6.59	2.15	8.01	3.11	4.01	-	3.97
Burns	7.19	3.09	7.69	4.09	5.59	-	4.60
Accidental	6.66	4.59	10.29	5.28	7.01	6.21	6.67
Psychiatry/Psychia	1.61	-	3.92	-	2.21	-	1.29
Blood Bank	12.80	6.50	18.21	4.49	8.91	6.44	9.55
Dental	8.61	4.92	14.31	3.31	6.59	-	6.29
First Aid	6.21	7.59	29.01	6.50	11.31	8.93	11.59
T.B and Leprosy	-	3.51	6.15	3.19	2.06	2.05	2.82
Total	6.63	4.35	11.09	4.46	5.90	4.69	6.18

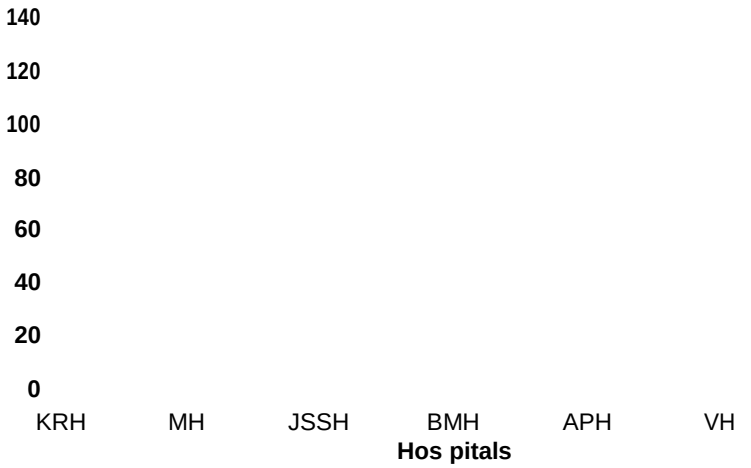

Figure 6. Solid wastes generated at all the six hospitals.

to color coding container has to be done.

iii. The transportation of bio-medical waste is to be done through desiccated vehicle specially constructed for the purpose.

iv. Proper treatment of different wastes is to be done after the classification.

v. All the generations of bio - medical waste should adopt universal precautions and appropriate safety measures while doing the therapeutic and diagnostic activities and also handling the bio - medical wastes.

vi. Training should be conducted to all categories of staff in appropriate language / medium and in an acceptable manner.

vii. The annual reports, accident reports as required under Bio - medical waste rule should be submitted to the

Table 6. Solid wastes generation in six major hospitals of Mysore city.

Hospitals	Average No. patients / day (A)	Average waste /capita / day (C)	Average waste generated /day S= AXC	Average collection of recyclable waste at Source Plastic Wares P	Glass G	Total P+G=R	Net sold waste generation at Dust bin S-R	Solid wastes incinerated/day	Net solid wastes generation at Hospitals
KRH	410	0.45	184.5	9.60	6.75	16.35	168.15	42.05	126.10
MH	210	0.30	63.0	3.20	2.3	5.5	57.5	42.05	41.15
JSSH	630	0.31	195.3	15.61	9.66	25.3	170.00	16.35	113.74
BMH	145	0.41	71.05	6.71	4.9	11.61	59.44	56.26	46.35
APH	90	0.55	49.55	3.1	1.7	4.8	44.7	13.09	34.47
VH	85	0.69	58.65	2.2	1.6	3.8	54.85	10.23	43.84

Metallic ware - It includes metallic seal, tablet, covers, aluminum foil, Ointment tube etc.
Plastic ware - It includes glucose bottles, tablet can, Hydrogen Peroxide bottles, Sprit bottles etc.
Glass ware - It includes injection vials, ampoules, bottles, syrup bottles etc.
Rubber - It includes bottle stoppers.
Paper - It includes news paper, wrappings, bags and soap covers etc.
Polythene - It includes polythene bags etc.
Food - It includes rice, meat, peeling, Chapatti, egg shell etc.
Inert material - It includes dust, sand, paper bits, soil etc.

Table 7. Qualitative and quantitative composition of infectious wastes in percentage by weight in six major hospitals of Mysore city.

Infectious wastes	Hospitals						Mean total
	KRH	MH	JSSH	BMH	APH	VH	
Metalic ware	1.45	0.49	3.41	0.56	1.65	0.34	1.31
Disposable Needle	0.84	0.37	2.95	0.51	1.34	0.41	1.07
Surgical Blade	0.51	1.12	1.59	1.14	1.51	2.06	1.32
Plastic ware	29.16	9.14	41.55	8.24	19.40	21.61	21.51
Disposable Syringe	3.14	4.24	6.51	3.61	4.84	4.01	4.39
Scalp vein set	5.10	1.81	3.43	1.95	3.93	1.06	2.88
Medicut	2.50	0.91	3.05	1.31	2.08	1.84	1.94
Drip Set	4.22	2.59	7.13	2.71	4.01	2.51	3.86
Urine bag	2.01	2.21	4.23	2.61	2.65	2.16	2.64
Ryle Tube	3.09	1.91	3.95	2.05	0.91	1.31	2.20
Blood Bag	3.79	2.61	4.19	2.89	2.25	2.81	3.09
Kidney Tubing	0.49	0.51	1.59	0.89	0.41	1.51	0.90
Rubber	11.49	6.51	8.34	7.09	6.71	5.16	7.55
Catheter	2.61	1.11	3.79	1.23	0.73	1.14	1.76
Gloves	3.01	1.71	3.51	1.65	1.84	2.08	2.30
Cotton	18.25	21.61	31.54	23.19	24.01	18.41	22.83
Cloth ware	31.14	19.15	51.80	18.24	18.64	13.10	25.34
Bandage	3.14	2.61	4.51	2.83	3.05	3.14	3.21
Rolled Bandage	3.65	5.13	5.19	6.35	4.86	4.10	4.88
Bandage Cloth	1.21	2.64	4.52	3.05	2.66	3.81	2.98
Gauze	2.18	3.01	3.82	3.44	2.56	3.39	3.06
Tape Role	3.21	1.65	7.01	2.06	1.81	1.40	2.85
Adhessive	7.12	9.01	4.19	10.66	10.33	6.01	7.88
Gyp.-plaster of paris	0.16	2.03	3.70	2.33	3.55	2.15	2.32
Disposable mask	0.66	1.21	3.81	1.39	3.41	1.49	1.99
Gynae waste	4.80	10.41	9.55	11.66	12.10	7.10	9.27
Average. total generation of infectious waste / day	5.72	4.45	8.80	4.75	5.43	4.38	5.58

Table 8. Showing qualitative and quantitative composition of non-infectious waste in percentage by weight in six major hospitals of Mysore city.

Non-Infectious waste	Hospitals						Mean total
	KRH	MH	JSSH	BMH	APH	VH	
Metallic ware	4.01	1.71	5.52	2.04	1.14	1.65	2.67
Plastic ware	6.54	3.23	9.81	3.61	2.79	2.18	4.69
Glass Ware	7.39	4.71	11.50	4.54	3.67	4.31	6.02
Rubber	2.01	1.84	3.65	2.32	2.06	1.44	2.22
Paper	11.01	9.44	16.50	10.51	8.66	9.61	10.95
Polythene	24.13	16.54	31.39	17.91	13.46	13.15	19.43
Food	76.13	56.14	81.14	61.29	60.19	50.16	64.17
Inert material	1.91	0.91	2.09	1.30	0.55	0.91	1.27
Average. total generation of Non-infectious waste/ day	16.64	11.81	20.20	12.94	11.56	10.42	13.92

concerned authority as per B.M.W. rules formula.

viii. Establish effective and sound recycling policy for plastic recycling and get in touch with authorized manufacturers.

ix. There should be co-ordination between hospitals and outside agencies or non government organizations.

Suggestions

i. To set up a central agency this can formulate a course in Hospital Waste Management and award a degree to the successful candidates. This course must be more practical oriented rather than theory and candidates must be directly exposed for the problem.

ii. Each hospital depending upon the size must have a team of such qualified persons only who are capable of managing hospital wastes.

iii. Any other Private or Government sponsored agency which has all facilities of hospital waste management may be authorized to carryout this process.

vi. Separate land far away from dwellings must be allotted for waste disposal where, air pollution control standards are strictly maintained.

v. All hospitals generating any kind of waste must be registered and regularly monitored by a Government agency.

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