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The quantification study of biomedical waste management of the private hospitals in the Allahabad city

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Abstract
The handling and disposal of Bio-medical waste (BMW) proper is very imperative. There are set of rules for handling biomedical wastes worldwide. Unfortunately, due to lack of an adequate training and awareness, in execution of these rules leads to staid health and environment apprehension. The issue of indiscriminate Bio-Medical Waste in India has attracted the attention of the highest judicial body at the level of Hon'ble Supreme court of India and Apex court has, from time to time issued instructions regarding management of Bio-Medical Waste. According to a WHO report, around 85% of the hospital wastes are actually non-hazardous, 10% are infective (hence, hazardous), and the remaining 5% are non-infectious but hazardous (chemical, pharmaceutical and radioactive). In this background in persuasion to the directive of the Court, the Ministry of Environment and Forests, Government of India notified the Bio-Medical Waste (Management and Handling) Rules on 27th July 1998; under the provision of Environment Protection Act 1986. Accordingly, all the hospitals in the public and private sector are now bound to follow these rules to evade legal actions.

Keywords: Quantification study, biomedical waste, waste management

1. Introduction
It is important to know the quantity of waste generated in order to treatment options. However, it is very difficult to estimate the quantity of waste generation rate. Quantity of waste or waste generation rate depends on the hospital's capacity, the number of medical staffs, and the applied practices. In the course of curing health problems, the health care sector produces huge amount of bio-medical waste which may be hazardous to all those who come in contact with this waste. For every health care organization, hazardous waste management is a concern. In the waste management, the health care waste management is a process that helps to ensure proper hospital hygiene and safety of health care workers and communities. Health care workers plays an important role to manage the environmental effects of their practice. Their efforts may seem small, but each step builds a base of sound behavior and thinking that are necessary for the success of the whole. The present study tries to find out the real state of affairs of the awareness, knowledge, attitude and practices of the health care personnel of the different hospitals regarding BMW management. (Shalini Sharma)

2. Objectives
This study is based on the need to:
- Generate Quantitative study and data regarding various components of hospital waste, and its management in the Allahabad city.
- Improve the existing system of medical waste management of the city. (Hasina Quari, Shah Naveed *et al.*)

3. Material and Methods
Quantitative analysis of medical waste generation is needed to determine the potential risk towards the environmental factors and different mankind. All medical wastes are collected under the guidelines of Biomedical Waste Rules 1998. According to rules the biomedical waste should not be store more than 24 hours in a ordinary room temperature. The present study used a statistically designed sampling of waste generation in the hospitals to indicate that the amount of waste produced. The amount of waste is also affected by the mismanagement of waste handling and operators.
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waste should not be store more than 24 hours in a ordinary room temperature. The amount of waste is also affected by the mismanagement of waste handling and operators.

The quantity of wastes is based on the amount of waste produced per capita which is depends or influenced by the number of patients, types of hospitals and treatment facilities available in the hospitals. The waste quantity can be reduced on the site of waste generation by the proper segregation procedures. Segregation of the waste according to the biomedical rules and color-coded containers at point of waste generation can minimize the waste quantity from which only infectious waste or hazardous waste can reach at the common treatment facilities and more treatment procedure can be done in the less time. Because if infectious waste and non-infectious waste, hazardous and non-hazardous waste, degradable and non-degradable waste, and recyclable and non-recyclable waste can segregate at the source of waste generation by which it will helpful or easy to handle the wastes.

To determine the waste generated in hospital an on-site evaluation is the most appropriate way. In this study, the quantity and characteristics of waste produced was investigated by personal observations daily for a period of one year (Aug 2013-Jul 2014). The quantity of BMW generated each day as per its character was recorded and percentages are presented by weight. Precautions like wearing an apron, face mask and use of thick impermeable gloves were taken. The principal investigator and the BMW handlers involved in the study were inoculated against tetanus. Brain storming sessions were held with health care workers 2 times during the study period. As per the study, in spite of high sickness rate among the sanitation staff dealing with health care waste, the awareness regarding the protection of their bodies and manual handling was found to be missing The sanitation staff does understand the relation of waste and diseases but they replied that they have been doing the same for a very long time so they have become immune to many health problems. As a protective measure the municipal collection staff wears a head gear to protect the waste falling on their bodies while loading it in the refuse van. The sanitation staff working in hospital and health care facilities gets free medication from their place of work. The interviews revealed that to avoid absenteeism from work and probably sickness due to handling of waste, the scavengers get the injections once a week or a prior dose of medicines. And also, they were not fully aware of the BMW management rules. Personnel responsible for the disposal of BMW were not adequately trained which led to inappropriate collection, separation of BMW and insufficient implementation of the regulation. These practices contaminate noninfectious waste as infectious. A proposed study area or different hospitals situated in Allahabad city are as follows:

1. Heart line cardiac center
2. Yash Lok hospital & research center
3. Parvati hospital
4. Anand hospital
5. Bharat hospital and orthopedic research center

The data will be collected from common treatment site (FERRO) at a time of interval is vary from every fifteen days

4. Result and Discussion

The following data collected from the site of the common treatment facility, the waste comes from the different hospitals of Allahabad and segregate at the common treatment facility by the workers who handled the biomedical waste under the guidelines of the biomedical waste rules.

4.1 Quantification of Biomedical waste in private hospital

The quantity of wastes is based on the amount of waste produced per capita which is depends or influenced by the number of patients, types of hospitals and treatment facilities available in the hospitals. The waste quantity can be reduced on the site of waste generation by the proper segregation procedures. Segregation of the waste according to the biomedical rules and color-coded containers at point of waste generation can minimize the waste quantity from which only infectious waste or hazardous waste can reach at the common treatment facilities and more treatment procedure can be done in the less time. Because if infectious waste and non-infectious waste, hazardous and non-hazardous waste, degradable and non-degradable waste, and recyclable and non-recyclable waste can segregate at the source of waste generation by which it will helpful or easy to handle the wastes. It is important to know the quantity of waste generated in order to treatment options. However, it is very difficult to estimate the quantity of waste generation rate. Quantity of waste or waste generation rate depends on the hospital's capacity, the number of medical staffs, and the applied practices.

The biomedical waste quantity produced in fortnightly was examined and results of the analysis reported in the tables. The quantity of waste includes Human anatomical waste, Waste sharps, Medicines and cytotoxic drugs, solid waste and liquid waste. Liquid portion of Chemical waste (Cat 10) was generally drained out from the hospital care units and solid portion also was not separately collected. As such quantification of the same could not be possible. So, Categories 8, and 10 have been included in the quantification study but the accuracy of quantity of liquid waste is not assured.

Table 1: Biomedical waste generated in Heart line cardiac Centre hospital

Months	Days	Human anatomical waste	Waste sharps	Medicines & cytotoxic drugs	Solid waste	Total solid waste (kg)	Chemical waste	Liquid waste (Liters)	Total Liquid waste (Liters)
JAN	1-15	35	37	30	43	145	35	45.5	80.5
	16-31	40	45	35	50	170	45	50	95
FEB	1-15	55	60	50	75	240	60	70	130
	16-28	40	45	40	80	205	50	80	130
MAR	1-15	35	40	30	50	155	40	55	95
	16-31	30	35	25	55	145	35	50	85
APR	1-15	35	40	30	50	155	45	55	100
	16-30	30	35	20	65	150	35	60	95
MAY	1-15	40	45	35	50	170	42	52	94
	16-31	30	35	25	45	135	35	55	90
JUNE	1-15	40	45	25	65	175	40	55	95
	16-30	35	40	20	55	150	35	45	80

JULY	1-15	35	45	30	65	175	40	50	90
	16-31	30	35	25	60	150	35	45	80
AUG	1-15	30	45	30	50	155	40	50	90
	16-31	40	50	40	60	190	55	65	120
SEPT	1-15	35	40	30	45	150	40	50	90
	16-30	40	45	20	45	150	45	52	97
OCT	1-15	30	30	20	40	120	30	40	70
	16-31	25	35	10	50	120	25	45	70
NOV	1-15	40	45	30	50	165	35	45	80
	16-30	45	50	20	65	180	45	60	105
DEC	1-15	35	40	30	50	155	30	50	80
	16-31	25	35	25	60	145	25	45	70
Mean		35.63	41.54	28.12	55.13	160.42	39.25	52.9	92.15
Max		55	60	50	80	240	60	80	130
Min		25	30	10	40	120	25	40	70
Std		15.21	15.13	20.03	20.20	61.06	17.60	20.42	30.34

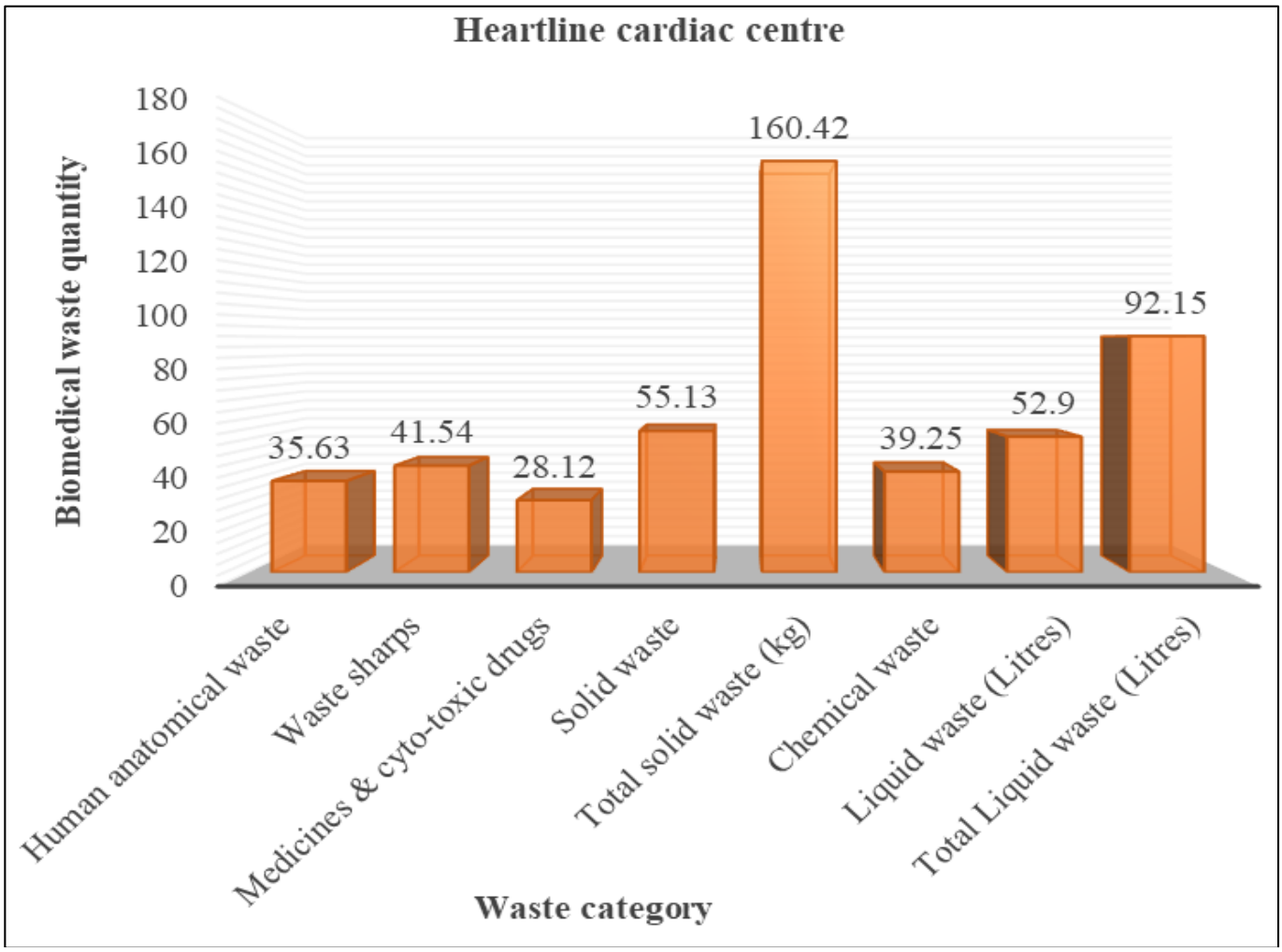

Fig 1: Biomedical waste quantity in Heartline cardiac Centre

Figure 1 showed that biomedical waste quantity in different categories including solid and liquid waste. The average quantity of biomedical waste in different category followed by Human anatomical waste 35.63 kg, Waste sharps 41.54, Medicines and cytotoxic drugs was 28.12 kg, solid waste 55.13 kg and total solid waste(kg) 160.42 kg. In the category of liquid waste contain chemical waste from autoclaving and sterilization process in the hospital. The average quantity of chemical waste 39.25 liter and liquid waste 52.9 liter from the different activities cleaning, washing and floor cleaning generated the quantity of liquid waste.

The minimum and maximum variation of Human anatomical waste 25-55 kg, Waste sharps 30-60 kg, Medicines and cytotoxic drugs 10-50 kg, solid waste 40-80 kg, Total waste 120-240 kg, chemical waste 25-60 liter and liquid waste 40-80 liter respectively. The variation of biomedical waste quantity due to climatic variation and reported number of cases in the hospital. The minimum value was observed in the months of October.

The total quantity of biomedical waste 252.56 kg/yr. is obtained in heartline cardiac center and the total waste of biomedical waste quantity is carried forwarded to the common biomedical waste treatment facility where all wastes are measured by the weighing balance and segregated according to the waste disposal method.

Table 2: Biomedical waste generated in Yash Lok Hospital & Research Centre

Months	Days	Human anatomical waste	Waste sharps	Medicines & cytotoxic drugs	Solid waste	Total solid waste (kg)	Chemical waste	Liquid waste (Liters)	Total Liquid waste (Liters)
JAN	1-15	195	210	75	390	870	235	335	570
	16-31	200	220	80	420	920	230	350	580
FEB	1-15	175	185	85	420	865	195	400	595
	16-28	160	175	75	430	840	185	400	585
MAR	1-15	170	180	85	450	885	190	400	590
	16-31	165	170	90	430	855	180	410	590
APR	1-15	160	170	80	440	850	180	420	600
	16-30	150	165	70	460	845	175	440	615
MAY	1-15	160	170	65	450	845	185	415	600
	16-31	155	165	70	460	850	175	430	605
JUNE	1-15	160	180	85	410	835	200	380	580
	16-30	165	175	80	430	850	195	390	585
JULY	1-15	160	170	90	435	855	175	415	590
	16-31	155	165	80	450	850	175	400	575
AUG	1-15	170	185	90	465	910	195	430	625
	16-31	155	165	80	460	860	175	410	585
SEPT	1-15	175	185	90	480	930	195	445	640
	16-30	125	140	75	420	760	150	390	540
OCT	1-15	145	155	85	450	835	170	420	590
	16-31	135	140	70	440	785	150	432	582
NOV	1-15	140	150	85	465	840	170	390	560
	16-30	145	155	80	470	850	165	420	585
DEC	1-15	210	230	80	360	880	245	310	555
	16-31	190	200	65	400	855	220	380	600
Mean		163.33	175.21	79.58	436.88	855.00	187.92	400.50	588.42
Max		210.00	230.00	90.00	480.00	930.00	245.00	445.00	640.00
Min		125.00	140.00	65.00	360.00	760.00	150.00	310.00	540.00
Std		42.57	45.35	12.56	60.79	85.20	47.82	68.79	50.01

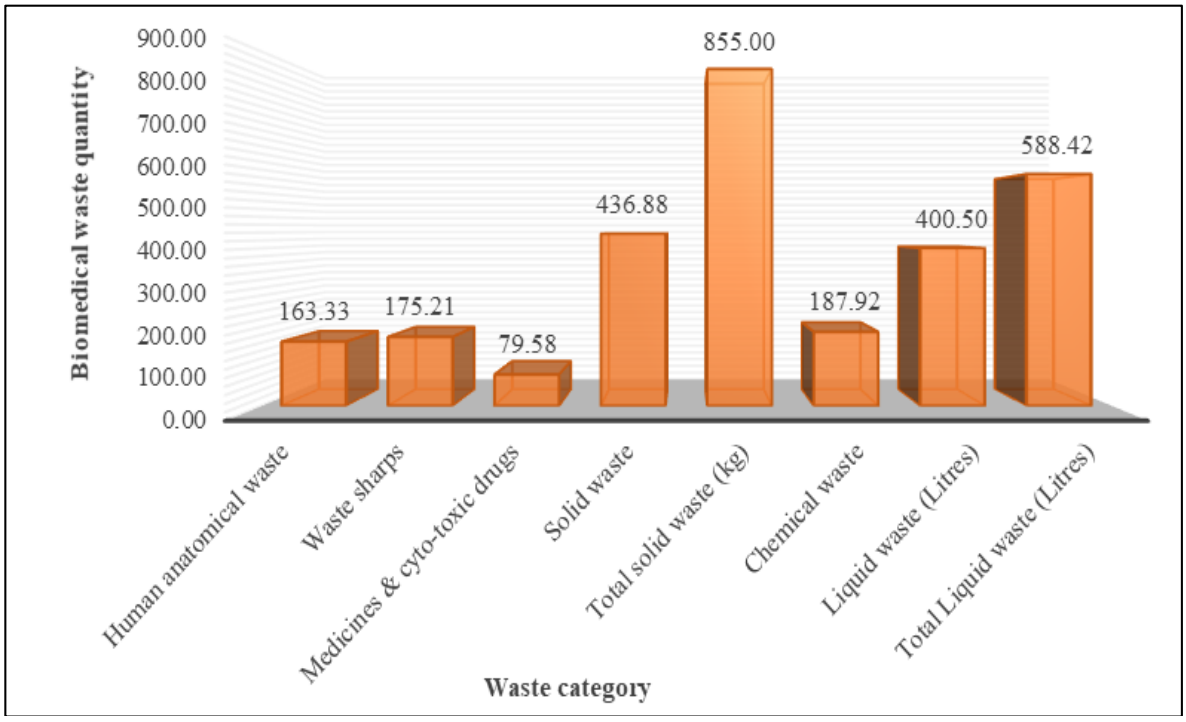

Fig 2: Biomedical waste quantity in Yash Lok hospital and research center

Figure 2 showed that biomedical waste quantity in different categories including solid and liquid waste. The average quantity of biomedical waste in different category followed by Human anatomical waste 163.33 kg, Waste sharps 175.21 kg, Medicines and cytotoxic drugs was 79.58 kg, solid waste 436.88 kg and total solid waste(kg) 855.00 kg. In the category of liquid waste contain chemical waste from autoclaving and sterilization process in the hospital. The average quantity of chemical waste 187.92 liter and liquid waste 400.50 liter from the different activities cleaning, washing and floor cleaning generated the quantity of liquid waste. The minimum and maximum variation of Human anatomical waste 125-210 kg, Waste sharps 140-230 kg, Medicines and cytotoxic drugs 65-90 kg, solid waste 360-480 kg, Total solid waste 760-930 kg, chemical waste 25-60 liter and liquid waste 40-80 liter. The variation of biomedical waste quantity due to climatic variation and reported number of cases in the hospital. The minimum value was observed in the months of October.

Table 3: Biomedical waste generated in Parvati Hospital

Months	Days	Human anatomical waste	Waste sharps	Medicines & cytotoxic drugs	Solid waste	Total solid waste (kg)	Chemical waste	Liquid waste (Liters)	Total Liquid waste (Liters)
Jan	1-15	116	129	75	350	670	110	172	282
	16-31	168	122	74	350	714	114	176	290
Feb	1-15	164	176	160	246	746	100	138	238
	16-28	150	164	152	218	684	82	144	226
Mar	1-15	160	174	142	228	704	102	164	266
	16-31	164	176	144	230	714	104	166	270
Apr	1-15	154	162	132	216	664	96	164	260
	16-30	160	168	138	222	688	100	172	272
May	1-15	158	170	140	220	688	102	170	272
	16-31	164	172	142	222	700	106	168	274
June	1-15	150	168	140	208	666	104	170	274
	16-30	154	170	142	210	676	104	174	278
July	1-15	164	167	132	205	668	102	185	287
	16-31	148	164	124	224	660	109	191	300
Aug	1-15	146	164	132	202	644	90	166	256
	16-31	154	172	140	210	676	98	176	274
SEPT	1-15	148	162	128	204	642	96	164	260
	16-30	158	172	138	214	682	106	172	278
Oct	1-15	138	160	124	202	624	92	160	252
	16-31	140	162	122	198	622	96	162	258
Nov	1-15	130	135	129	255	649	99	168	267
	16-30	148	170	130	206	654	106	170	276
Dec	1-15	152	174	134	210	670	110	172	282
	16-31	154	176	136	212	678	106	176	282
Mean		151.75	163.71	131.25	227.58	674.29	101.42	168.33	269.75
Max		168.00	176.00	160.00	350.00	746.00	114.00	191.00	300.00
Min		116.00	122.00	74.00	198.00	622.00	82.00	138.00	226.00
Std		26.60	28.30	43.78	80.59	62.25	16.12	26.59	37.20

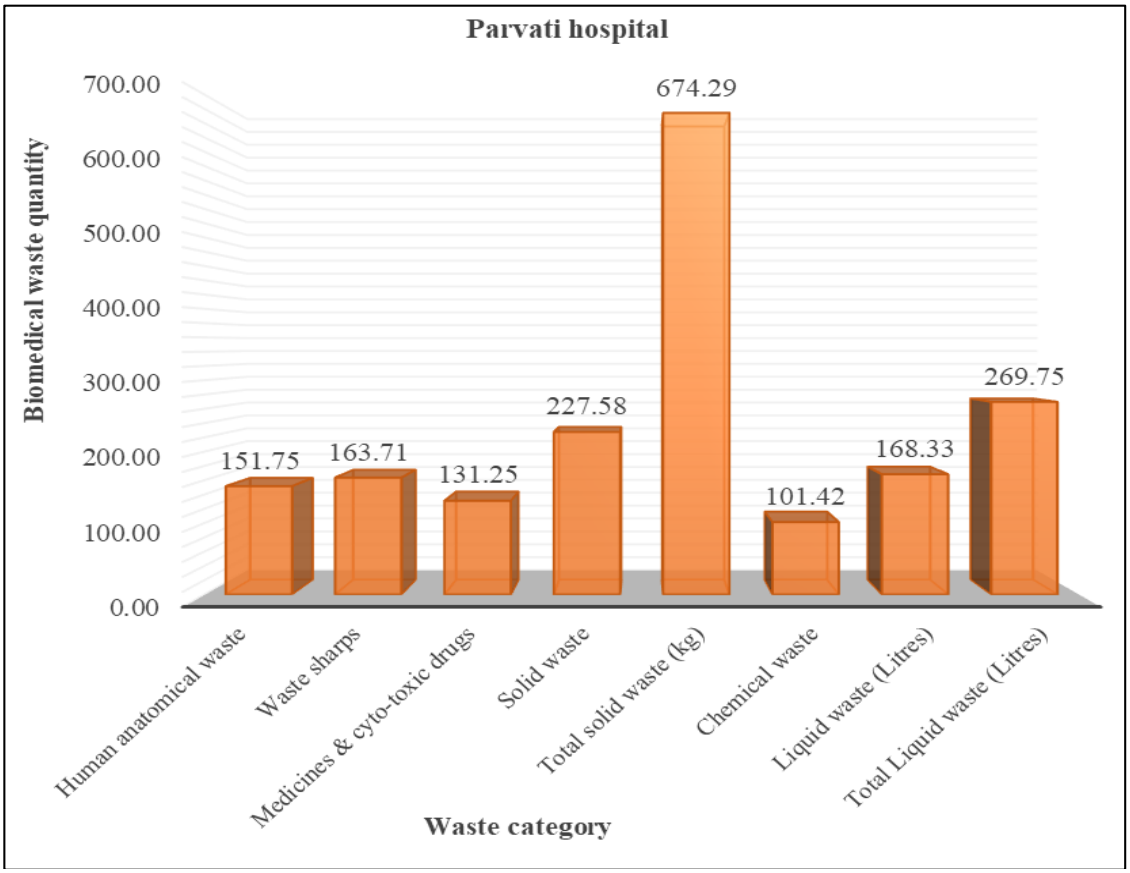

Fig 3: Biomedical waste quantity in Parvati hospital

Figured 3 showed that biomedical waste quantity in different categories including solid and liquid waste. The average quantity of biomedical waste in different category followed by Human anatomical waste 151.75 kg, Waste sharps 163.71 kg, Medicines and cytotoxic drugs was 131.25 kg, solid waste 227.58 kg and total solid waste(kg) 674.29 kg. In the category of liquid waste contain chemical waste from autoclaving and sterilization process in the hospital. The average quantity of

chemical waste 101.42 liter and liquid waste 168.33 liter from the different activities cleaning, washing and floor cleaning generated the quantity of liquid waste.

The minimum and maximum variation of Human anatomical waste 116-168 kg, Waste sharps 122-176 kg, Medicines and cytotoxic drugs 74-160 kg, solid waste 198-350 kg, Total solid waste 622-746 kg, chemical waste 82-114 liter and liquid waste 138-191 liter. The variation of biomedical waste quantity due to climatic variation and reported number of cases in the hospital. The minimum value was observed in the months of January and February.

Table 4: Biomedical waste generated in Anand Hospital

Months	Days	Human anatomical waste	Waste sharps	Medicines & cytotoxic drugs	Solid waste	Total solid waste (kg)	Chemical waste	Liquid waste (Liters)	Total Liquid waste (Liters)
Jan	1-15	192	270	192	412	1066	210	284	494
	16-31	188	266	188	404	1046	206	280	486
Feb	1-15	180	258	90	396	924	198	358	556
	16-28	194	272	96	414	976	184	294	478
Mar	1-15	184	262	91	404	941	186	367	553
	16-31	186	264	90	406	946	184	370	554
Apr	1-15	170	260	82	414	926	160	318	478
	16-30	184	278	102	424	988	184	378	562
May	1-15	184	272	133	455	1044	190	280	470
	16-31	196	280	140	470	1086	194	284	478
June	1-15	192	276	135	457	1060	192	282	474
	16-30	194	278	136	460	1068	190	288	478
July	1-15	190	274	134	454	1052	186	292	478
	16-31	194	278	136	462	1070	184	296	480
Aug	1-15	174	258	126	448	1006	160	260	420
	16-31	162	246	140	410	958	148	244	392
Sept	1-15	180	264	129	457	1030	170	260	430
	16-30	170	254	124	436	984	160	250	410
Oct	1-15	178	262	128	454	1022	168	260	428
	16-31	166	252	123	439	980	162	244	406
Nov	1-15	184	268	126	460	1038	180	268	448
	16-30	190	280	132	468	1070	192	272	464
Dec	1-15	192	282	133	471	1078	188	276	464
	16-31	194	284	132	472	1082	192	278	470
Mean		184.08	268.25	126.58	439.46	1018.38	182.00	290.96	472.96
Max		196.00	284.00	192.00	472.00	1086.00	210.00	378.00	562.00
Min		162.00	246.00	82.00	396.00	924.00	148.00	244.00	392.00
Std		10.42	11.14	29.49	26.41	54.89	17.05	41.72	50.21

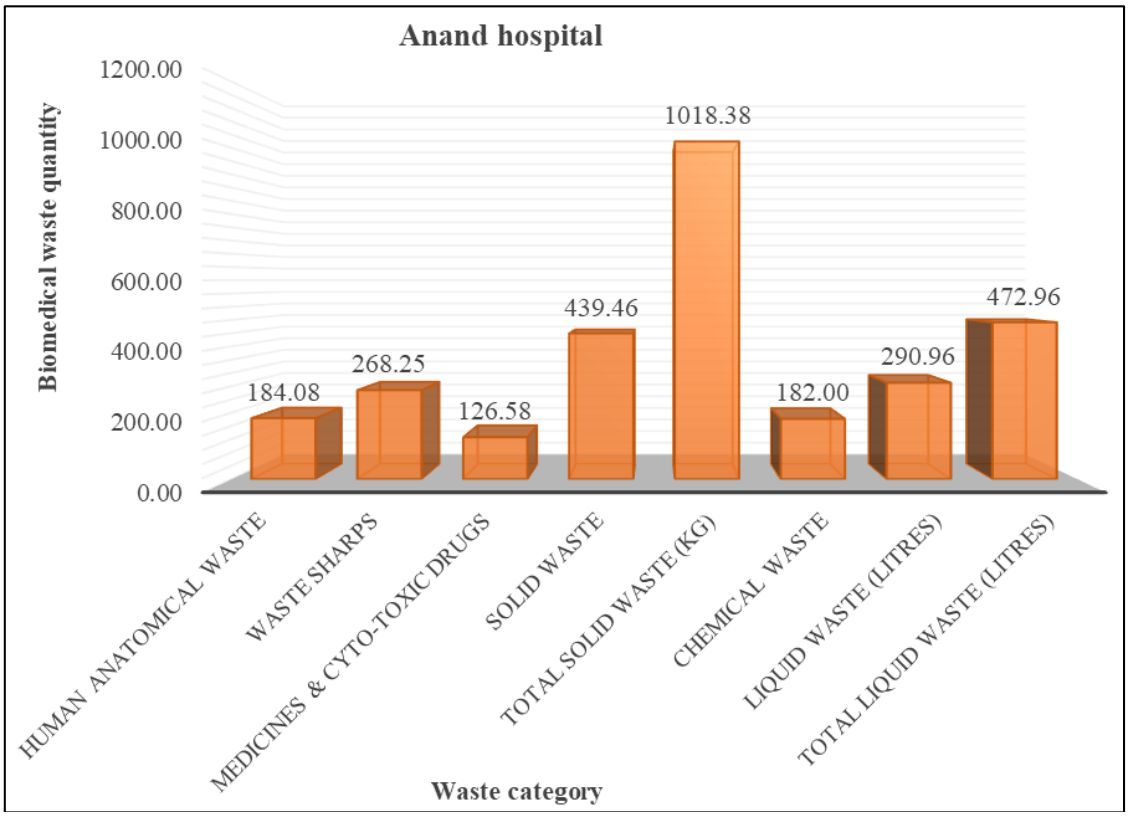

Fig 4: Biomedical waste quantity in Anand hospital

Figured 4 showed that biomedical waste quantity in different categories including solid and liquid waste. The average quantity of biomedical waste in different category followed by Human anatomical waste 184.08 kg, Waste sharps 268.25 kg, Medicines and cytotoxic drugs was 126.58 kg, solid waste 439.46 kg and total solid waste(kg) 1018.38 kg. In the category of liquid waste contain chemical waste from autoclaving and sterilization process in the hospital. The average quantity of chemical waste 182.00 liter and liquid waste 290.96 liter from the different activities cleaning, washing and floor cleaning generated the quantity of liquid waste.

The minimum and maximum variation of Human anatomical waste 162-196 kg, Waste sharps 246-284 kg, Medicines and cytotoxic drugs 82-192 kg, solid waste 396-472 kg, Total solid waste 924-1086 kg, chemical waste 148-210 liter and liquid waste 244-378 liter. The variation of biomedical waste quantity due to climatic variation and reported number of cases in the hospital. The minimum value was observed in the months of January and February.

Table 5: Biomedical waste generated in Bharat Hospital and Orthopedic Research Centre

Months	Days	Human anatomical waste	Waste sharps	Medicines & cytotoxic drugs	Solid waste	Total solid waste (kg)	Chemical waste	Liquid waste (Liters)	Total Liquid waste (Liters)
Jan	1-15	75	82	44	139	340	75	95	170
	16-31	79	85	55	155	374	89	102	191
Feb	1-15	77	85	48	135	345	78	97	175
	16-28	72	78	85	91	326	72	90	162
Mar	1-15	70	80	50	140	340	80	110	190
	16-31	65	72	47	125	309	65	101	166
Apr	1-15	67	71	45	127	310	63	102	165
	16-30	68	73	48	126	315	65	100	165
May	1-15	73	76	57	135	341	72	102	174
	16-31	61	62	52	125	300	55	90	145
June	1-15	62	67	55	126	310	60	95	155
	16-30	55	62	51	113	281	59	95	154
July	1-15	37	32	46	85	200	105	150	255
	16-31	36	36	49	87	208	110	157	267
Aug	1-15	35	27	36	45	143	93	104	197
	16-31	44	32	42	49	167	109	124	233
Sept	1-15	32	22	35	59	148	86	106	192
	16-30	38	33	39	62	172	85	93	178
Oct	1-15	36	36	45	86	203	84	98	182
	16-31	35	33	42	79	189	74	90	164
Nov	1-15	74	50	50	111	285	75	85	160
	16-30	63	45	41	108	257	65	68	133
Dec	1-15	79	65	67	135	346	55	102	157
	16-31	70	62	62	127	321	41	85	126
Mean		58.46	56.92	49.63	107.08	272.08	75.63	101.71	177.33
Max		79.00	85.00	85.00	155.00	374.00	110.00	157.00	267.00
Min		32.00	22.00	35.00	45.00	143.00	41.00	68.00	126.00
STDEV		23.56	31.56	25.71	55.15	115.77	34.50	44.93	71.36

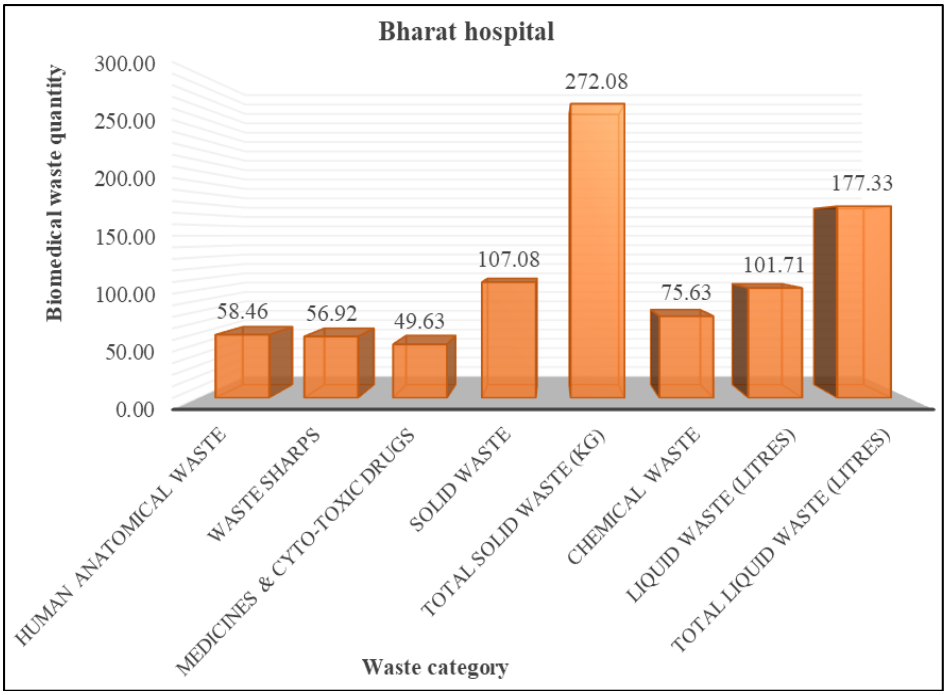

Fig 5: Biomedical waste quantity in Bharat Hospital and Orthopedic Research Centre

Figure 5 showed that biomedical waste quantity in different categories including solid and liquid waste. The average quantity of biomedical waste in different category followed by Human anatomical waste 58.46kg, Waste sharps 56.92 kg, Medicines and cytotoxic drugs was 49.63kg, solid waste 107.08 kg and total solid waste (kg) 272.08 kg. In the category of liquid waste contain chemical waste from autoclaving and sterilization process in the hospital. The average quantity of chemical waste 75.63 liter and liquid waste 101.71 liter from the different activities cleaning, washing and floor cleaning generated the quantity of liquid waste. The minimum and maximum variation of Human anatomical waste 32-79 kg, Waste sharps 22-85 kg, Medicines and cytotoxic drugs 35-85 kg, solid waste 45-155 kg, Total solid waste 143-374 kg, chemical waste 41-110 liter and liquid waste 68-157 liter. The variation of biomedical waste quantity due to climatic variation and reported number of cases in the hospital. The minimum value of human anatomical waste, sharp waste and medicines and cytotoxic drugs was observed in the months of September, the minimum value of solid waste was observed in the August, the minimum value of chemical waste and liquid waste was observed in the month of December and November respectively.

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