consequence of careless management. Exposure to hazardous health-care waste can result in
disease or injury.

The main groups of people who are a part of the waste management cycle as waste
generators or handlers are as follows:

- medical doctors, nurses, health-care auxiliaries and hospital personnel;
- patients in health-care establishments
- visitors to health-care establishments;
- workers in support services allied to health-care establishments, such as laundries, waste
  handling, and transportation;
- workers in waste disposal facilities (such as landfills or incinerators)

The greatest risk of biomedical waste is from the infectious, and sharp components of the
waste because Health Care Workers and people associated with handling waste are often getting
needle prick injuries (Kishore 2000) and can contract HIV/AIDS, Hepatitis B and C. Effective
confinement of waste and safe handling measures provide significant health protection. Reducing
the amount of hazardous waste by segregation is better than accumulating large quantities;
proper identification of waste packages warns health-care personnel and waste handlers about
their contents. All these measures to reduce risk are relatively simple and cheap and should be
considered by any health-care establishment. The principle of ‘doing something is better than
doing nothing’ is important and underlies any effort to initiate a system for the management of
health-care related waste.

**Major findings regarding BMWM policy related implementation in select hospitals**

Waste generation is inevitable in a hospital. Inhabitants of hospital i.e. patients, staff and
visitors all produce waste. BMWM policies aim for a combination of necessary human beings,
material, tools, equipment, working space and apparatus brought together in systematic and
effective coordination for the management of biomedical waste in the hospital. The present
study has been the endeavour to examine and investigate into the problem of BMWM in select
hospitals. The study has devised and used tools to look into the management of bio medical
waste in these select hospitals in some areas by raising queries to the respondents in the related
area. In the preceding chapters, the responses have been analysed and described and the findings
have been mentioned subsequently. In the present chapter, with the help of these findings and
observations, the hypotheses have been validated and the issues and problems have been
summarised while putting some suggestions seeking some policy issues.

To protect the environment, Government of India, on July 20, 1998, under the Environment (Protection) Act, 1986, had notified the ‘Bio-Medical Waste (Management and Handling) Rules, 1998. In accordance with the Bio-Medical Waste (Management and Handling) Rules, 1998 and the amendments issued in the year 2000 for technology acquisition, health care facilities are required to take necessary measures for proper segregation, handling and disposal of infectious waste to reduce the hazards of (re)use and disposal. As per the BMWM rules, it is the duty of the occupier (operator) of a health care facility—to ensure that biomedical wastes are handled without any adverse effect to human health and the environment, and according to the prescribed treatment and disposal requirements in the State Pollution Control Boards (SPCBs) in states and Pollution Control Committees in Union Territories are responsible for permitting and enforcing the requirements of the Biomedical Waste Rules.7

➢ All the three hospitals taken in the study were multispecialty hospitals with bed occupancy more than 500 and were authorized as per the BMWM rules to have provision of terminal waste disinfection in the form of incinerator and shredder.
➢ The present study had included BMWM in two selected hospitals i.e. Government Medical College and Hospital Sector 32, Chandigarh, which was referred to as Hospital (I) and Government Multispecialty Hospital Sector 16, Chandigarh which was referred to as Hospital (II). As there was no benchmark studies available to compare these two hospitals, Command Hospital, Army Western Command, Chandimandir, hence referred to as Hospital(III) was taken as a bench mark hospital.

Hospital (I)

➢ Hospital (I) had a multistoried building divided into different areas.
➢ The Head of department of Microbiology department was heading BMWM Committee along with the Deputy Medical Superintendent (DMS) of the hospital.
➢ Infection Control Nurse (ICN) reported to HOD directly.
➢ The specifications for biomedical waste were approved by technical committee of the Hospital.
➢ The Department carried out hospital acquired infection survey by collecting information through a questionnaire.
➢ The senior most nurse in the ward was in charge of the administration of the ward.

260
Hospital (I) had better segregation as the waste transporters were not transporting ill separated waste.

Sanitary Inspector strictly monitored any lapses noted in the BMWM cycle and corrected it promptly.

The hand carts for waste transportation were painted black, green, yellow and red and had the hospital’s name written on it.

There was a fixed path to take waste to the kerb area, however not all waste transporters were aware of this.

The kitchen waste that consists of non citrus waste, was taken to vermicompost by waste transporter.

Waste Management record was maintained by the Sanitary Inspector and the ANS and included daily weight of municipal waste, record of State Pollution Control Board Inspections, incinerator and shredder maintenance book and attendance book of workers.

The capacity of the incinerator was less (10 kilograms/hour), so the waste was being transported to Hospital (II) for further management.

Hospital (II)

Hospital (II), a 500 bedded hospital with a bed occupancy of 350-400, was a multistoried building divided into three distinct areas.

The BMWM committee consists of Medical superintendent as its In-Charge and its members were Head of Department of Hospital Administration, Head of Department Pathology laboratory and Assistant Nursing Superintendent.

The Sanitary Inspector was directly responsible for management of biomedical waste in wards and departments.

The Sanitary Inspector was also made responsible for the proper functioning of the incinerator and the shredder as well the supervision of the waste segregation in the wards and its correct transportation to the kerb area and finally to the municipal bins, incinerator and shredder.

The Sanitary Inspector indented for BMWM and monitored the records of BMWM. He prepared periodic reports for State Pollution Control Board. He had two senior Group D employees helping him in monitoring all the sweepers and ward boys.
Barrier clothing was being provided to waste handlers and they are aware of its use and of universal precautions applicable to them. Long gum boots, heavy duty gloves and plastic aprons and masks are being provided to the waste handlers and transporters.

The segregation practices followed in Hospital (II) were very different from those in Hospital (I). In Hospital (I), different workers were assigned to collect different coloured bins from all areas of the hospital whereas in Hospital (II), same workers who were segregating the waste in the wards and departments were tying and transporting it.

Hospital (III)

- The total bed strength available was 841. This Hospital was referral centre for emergency care of troops who are deployed in Northern Command and it also looked after ex-servicemen and their families.
- Director General Armed Forces Medical Services was prescribed authority for authorizing and implementing the BMWM rules in the Armed Forces Medical Services.
- There existed a Committee for Hospital Infection control and the same looked after the BMWM of the hospital. The Committee consisted of Head of the Department of Microbiology, Nursing Superintendent called the Principal Matron and an Administrative Officer.
- There was no post of Infection Control Nurse in the hospital however there was a senior nurse akin to Assistant Nursing Superintendent of other hospitals who looked after BMWM of the wards.
- A Nursing Assistant designated Sanitary JCO was detailed to look after the working of the incinerator and shredder and also to supervise the waste transport from the wards to the kerb area and from there to the final treatment site i.e. the incinerator, shredder, burial site or municipal dump.
- A Class I Nursing Assistant called a Ward Master, was responsible for the supplies of the ward, he indented buckets and plastics for the bio medical waste.
- Nurses were being aided by Nursing Assistants –Class I, II and III. The Class III Nursing Assistants were the junior most with less than a year of training, while the Class II and the Class I had a year of training each.
- The collection part of the waste management cycle was outsourced to a civil vendor by a Board of Officers who ensured that the vendor had a valid license for carrying out
biomedical waste handling and disposal and the vendor had a tie up with a common BMWM facility with requisite infrastructure, duly authorized and licensed by State Pollution Control Board.

- The quantity of the biomedical waste produced in three select Hospitals depicted in Table 7.1 shows that the waste produced in Hospital (I) was the maximum followed by Hospital (III) and then Hospital (I). It is depicted as follows:

<table>
<thead>
<tr>
<th>Waste</th>
<th>Hospital (I)</th>
<th>Hospital (II)</th>
<th>Hospital (III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incinerated  waste</td>
<td>230 kgs/day</td>
<td>100 kgs/day</td>
<td>120 kgs/day</td>
</tr>
<tr>
<td>Shredded waste</td>
<td>40 kgs/day</td>
<td>15 kgs/day</td>
<td>15 kgs/day</td>
</tr>
<tr>
<td>Municipal waste</td>
<td>2000 kgs/day</td>
<td>1000 kgs/day</td>
<td>2000 kgs/day</td>
</tr>
</tbody>
</table>

Source: Primary data

**Objective 1**


This objective was attained by testing the following hypothesis.

**Hypothesis 1**

The select hospitals have adopted their own policies and resources regarding biomedical waste management which are well within the framework of Biomedical Waste Management and Handling Rules of India.

The testing of the above hypothesis is based on secondary data only. To reach this analysis, the various parameters related to BMWM as per the Gazette Rules were assessed using observation scale, questionnaire and interviews of the waste treatment facility handlers. The findings were tabulated as being adequate or inadequate. The adequate responses were given 1 score, partially adequate as 0.5 score and inadequate as zero score. The policy implementation is analysed as follows:
<table>
<thead>
<tr>
<th>BMWM parameter</th>
<th>Hospital (I)</th>
<th>Hospital (II)</th>
<th>Hospital (III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearly written policy</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Authorisation by State Pollution Control Boards</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Annual report being sent in Form II to SPCB</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Records on the generation, collection, reception, storage, transportation, treatment, and disposal of biomedical wastes maintained</td>
<td>Present (1.0)</td>
<td>Partially present (0.5)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Colour coded segregation</td>
<td>Partially present (0.5)</td>
<td>Partially present (0.5)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Technology Standards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incinerator</td>
<td>Inadequate (0.0)</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Shredder</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Municipal dump</td>
<td>Present (1.0)</td>
<td>Partially present (0.5)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Hydroclave</td>
<td>Absent (0.0)</td>
<td>Absent (0.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Storage area</td>
<td>Present (1.0)</td>
<td>Absent (0.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Laminar flow machines in laboratory</td>
<td>Present (1.0)</td>
<td>Absent (0.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Vermiculture</td>
<td>Present (1.0)</td>
<td>Absent (0.0)</td>
<td>Absent (0.0)</td>
</tr>
<tr>
<td>Deep burial pit</td>
<td>Absent (0.0)</td>
<td>Absent (0.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Infection control nurse</td>
<td>Present (1.0)</td>
<td>Partially present (0.5)</td>
<td>Partially present (0.5)</td>
</tr>
<tr>
<td>Sanitary Inspector</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Use of disinfectants</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Immunisation status of health care employees</td>
<td>Partially adequate (0.5)</td>
<td>Inadequate (0.0)</td>
<td>Partially adequate (0.5)</td>
</tr>
<tr>
<td>Place of incinerator</td>
<td>Proper (1.0)</td>
<td>Improper (0.0)</td>
<td>Proper (1.0)</td>
</tr>
<tr>
<td>Store for mass casualty facilities for BMWM</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
<td>Present (1.0)</td>
</tr>
<tr>
<td>Total</td>
<td>15/19</td>
<td>10/19</td>
<td>17/19</td>
</tr>
</tbody>
</table>

Source: Primary data

It was found that the Hospital (III) scored 17 out of 19, while Hospital (I) scored 15 out of 19 and Hospital (II) scored the least of 10 out of 19. Hence the biosafety techniques followed in select hospitals conformed to the standards laid down in the Biomedical Waste Management and Handling Rules of India. Further, the policies and resources of Hospital (III) conformed most to the Biomedical Waste Management and Handling Rules of India as compared to the other two select hospitals. Hence the policies and the resources regarding BMWM were found to be well within the framework of Biomedical Waste Management and Handling Rules of India with Hospital (III) proving to be a benchmark for other two hospitals.

**Hence the Hypothesis stands accepted**

264
Major findings on knowledge and practices of nurses regarding BMWM in select hospitals

Though the main purpose of the nursing services in the three hospitals was the prevention of disease, preservation and promotion of health and also to provide economic and efficient health services to people, they were also found to have a responsibility to care for the environment and for public health particularly in relation to the waste they produced.

- There was an appointment of Infection Control Nurse (ICN) in Hospital (I) to look after the administration of BMWM in the hospital. She was reporting to the Head of the Department directly, there was a senior nurse similar to Assistant Nursing Superintendent of other hospitals who looked after BMWM of the wards in Hospital (III). There was no such post in Hospital (II).
- Most of the nurses working in Hospital (I) and (II) were GNM qualified with Hospital (I) and (II) having high majority of GNM nurses. Hospital (III) had fair proportion of GNM qualified nurses and more number of B.Sc. nurses.
- A high proportion of the nurses in all the three hospitals were permanently employed with all being permanently employed in Hospital (III).

Knowledge regarding BMWM policies

- Majority of nurses in Hospital (III) had adequate knowledge regarding BMWM policies followed by Hospital (I) and least in Hospital (II).
- The permanently employed nurses in Hospital (I) and (III) had better knowledge and contract nurses in Hospital (II) were found to have more knowledge regarding policies related to BMWM.
- High majority of permanently employed nurses had adequate knowledge regarding BMWM policies in all the Hospitals.
- The permanently employed nurses in Hospital (I) and (III) had better knowledge and contract nurses in Hospital (II) were found to have more knowledge regarding policies related to BMWM.
- In all the three hospitals, the increase in age was directly proportional to increase in knowledge regarding policies related to biomedical waste i.e. in all the three hospitals, as the age increased, the knowledge regarding BMWM increased.
- In Hospital (I), GNM qualified nurses had better knowledge than B.Sc. Nursing qualified nurses while opposite findings were observed in Hospitals (II), where B.Sc. Nursing
qualified nurses had better knowledge as compared to GNM qualified nurses. In Hospital (III), all nurses both GNM and B.Sc. Nursing qualified, had adequate knowledge regarding these policies.

- Age wise, the knowledge score of nurses in Hospital (III) were found to be more as compared to Hospital (II) and (I). The in-service education programs being conducted by the hospital administrators could be a reason for this finding.

**Knowledge regarding waste segregation**

- A high proportion of nurses in Hospital (III) had partially adequate knowledge regarding waste segregation followed by Hospital (I) and then Hospital (II).
- In regards to waste segregation, contract nurses and permanently employed both had good knowledge with contract nurses scoring better than permanently employed nurses in Hospital (I).
- More of the permanently employed nurses in Hospital (III) followed by Hospital (II) had better knowledge regarding waste segregation.
- In Hospital (I) and (III), high majority of nurses in age group of < 40 years had adequate knowledge regarding waste segregation as compared to nurses in the same age group in Hospital (II).
- Further an inverse relation was observed between age and knowledge level i.e. increase in age was found to be related to decrease in knowledge in Hospital (I) and Hospital (III).
- More of B.Sc. qualified nurses in Hospital (III) had knowledge regarding waste segregation as compared to GNM qualified nurses while the results were similar in Hospital (I) in both the qualified groups and in Hospital (II), the GNM qualified nurses had more knowledge than B.Sc. nurses.
- In all the three hospital, nurses with 01-05 years of duration were found to have better knowledge regarding waste segregation.

**Knowledge regarding waste transport**

- In regards to the waste transport and disposal, it was seen that high majority of nurses in Hospital (II) had adequate knowledge of waste transport followed Hospital (III) and least knowledge scores of Hospital (I).
- Nurses in Hospital (II) had more knowledge regarding biomedical waste transportation.
- All the nurses on contract in Hospital (II) and high majority of permanently employed
nurses had adequate knowledge regarding biomedical waste transportation followed by Hospital (III) and then Hospital (I).

- All the permanently employed nurses had adequate knowledge in all the three hospitals.
- All nurses in age group of 41-50 years had adequate knowledge.
- In all the hospitals, both GNM qualified and B.Sc. Nursing qualified, had adequate knowledge regarding waste transportation in their hospital except the B.Sc. Nursing qualified nurses in Hospital (I).
- The knowledge scores were found more among GNM qualified nurses in Hospital (I) and in B.Sc. Nursing qualified in Hospital (II) and equally distributed in Hospital (III).

**Knowledge regarding waste treatment and transport**

- Nurses in all the three hospitals had very low scores on adequate knowledge regarding waste treatment as the nurses were not responsible for treatment or transport.
- The scores of Hospital (III) were far superior to the other two hospitals with majority of nurses having partially adequate knowledge.
- None of the nurses in the three hospitals had adequate knowledge regarding the final modes of disposal of wastes in their hospitals.
- In Hospital (I), more number of nurses on contract employment were found to have adequate knowledge regarding biomedical waste treatment than those who were permanently employed followed by poor proportion of permanently employed nurses in Hospital (III) and Hospital (II).
- In all the three hospitals nurses in the age group of < 40 years had more knowledge compared to other age groups with Hospital (I) scoring way beyond the other two hospitals.
- The nurses in Hospital (I) who were GNM qualified had more knowledge compared to B.Sc. Nursing qualified nurses regarding knowledge of biomedical waste treatment in the hospital.
- The nurses who had been working for 6-10 years, in Hospital (I) and (II) had better knowledge scores.
- There was an inverse relationship between the age and knowledge level of the nurses regarding various treatment modalities for waste available in their respective hospitals.
Knowledge regarding colour coding

- All nurses in three hospitals had adequate knowledge of colour code for infectious waste and anatomical waste i.e. yellow colour and red plastic bags as well as containers to be used. Nurses in Hospital (III) had comparatively better knowledge scores followed by Hospital (II) and Hospital (I) for yellow coloured anatomical waste.
- All nurses in Hospital (I) had complete knowledge about colour coding for black colour for general waste followed by Hospital (II) and Hospital (III).
- High majority of nurses in Hospital (III) had adequate knowledge for blue colour code followed by Hospital (II) and Hospital (I).
- Majority of nurses in three hospitals had adequate knowledge regarding type of waste to be put in different coded containers.

Perceived risk for injury from BMWM

- Risk for injury or health hazard due to handling of biomedical wastes was perceived comparatively higher by nurses in Hospital (II).
- None of the nurses verbalized complete freedom from risk.
- Biomedical waste was perceived most hazardous by nurses of Hospital (II) while none of the nurses in Hospital (III) perceived it as a constant threat.
- There was a inverse relationship between the use of universal precautions like wearing gloves, mask, washing hands while handling waste and perceiving the waste handling as hazardous.
- Nurses in Hospital (II) perceived high risk followed by Hospital (I) while none of the nurses in Hospital (III) had high perception of risk, however all nurses had sometimes felt at risk.
- Risk was perceived less by the nurses above 51 years in Hospital (II) and more by B.Sc nurses in Hospital (I).
- In Hospitals (I), all nurses whether on contract or permanently employed had adequate knowledge regarding using universal precautions while in Hospital (II), high majority of nurses on contract had adequate knowledge regarding use of universal precautions in biomedical waste handling.
- All nurses in Hospital (III) who were permanently employed had adequate knowledge regarding universal precautions.
Observations made on the nurses

- The researcher observed the nurses for their waste segregation practices in the ward on three consecutive observations, the observations being non-participatory observations.
- High majority of nurses in Hospital (III) were following correct practices regarding BMWM followed by majority of nurses in Hospital (I) and moderate proportion in Hospital (II).
- Incorrect practices were being followed more by nurses in Hospital (II) while most correct practices were being followed by nurses in Hospitals (III).
- A moderate proportion nurses on an average were being assisted sometimes in waste segregation in Hospital (I) followed by Hospital (II) and least in Hospital (III).

In order to compare the biomedical waste management in the three hospitals, objectives were formulated to assess the BMWM cycle in the select hospitals and to assess the knowledge and practices of different groups of workers regarding BMWM. Detailed hypothesis were framed thereafter to achieve the objectives. The sub hypothesis were framed and tested. While testing the hypothesis non-parametric tests were used in the form of Chi-square. Wherever the calculated values of chi-square were found to be more than the Table values at 99 per cent confidence intervals and a permissible alpha error of 1 per cent, the findings were termed found to be statistically highly significant.

Objective 2

1. To assess the knowledge and practices of biomedical waste management among the nurses in the three hospitals.

This objective was attained by testing the following hypothesis.

Hypothesis 2

The nurses in Hospital (III) had better knowledge and practices related to BMWM as compared to other two hospitals.

Further this hypothesis was divided into various sub-hypothesis as follows:

2 (a) Nurses in Hospital (III) had better knowledge regarding biomedical waste management policies as compared to other two hospitals.

2 (b) Nurses in Hospital (III) had better knowledge regarding waste segregation as compared to other two hospitals.
2 (c) Nurses in Hospital (III) had better knowledge regarding waste transport as compared to other two hospitals.

2 (d) Nurses in Hospital (III) had better knowledge regarding waste treatment as compared to other two hospitals.

2 (e) Nurses in Hospital (III) had better knowledge regarding final disposal of waste as compared to other two hospitals.

2 (f) Nurses in Hospital (III) had better knowledge regarding colour coding for as compared to other two hospitals.

2 (g) Nurses in Hospital (III) had better knowledge regarding use of universal precautions in BMWM as compared to other two hospitals.

2 (h) Nurses in Hospital (III) had lower perception of risk to health from BMWM as compared to other two hospitals.

2 (i) Nurses in Hospital (III) had better waste segregation practices compared to other two hospitals.

**Hypothesis testing**

**Hypothesis 2(a)**

Nurses in Hospital (III) had better knowledge regarding biomedical waste management policies as compared to other two hospitals.

It was found that the majority of nurses in Hospital (III) had adequate knowledge followed by fair proportion of nurses in Hospital (I) and with least knowledge score in Hospital (II) as analysed by the data in Tables 3.4 and 3.8. The difference between the knowledge scores was found to be statistically highly significant.

**Hence the sub hypothesis stands accepted.**

**Hypothesis 2(b)**

Nurses in Hospital (III) had better knowledge regarding waste segregation as compared to other two hospitals.

The data in Tables 3.4 and 3.10 brought out that none of the nurses in the three hospitals had adequate knowledge regarding waste segregation in their hospitals. However high proportion of nurses in Hospital (III) had partially adequate knowledge regarding waste segregation followed by high proportion in Hospital (I) and fair proportion in Hospital (II). The difference in knowledge scores were found to be statistically highly significant.
Hence the sub hypothesis stands accepted

Hypothesis 2(c)

Nurses in Hospital (III) had better knowledge regarding waste transport as compared to other two hospitals.

In regards to the waste transport, it was seen in Tables 3. 5 and 3.11 that high majority (98.6 per cent) nurses in Hospital (II) had adequate knowledge of waste transport and disposal followed by high majority in Hospital (III) and least knowledge scores of Hospital (I). Comparatively, the knowledge of nurses in Hospital (II) was found better than the other two hospitals and this difference in knowledge was statistically significant.

Hence the sub hypothesis stands rejected.

Hypothesis 2(d)

Nurses in Hospital (III) had better knowledge regarding waste treatment as compared to other two hospitals.

The nurses in all the three hospitals had very low scores on adequate knowledge regarding waste treatment as described in Tables 3.5 and 3.9. Fair proportion of nurses in Hospital (I) had partial knowledge regarding waste treatment as compared to poor proportion of nurses in Hospital (III) followed by Hospital (II). Almost all the nurses Hospital (II) had no knowledge of waste treatment as the nurses were not responsible for transport, findings were similar in Hospital (III).

Hence the sub hypothesis stands rejected.

Hypothesis 2(e)

Nurses in Hospital (III) had better knowledge regarding final disposal of waste as compared to other two hospitals.

The knowledge scores of nurses in Tables 3.5 and 3.12 described that knowledge of nurses in Hospital (III) was better than the other two hospitals regarding final disposal of waste with majority of nurses having partially adequate knowledge followed by a poor scoring in Hospital (II) and Hospital (I).

Hence the sub hypothesis stands accepted.

Hypothesis 2(f)

Nurses in Hospital (III) had better knowledge regarding colour coding for BMWM as compared to other two hospitals.

Further that-
i) Nurses in Hospital (III) had better knowledge regarding red colour coding as compared to other two hospitals.

The data in Tables 3.6 showed that all the nurses in Hospital (III) had adequate knowledge regarding red colour coded waste with similar findings in Hospital (II) while Hospital (I) had comparatively lesser knowledge scores.

Hence the sub sub hypothesis stands partially accepted.

ii) Nurses in Hospital (III) had better knowledge regarding yellow colour coding as compared to other two hospitals.

All the nurses in all the three hospitals had adequate knowledge regarding yellow colour coded waste (human anatomical waste) as shown in Table 3.6.

Hence the sub sub hypothesis stands rejected.

iii) Nurses in Hospital (III) had better knowledge regarding blue colour coding as compared to other two hospitals.

High majority of nurses in Hospital (III) as shown in Table 3.6 had adequate knowledge of blue colour code (plastic waste) followed by high majority in Hospital (II) and then Hospital (I). Hence the nurses in Hospital (III) were found to have better knowledge than other two hospitals.

Hence the sub sub hypothesis stands accepted.

iv) Nurses in Hospital (III) had better knowledge regarding black colour coding as compared to other two hospitals.

All nurses as shown in Table 3.6 in Hospital (I) had adequate knowledge about colour coding for black i.e. general waste followed by high proportion in Hospital (II) and majority proportion in Hospital (III). Thus nurses in Hospital (I) were found to have better knowledge scores than other two hospitals.

Hence the sub sub hypothesis stands rejected.

v) Nurses in Hospital (III) had better knowledge regarding waste container colour coding as compared to other two hospitals.

As revealed in Table 3.6, high majority of nurses in Hospital (III) had adequate knowledge regarding the type of container to be used for black, blue, red and yellow as compared to other two hospitals.

Hence the sub sub hypothesis stands accepted
vi) Nurses in Hospital (III) had better knowledge regarding waste type in all colour coding as compared to other two hospitals.

The knowledge of the nurses was assessed for the type of waste to be put in the different colour coded containers. High majority of nurses in three hospitals had adequate knowledge regarding waste type to be put in different coded containers with Hospital (III) having better scores for yellow and red coded waste (infectious) while Hospital (I) had better scores for blue (plastic waste) and black coded waste (general waste) as highlighted in Table 3.6.

Hence the sub sub hypothesis stands partially accepted.

vii) Nurses in Hospital (III) had better knowledge regarding disposal of different colour coded waste as compared to other two hospitals.

The knowledge scores regarding disposal of waste was found to be better for yellow, red and blue coded waste in Hospital (III) while the knowledge scores for black coded (general) waste was found to be better in Hospital (I) as described in Table 3.6.

Hence the sub sub hypothesis stands partially accepted.

The overall hypothesis 2(f) that the nurses in Hospital (III) had better knowledge regarding colour coding for BMWM as compared to other two hospitals was tested in sub sub hypothesis i) to vii). It was found that out of the seven sub hypotheses, two were accepted, three partially accepted and two rejected.

Hence hypothesis 2(f) stands partially accepted.

Hypothesis 2(g)

Nurses in Hospital (III) had better knowledge regarding use of universal precautions in BMWM as compared to other two hospitals.

Majority of the nurses in Hospital (III) were found to have adequate knowledge followed by moderate proportion nurses in Hospital (I) followed by fair proportion in Hospital (II) as discussed in Table 3.7 The knowledge of the nurses in Hospital (III) was found to be better than the other two hospitals. This difference in knowledge was found to be statistically highly significant

Hence the sub hypothesis stands accepted.
Hypothesis 2(h)

Nurses in Hospital (III) had lower perception of risk to health from BMWM as compared to other two hospitals.

It was observed that the risk scores were comparatively higher for Hospital (II) with moderate proportion of nurses perceiving high risk and moderate risk in Hospital (I). None of the nurses in Hospital (III) felt high risk due to BMWM in their wards. The nurses in Hospital (III) were hence found to have low perception of risk from BMWM as shown in Tables 3.7 and 3.13.

Hence the hypothesis stands accepted.

Hypothesis 2(i)

Nurses in Hospital (III) had better waste segregation practices compared to other two hospitals.

The researcher observed the nurses for their waste segregation practices in the ward on three consecutive observations, the observations being non participatory observations depicted in Table 3.14. Incorrect practices were being followed more by nurses in Hospital (I) while most correct practices were being followed by nurses in Hospitals (III).

Incorrect practices were being followed more by nurses in Hospital (I) while most correct practices were being followed by nurses in Hospitals (III).

Hence the sub hypothesis stands accepted.

The overall hypothesis 2 of the present study was tested as follows:

The nurses in Hospital (III) had better knowledge and practices related to BMWM as compared to other two hospitals.

The knowledge of nurses in various aspects were assessed from Tables 3.4 to Table 3.15 and tabulated as being adequate and inadequate. Adequate knowledge in various parameters was given a scoring of 1 and inadequate scored as zero as described below:
The nurses in Hospital (III) scored a total of 11 out of 12, Hospital (I) scored 8 out of 12 and Hospital (II) scored 5 out of 12. Hence the knowledge and practices of BMWM by nurses in Hospital (III) was found to be better than other two hospitals. Hence the hypothesis got strong support.

Hence the hypothesis 2 that the nurses in Hospital (III) had better knowledge and practices related to BMWM as compared to other two hospitals stands accepted.

**Major findings on knowledge and practices of doctors regarding BMWM in select hospitals**

The doctors play a very important role in BMWM in the hospital. In any hospital, the Senior Medical Officer who takes the responsibility of the Head of Hospital is legally and financially responsible for waste management in the hospital. The doctor takes up multiple role in a hospital as Ward–In-Charge, HOD and head of health-care establishment and is responsible for health protection and safety at the workplace and bears legal responsibility for the safe disposal of health-care waste generated in the establishment.

- Out of the three hospitals, maximum number of Medical Specialists were found in Hospital (II) while Hospital (I) had more number of Surgical specialists.
- Hospital (III) had more number of doctors working in Surgical department out of the three hospitals.
- Maximum numbers of the doctors in Medical department were found in Hospital (I).
- The doctors below the age of 30 years were the least in all the three hospitals.
The distribution of the doctors in three hospitals as per their age was comparable, however there were more young doctors aged 30 to 40 years in Hospital (I) while there were more senior doctors aged 40 to 50 years in Hospital (III).

Majority of the doctors had spent 1 to 5 years in their respective departments

Knowledge regarding BMWM policies

- Alarming by, none of the doctors in the three hospitals had complete knowledge regarding the policies of BMWM in the three hospitals.
- All the doctors in Hospital (III) had partially adequate knowledge whereas majority of the doctors in Hospital (I) and (II) had inadequate knowledge regarding the Gazette notification related to biomedical waste in the country and biomedical waste generation policies in their hospitals.
- All the doctors in Hospital (III) working in Medical and Surgical department had adequate knowledge regarding BMWM policies.
- Moderate proportion of doctors working in Medical department in Hospital (II) had adequate knowledge whereas fair proportion of Surgeons of Hospital (I) were found to have better knowledge regarding BMWM policies.
- Moderate proportion of doctors in all the three hospitals in the age group of 41 to 50 years had better knowledge as compared to other age groups.
- It was found that as the number of years of working in the hospital increased, the knowledge regarding hospital policies increased, hence there was a direct relationship between number of years of working and knowledge regarding BMWM policies.
- The overall knowledge scores of doctors were found to be low regarding categories of waste in their hospitals. Hence graduates in Hospital (I) had better knowledge regarding category wise waste generation while specialist in Hospital (II) and (III) were found to have adequate knowledge regarding categories of waste.

Knowledge regarding BMWM transport

- High majority of doctors in Hospital (III) were found to have adequate knowledge regarding waste transport followed by Hospital (I) and then Hospital (II).
- Findings were similar in regards to knowledge of waste treatment where the doctors in Hospital (III) was better than the doctors in other two hospitals.
- The doctors working in Surgical department of the three hospitals were found to have
better knowledge scores as compared to doctors working in Medical departments regarding waste transportation.

- Majority of the doctors in the age group of 21 to 40 years in Hospital (I) and Hospital (II) had knowledge compared to age group of 41 to 50 years in Hospital (III).
- Surgical Specialists of Hospitals (III) had better knowledge followed closely by Medical Specialists and MBBS doctors.
- An increase in qualifications was found to have affected the knowledge scores adversely. In Hospital (I) and (II), majority of doctors who were just graduates had better knowledge as compared to Specialists.
- There was an inversely proportional relationship between the duration of working in the hospital and knowledge regarding waste transportation.

Knowledge regarding waste treatment

- While none of the doctors were found to be completely ignorant regarding waste treatment, their knowledge was found lacking in areas like treatment of plastics in shredder, disposal of expired and unused medicines, cytotoxic and radioactive waste etc.
- The doctors were practicing waste treatment in ward hence had better knowledge scores about those aspects of biomedical waste, however their scores regarding waste treatment outside the ward and its final disposal were comparatively low.
- The doctors in Hospital (III) had better scores as they had given in-service training and orientation programmes regarding these aspects of BMWM.

Knowledge regarding final waste disposal

- None of the doctors in three hospitals, had adequate knowledge regarding final disposal of waste. The knowledge of doctors in Hospital (III) was found to be comparatively better.
- The overall knowledge of doctors regarding waste disposal outside their wards / clinics/ departments was inadequate all the three hospitals.
- Moderate proportion of doctors working in Medical department of Hospital (III) had adequate knowledge regarding final disposal of biomedical waste followed by Hospital (I) and poor proportion of doctors in Hospital (II).
- All the doctors working in Surgical department of three hospitals had poor response regarding final disposal of biomedical waste.
The graduate doctors of Hospital (III) had better knowledge score compared to other doctors in three hospitals.

The Super Specialists in Hospital (III) and (I) had better knowledge and in contrast, none of the Super Specialists were found to have adequate knowledge on final disposal of biomedical waste in Hospital (II).

The knowledge was found to increase with increase in number of years of working in Hospital (I) and (II) while this observation could not be made in Hospital (III) as doctors were transferred within a period of 5 years.

Knowledge regarding colour coding related to BMWM

- High majority of doctors in Hospital (III) had adequate knowledge related to colour coding for waste followed by Hospital (I) and then Hospital (II).
- The knowledge scores of red colour code (infectious waste) were found to be less in all the three hospitals as compared to other colour codes. The possible reason for this could be that Hospital (I) and (II) were not using the red colour code and were using yellow instead of it.
- High majority of doctors in Hospital (III) and (I) had adequate knowledge regarding colour code for waste but were found to have low knowledge scores for black colour coded container.
- Majority of doctors had adequate knowledge regarding plastic waste disposal. The comparative least scores regarding final disposal of waste were found to be among doctors in Hospital (II).

Knowledge regarding use of universal precautions in BMWM and

- The doctors in Hospital (III) scored much higher than doctors in other two hospitals in their knowledge of use of universal precautions in BMWM while none of the doctors in Hospital (II) had adequate knowledge.
- The overall knowledge scores regarding use of universal precautions in BMWM in three hospitals calculated against departments, age of doctors, professional qualifications and duration of work in the hospitals was found adequate in Hospitals (III), poor in Hospital (I) and dismal in Hospital (II).
- The doctors in surgical department of Hospital (III) had better knowledge scores than doctors in Medical department.
In Hospital (III), more specialist doctors working in Surgical department, in the age group of 21 to 40 years and more than 51 years of age who had been working for 1 to 5 years were found to have better knowledge regarding use of universal precautions in the management of biomedical wastes.

These low scores in Hospital (I) and (II) bring out the lack of knowledge of doctors regarding handling of biomedical waste carefully.

Risk perceived from handling waste

The overall risk perception was more in doctors of Hospital (I) followed by Hospital (II) and least in Hospital (III).

There was an inverse relationship between knowledge regarding use of universal precautions in BMWM and risk of harm for it.

In sharp contrast, the findings of the Hospital (I) were exactly opposite to that in Hospital (III). In Hospital (III) doctors had better knowledge regarding use of universal precautions while handling BMWM and had low risk perception while a high number of doctors in Hospital (I) had poor knowledge regarding use of universal precautions and scored high in risk perception related to BMWM in their hospital.

Young doctors perceived more risk as compared to elder doctors.

As age increased, risk perception decreased hence, an inversely proportional relationship was seen between age of doctor and risk perception.

Majority of doctors with MBBS qualifications perceived high risk while Specialists and Super Specialist perceived a lower risk from BMWM.

As qualifications increased, the risk perception decreased, hence an inversely proportion relationship was seen between the two.

Doctors working in Surgical department in three hospitals expressed more concern over the bio-hazardous of the waste as compared to doctors working in Medical department.

None of the doctors expressed no health hazard from biomedical waste in all the three hospitals.

Age wise a direct relationship was observed between risk perception and age of the doctors; as the age increased, risk perceived “sometimes” by doctors also increased.

All the doctors in the age groups of 51 years and above in Hospital (III), (II) and (I) perceived risk from handling biomedical waste in their hospital. The Super Specialists in
three hospitals perceived less risk as compared to other doctors.

- It was further seen that more the duration of work, less was the perception of high risk, hence more doctors who had been working for 5-15 years in their hospital, expressed lesser perception of health hazard at all times even though none of the doctors were free of the fear of perceived risk.

**Observations made on the doctors**

- A total of 153 observations were made in Hospital (I), 135 in Hospital (II) and 150 in Hospital (III). Medical OPDs and Surgical OPDs were found to be most busy.
- The waste segregation practices of doctors in Hospital (III) were found to be better than other two hospitals followed by Hospital (I) and Hospital (II).
- Moderate proportion of doctors in Hospital (II) were found to be having incorrect practices related to BMWM. Hence the practices were found to be worst in Hospital (II).

The knowledge of the doctors was assessed along with their waste segregation practices in the present study. The objectives and hypotheses are described as follows:

**Objective 3**

To assess the knowledge and practices of biomedical waste management among the doctors in the three hospitals.

This objective was attained by testing the following hypothesis.

**Hypothesis 3**

The doctors in Hospital (III) had better knowledge and practices related to BMWM as compared to other two hospitals.

Further this hypothesis was divided into various sub hypothesis as follows:

3 (a) The doctors in Hospital (III) had better knowledge regarding biomedical waste management policies as compared to other two hospitals.
3 (b) The doctors in Hospital (III) had better knowledge regarding waste segregation as compared to other two hospitals.
3 (c) The doctors in Hospital (III) had better knowledge regarding waste transport as compared to other two hospitals.
3 (d) The doctors in Hospital (III) had better knowledge regarding waste treatment as compared to other two hospitals.
3 (e) The doctors in Hospital (III) had better knowledge regarding final disposal of waste as
compared to other two hospitals.
3 (f)  The doctors in Hospital (III) had better knowledge regarding colour coding for BMWM as compared to other two hospitals.
3 (g)  The doctors in Hospital (III) had better knowledge regarding use of universal precautions in BMWM as compared to other two hospitals.
3 (h)  The doctors in Hospital (III) had lower perception of risk to health from BMWM as compared to other two hospitals.
3 (i)  The doctors in Hospital (III) had better waste segregation practices compared to other two hospitals.

Hypothesis testing

Hypothesis 3(a)

The doctors in Hospital (III) had better knowledge regarding BMWM policies as compared to other two hospitals.
It was found in Table 4.4 that all the doctors in Hospital (III) had partially adequate knowledge whereas majority of the doctors in Hospital (I) and (II) had inadequate knowledge regarding the Gazette notification related to biomedical waste in the country and biomedical waste generation in their hospitals. The difference between the knowledge scores was found to be statistically highly significant.

Hence the sub hypothesis stands accepted.

Hypothesis 3(b)

The doctors in Hospital (III) had better knowledge regarding category wise waste generation as compared to other two hospitals.
The data in Table 4.4 highlighted that moderate proportion of doctors in Hospital (III) had adequate knowledge regarding the ten categories of waste generated in the hospitals as compared to other two hospitals. The difference in knowledge scores was found to be statistically highly significant.

Hence the sub hypothesis stands accepted

Hypothesis 3(c)

The doctors in Hospital (III) had better knowledge regarding waste transport as compared to other two hospitals.
A high majority of doctors in Hospital (III) were found to have adequate knowledge
regarding waste transport followed by majority of doctors in Hospital (I) and fair proportion of doctors in Hospital (II) as described in Table 4.5. This difference in knowledge was found to be statistically highly significant.

**Hence the sub hypothesis stands accepted**

**Hypothesis 3(d)**

The doctors in Hospital (III) had better knowledge regarding waste treatment as compared to other two hospitals.

Majority of doctors as indicated in Table 4.5 had adequate knowledge regarding waste treatment, followed by doctors in Hospital (I) and Hospital (II). Statistically the difference in knowledge was found to be highly significant.

**Hence the sub hypothesis stands accepted**

**Hypothesis 3(e)**

The doctors in Hospital (III) had better knowledge regarding final disposal of waste as compared to other two hospitals.

The analysis depicted in Table 4.5 revealed that the knowledge of doctors in Hospital (III) was comparatively better regarding final disposal of waste with fair proportion having adequate knowledge as compared to other two hospitals. Statistically the difference in knowledge was found to be highly significant.

**Hence the sub hypothesis stands accepted**

**Hypothesis 3(f)**

The doctors in Hospital (III) had better knowledge regarding colour coding for BMWM as compared to other two hospitals.

**Further that:**

i) The doctors in Hospital (III) had better knowledge regarding red colour coding as compared to other two hospitals.

It was found that majority of doctors in Hospital (III) had adequate knowledge related to colour coding for waste (infectious waste) followed by fair proportion in Hospital (II) and poor proportion in Hospital (I).

**Hence the sub sub hypothesis stands accepted.**

ii) The doctors in Hospital (III) had better knowledge regarding yellow colour coding as compared to other two hospitals.
All the nurses in Hospital (III) and Hospital (I) had adequate knowledge followed by majority of doctors in Hospital (II). Thus not one but two hospitals were found to have cent percent result.

Hence the sub sub hypothesis stands partially accepted.

iii) The doctors in Hospital (III) had better knowledge regarding blue colour coding for as compared to other two hospitals.

Doctors in Hospital (I) had cent percent results followed by high majority in Hospital (III) and majority in Hospital (II). Hence the doctors in Hospital (I) had better knowledge than other two hospitals.

Hence the sub sub hypothesis stands rejected.

iv) The doctors in Hospital (III) had better knowledge regarding black colour coding for as compared to other two hospitals.

All the nurses in Hospital (III) and Hospital (I) had adequate knowledge followed by majority of doctors in Hospital (II). Thus two hospitals were found to have cent percent result.

Hence the sub sub hypothesis stands partially accepted.

v) The doctors in Hospital (III) had better knowledge regarding waste container colour coding for as compared to other two hospitals.

A high majority of nurses in Hospital (III) had adequate knowledge regarding the type of container to be used for black, blue, red and yellow as compared to other two hospitals.

Hence the sub sub hypothesis stands accepted.

vi) The doctors in Hospital (III) had better knowledge regarding waste type in all colour coding for as compared to other two hospitals.

A high majority of doctors in Hospital (III) had adequate knowledge about container to be used for red and yellow waste, majority for black coloured waste while high majority of doctors in Hospital (I) had adequate knowledge regarding black coloured container (general waste). The knowledge scores were found adequate in three out of four colour codes for container.

Hence the sub sub hypothesis stands partially accepted.

vii) The doctors in Hospital (III) had better knowledge regarding disposal of different colour coded waste as compared to other two hospitals.
The data in Table 4.6 describes that the knowledge scores regarding disposal of waste was found to be better for yellow, red and blue coded waste in Hospital (III) while the knowledge scores for black coded (general) waste was found to be better in Hospital (I).

Hence the sub sub hypothesis was partially accepted.

The above sub hypotheses i) to vii) were tested to test hypothesis 3 (f). It was found that three sub hypotheses tested in favour of Hospital (III) and three partially in its favour and one was rejected.

Hence the hypothesis 3 (f) that the doctors in Hospital (III) had better knowledge regarding colour coding for BMWM as compared to other two hospitals stands partially accepted.

Hypothesis 3(g)

The doctors in Hospital (III) had better knowledge regarding use of universal precautions in BMWM as compared to other two hospitals.

The doctors in Hospital (III) scored much better than doctors in other two hospitals in their knowledge of use of universal precautions in BMWM as shown in Table 4.7. None of the doctors in Hospital (II) had adequate knowledge regarding BMWM. This difference in knowledge was found to be statistically highly significant

Hence the sub hypothesis stands accepted.

Hypothesis 3(h)

The doctors in Hospital (III) had lower perception of risk to health from BMWM as compared to other two hospitals.

It can be observed by the data presented in Table 4.16, that the risk scores were comparatively higher for Hospital (I) where majority of doctors perceived high and moderate risk from BMWM. This was followed by fair proportion of doctors perceiving moderate risk in Hospital (II) while none of the doctors in Hospital (III) were found perceiving high or moderate risk, hence the doctors in Hospital (II) perceived least risk while the doctors in Hospital (I) perceived maximum risk comparatively. Statistically, this difference in risk perception was found to be highly significant.

Hence the sub hypothesis stands accepted.
Hypothesis 3(i)

The doctors in Hospital (III) had better waste segregation practices compared to other two hospitals.

The researcher observed the doctors for their waste segregation practices in the ward on three consecutive observations, the observations being non participatory observations depicted in Table 4.17. The waste segregation practices of Hospital (III) were found to be better than other two hospitals. A fair proportion of doctors in Hospital (III) were found to be segregating the wastes properly followed by fair proportion in Hospital (I) and least scores in Hospital (II)

Hence the sub hypothesis stands accepted.

The over all hypothesis 3 was tested as follows:
The knowledge and practices of BMWM among the doctors in Hospital (III) was more than other two hospitals.

The testing of the above hypothesis is based on the secondary data. The above hypotheses were tested, knowledge of doctors in various aspects of BMWM were assessed and tabulated as being adequate and inadequate. Adequate knowledge in various parameters was given a scoring of 1 and inadequate scored as zero as described below:

<table>
<thead>
<tr>
<th>BMWM scoring parameters</th>
<th>Hospital (I)</th>
<th>Hospital (II)</th>
<th>Hospital (III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policies</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Waste categories/ segregation</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Waste transport</td>
<td>Adequate (1.0)</td>
<td>Inadequate (0.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Waste treatment</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Final disposal of waste</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
</tr>
<tr>
<td>Colour coding</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Red (Infectious)</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Yellow (Infectious)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Blue (Plastic)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Black (General)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Use of universal precautions</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Perceived risks</td>
<td>High (0.0)</td>
<td>High (0.0)</td>
<td>Low (1.0)</td>
</tr>
<tr>
<td>Practices</td>
<td>Correct (1.0)</td>
<td>Incorrect (0.0)</td>
<td>Correct (1.0)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6/12</td>
<td>4/12</td>
<td>11/12</td>
</tr>
</tbody>
</table>

Source: Primary data

The doctors in Hospital (III) scored a total of 11 out of 12, Hospital (I) scored 6 out of 12 and Hospital (II) scored 5 out of 12. Hence the knowledge and practices of BMWM by doctors in Hospital (III) was found to be better than other two hospitals.
Hence the hypothesis 3 that the knowledge and practices of BMWM among the doctors in Hospital (III) was more than other two hospitals stands accepted.

The Figure 7.1 compares the knowledge and practices of doctors and nurses in select hospitals. The knowledge and practices of nurses and doctors were found to be more in Hospital (III) with the doctors and nurses having comparable scores. This was followed by Hospital (I) where the nurses had more knowledge and better practices than the doctors. The Hospital (II) scored least with the doctors and nurses of the hospital scoring less than other two hospitals. It was further seen that the nurses performed better than the doctor in Hospital (II). In fact the nurses in the Hospital (I) and (II) performed better than the doctors and were at par with the nurses in Hospital (III).

Major findings on knowledge and practices of Group D employees regarding BMWM in select hospitals

Management of health-care waste is an integral part of hospital hygiene and infection control. One of the most basic measures for the maintenance of hygiene, and one that is particularly important in the hospital environment, is cleaning which involves the handling of potentially hazardous material. The key to minimization and effective management of health-care waste is identification and segregation of the waste. Appropriate handling, production, segregation, transportation, treatment, and disposal of health-care waste reduces costs and does
much to protect public health. In all the three select hospitals under study, the Group D employees were divided into two categories, ward sweepers and Ward Helpers

- The Hospital (I) had outsourced the cleaning of the hospital outpatient departments and corridors to two contractors.
- In Hospital (III), the collection part of the waste management cycle was outsourced to a civil vendor while there was no such outsourcing in Hospital (II).
- In the two hospitals that had outsourced their waste transport, the cleaning material, dress of Group D employees and the gloves, shoes etc. were being provided by the contractors.
- There were more number of Group D employees working in the Surgical wards of all the three hospitals as compared to the Medical wards.
- Hospital (II) had more workers in Surgical wards compared to other two hospitals.
- All the three hospitals had poor proportion of workers in > 45 years of age with Hospital (III) having least number.
- There were more number of male Group D employees in all the three hospitals as compared to females.
- Most of the workers had been working in the hospital from 1 to 10 years in Hospital (I) and (III) while majority of Group D employees in Hospital (II) had been working for more than 10 years.
- More number of workers in Hospital (III) had been working for more than 10 years as compared to other two hospitals.

Knowledge of Group D employees regarding BMWM policies

- A high majority of Group D employees had inadequate knowledge regarding BMWM policies in their hospitals.
- The knowledge of the Ward Helpers was found to be more than that of sweepers in Hospital (I) and (II) while the sweepers in Hospitals (III) were found to have more knowledge regarding the BMWM policies as compared to Ward Helpers.
- Ward Helpers in Hospital (III) working in Surgical wards had more knowledge as compared to Ward Helpers in other two hospitals.
- The sweepers in Medical ward had more knowledge than Ward Helpers in all the three select hospitals.
- None of the sweepers in Surgical ward in Hospital (III) or (II) had adequate knowledge
regarding the hospital policies related to BMWM while it was found adequate in Hospital (III).

- A fair proportion of the Ward Helpers in Hospital (III) who were graduates possessed adequate knowledge regarding BMWM policies of their hospital and sweepers in Hospital (III) who had studied up to senior secondary level education had adequate knowledge. Gender wise, not much difference was observed between male and female Ward Helpers and sweepers in the same hospitals.

- A fair proportion of Ward Helpers who were permanently employed in Hospital (III) had adequate knowledge, followed by sweepers in same hospital and sweepers in Hospital (I). A fair proportion of Ward Helpers who had more than 10 years of working in same hospital had better knowledge scores.

**Knowledge of Group D employees regarding waste segregation**

- More number of Ward Helpers were found to have knowledge regarding waste segregation in Hospital (II) followed by Hospital (I) while none of the Ward Helpers in Hospital (III) had this knowledge.

- Similarly, sweepers in Hospital (II) were found to have better knowledge regarding bio medical waste segregation followed by Hospital (I) and (III). The Group D employees in Hospital (II) were more involved in waste segregation in the wards and hence had better waste segregation knowledge.

- Age wise, the younger Group D employees in Hospital (II) in age group of 15-30 years had more knowledge followed by Group D employees in Hospital (I) in the age group of 31-45 years.

- In regards with education, it was observed that as education level increased, knowledge scores increased.

- In regards with employment, the employees on contract scored slightly better than those who were permanently employed.

- Gender wise, females scored better than males and Hospital (II) had better scores followed by Hospital (I) and then Hospital (III).

- As the duration of working in hospital increased, the knowledge of Group D employees regarding waste segregation and disposal increased for age group of 1 to 10 years and then reduced from > 10 years.
In all the parameters, i.e. age, ward, education, gender, employment and duration of work, the findings were below 40 per cent implying that the knowledge ranged from poor to fair in above mentioned parameters.

**Knowledge of Group D employees regarding waste transport**

- Though the Group D employees in all three hospitals had poor knowledge scores regarding BMWM policies and segregation, their knowledge regarding waste transport was found to be much better.
- The Group D employees of Hospital (III) had adequate knowledge followed by Hospital (II) and then Hospital (I).
- High majority of Wards Helpers and sweepers in Hospital (III) and (II) working in Surgical wards had adequate knowledge as compared to majority of Ward Helpers and sweepers in Medical ward of Hospital (I).
- Age wise, in all three hospitals it was seen that as age of Group D employees increased, knowledge decreased, hence knowledge related to waste transport was inversely proportional to age of Group D employees.
- The knowledge scores were highest in age group of 15-30 years in Hospital (III) followed by Hospital (II) and Hospital (I).
- Group D employees who were working on contract in Hospital (I) and (III) had better knowledge scores than permanently employed Group D employees.
- Surprisingly the knowledge regarding waste transport was inversely proportional to duration of working in hospitals, i.e. people with less than one year experience had more knowledge.
- Gender wise, male Group D employees in Hospital (II) and (III) had more knowledge than females while in Hospital (I), females had more knowledge than males.
- High majority of Group D employees, both males and females had adequate knowledge in Hospital (III) and (II) while majority of males and females in Hospital (I) had adequate knowledge.

**Knowledge of Group D employees regarding waste treatment**

- Moderate proportion of Ward Helpers had adequate knowledge regarding bio medical waste treatment followed by poor proportion in Hospital (I) and Hospital (II).
The sweepers scored better in Hospital (III) with moderate proportion having adequate knowledge regarding bio medical waste treatment followed by Hospital (I) and Hospital (II).

Majority of Group D employees working in Medical ward were found to have adequate knowledge in Hospital (III). The knowledge scores in other hospitals was found inadequate.

Age wise, in Hospital (I), moderate proportion were found to have adequate knowledge in employees above 45 years of age.

Increasing age was found related to proportional increase in knowledge in this hospital.

Education wise, similar results were observed with Hospital (III) having comparable better knowledge score than Hospital (I) or (II). Further, the graduate in three Hospital (I) was found to have lesser knowledge than the Matric passed Group D employees.

In all the three hospitals, males were found to have marginally better knowledge than females with Hospitals (III) leading followed by Hospital (I) and then (II).

Permanently employed Group D employees were found to have better knowledge than the employees working on contract.

While analysing the results according to duration of working in hospital, it was seen that majority of Group D employees who had spent less than one year in Hospital (II) had adequate knowledge regarding waste treatment in their hospital.

Knowledge of Group D employees regarding colour coding of waste

A high majority of Ward Helpers and sweepers in Hospitals (I) and (II) had adequate knowledge regarding the colour coding, as did the Ward Helpers in Hospital (III).

Majority of sweepers in Hospital (III) had adequate knowledge regarding colour for waste.

The Group D employees in Hospital (II) had poor knowledge regarding red colour as their hospital was not using this colour code.

High majority of Ward Helpers and sweepers had adequate knowledge regarding all of waste except blue color i.e. plastic waste in all the three hospitals. While assessing their knowledge regarding containers for waste, it was inferred that Hospital (II) had scored better than Hospital (I) in regards to yellow and red coloured containers, we
percent for black color, however in regards to blue coloured containers, sweepers in Hospital (I) scored high, followed by sweepers in Hospital (II) and then Hospital (II).

- The sweepers in Hospital (III) had better knowledge scores regarding plastic waste segregation and transport as compared to other two hospitals.

Knowledge of Group D employees regarding use of universal precautions in BMWM

- The knowledge regarding use of universal precautions among Group D employees of the select hospitals was overall found inadequate.

- It was further noted that the Ward Helpers had more knowledge than the sweepers in Hospital (III) while the sweepers had more knowledge than Ward Helpers in Hospital (I).

- A fair proportion of Ward Helpers in Hospital (III) had adequate knowledge followed by poor proportion of sweepers in Hospital (I).

- None of the Ward Helpers or sweepers in Hospital (II) had knowledge regarding use of universal precautions in BMWM.

- It was seen that poor proportion of sweepers had adequate knowledge in Hospital (I) followed by poor proportion in Hospital (III).

- The Group D employees in Surgical wards had better knowledge than those in Medical wards.

- The graduate Group D employees of Hospital (III) had better knowledge scores and males had better knowledge scores.

- Permanently employed Group D employees were also found to have better knowledge regarding use of universal precautions in BMWM in Hospital (I) followed by Hospital (III).

- Group D employees, who had been working in Hospital (III) for 1-10 years, had better knowledge scores followed by those who had been working for more than 10 years Hospital (I).

Perceived risk from BMWM among Group D employees

- A moderate proportion of Ward Helpers in Hospital (I) perceived risk always from BMWM followed by moderate proportion in Hospital (II).

- The Ward Helpers of Hospital (III) perceived least risk out of the three hospitals. A fair proportion of sweepers of Hospital (II) perceives high risk out of the three hospitals.
The Group D employees in Medical ward perceived more risk than those in Surgical wards in all the three hospitals.

The younger Group D employees in age group 15-30 years perceived higher risk than those above 45 years of age in all three hospitals.

Interestingly, it was seen that as the duration of working in the hospital increased, the risk perception reduced in Hospital (I) and (III) while it increased in Hospital (II).

More number of Sweepers in Hospital (I) had adequate knowledge as compared to Ward Helpers and this could be attributed to the strict checks being maintained by the Sanitary Inspector of Hospital (I) who checked the sweepers detailed under her supervision for not wearing gloves or proper shoes while waste transportation and segregation.

Observations made on Group D employees regarding BMWM in select hospitals

The Group D employees of Hospital (I) were segregating the waste better than other two hospitals.

Moderate proportion of the Group D employees in Hospital (I) and Hospital (III) were segregating the waste as per the colour coding followed by poor proportion in Hospital (II).

Majority of Group D employees in Hospital (II) had incorrect segregation practices compared to poor proportion of Group D employees in Hospital (I).

Hence, the Group D employees of Hospital (I) had better waste segregation practices. This can again be explained by strict checks being maintained by the Sanitary Inspector and education by nurses in the ward.

The knowledge of the Group D employees was assessed along with their waste segregation practices in the present study. The objectives and hypotheses are described as follows:

**Objective 4**

To assess the knowledge and practices of biomedical waste management among the Group D employees in the three hospitals.

This objective was attained by testing the following hypothesis.
Hypothesis 4

The Group D employees in Hospital (III) had better knowledge and practices related to BMWM as compared to other two hospitals.

Further this hypothesis was divided into various sub hypothesis as follows:

4 (a) The Group D employees in Hospital (III) had better knowledge regarding biomedical waste management policies as compared to other two hospitals.

4 (b) The Group D employees in Hospital (III) had better knowledge regarding waste segregation as compared to other two hospitals.

4 (c) The Group D employees in Hospital (III) had better knowledge regarding waste transport as compared to other two hospitals.

4 (d) The Group D employees in Hospital (III) had better knowledge regarding waste treatment as compared to other two hospitals.

4 (e) The Group D employees in Hospital (III) had better knowledge regarding final disposal of waste as compared to other two hospitals.

4 (f) The Group D employees in Hospital (III) had better knowledge regarding colour coding for BMWM as compared to other two hospitals.

4 (g) The Group D employees in Hospital (III) had better knowledge regarding use of universal precautions in BMWM as compared to other two hospitals.

4 (h) The Group D employees in Hospital (III) had lower perception of risk to health from BMWM as compared to other two hospitals.

4 (i) The Group D employees in Hospital (III) had better waste segregation practices compared to other two hospitals

Hypothesis testing

Hypothesis 4(a)

The Group D employees in Hospital (III) had better knowledge regarding biomedical waste management policies as compared to other two hospitals.

As indicated by the data in Table 5.5 it was found that all the moderate proportion of Ward Helpers and poor proportion of sweepers in Hospital (III) had adequate knowledge regarding policies and this was more significant for Ward Helpers. Statistically, this knowledge difference was found to be highly significant for Ward Helpers.

Hence the sub hypothesis stands accepted.

293
Hypothesis 4(b)

The Group D employees in Hospital (III) had better knowledge regarding waste segregation as compared to other two hospitals.

The data in Table 5.5 describes that more number of Group D employees both Ward Helpers and sweepers in Hospital (II) had better knowledge scores followed by Hospital (I) while the scores were negligible in Hospital (III). Statistically this difference in knowledge scores was found to be highly significant for Ward Helpers.

Hence the sub hypothesis stands rejected

Hypothesis 4(c)

The Group D employees in Hospital (III) had better knowledge regarding waste transport as compared to other two hospitals.

The data in Table 5.5 describes that high majority of Group D employees both Ward Helpers and sweepers in Hospital (III) had adequate knowledge scores followed by Hospital (II) and Hospital (I). Statistically this difference in knowledge scores was found to be highly significant for sweepers and significant for Ward Helpers.

Hence the sub hypothesis stands accepted

Hypothesis 4(d)

The Group D employees in Hospital (III) had better knowledge regarding waste treatment as compared to other two hospitals.

Moderate proportion of Ward Helpers and sweepers as described by the data in Table 4.5 had adequate knowledge regarding waste treatment, followed by Hospital (I) and with poor proportions in Hospital (II). Statistically the difference in knowledge was found to be highly significant both for the Ward Helpers and sweepers.

Hence the sub hypothesis stands accepted

Hypothesis 4(e)

The Group D employees in Hospital (III) had better knowledge regarding waste segregation and disposal of waste as compared to other two hospitals.

The analysis depicted in Table 5.7 revealed that the knowledge of Group D employees in Hospital (II) was comparatively better regarding final disposal of waste with fair proportion having adequate knowledge as compared to other two hospitals. The knowledge scores were least for Hospital (III) Statistically the difference in knowledge was found to be highly
significant.

Hence the sub hypothesis stands rejected

Hypothesis 4(f)

The Group D employees in Hospital (III) had better knowledge regarding colour coding for BMWM as compared to other two hospitals.

Further that:

i) The Group D employees in Hospital (III) had better knowledge regarding red colour coding as compared to other two hospitals.

As revealed by the data presented in Table 5.8, it was found that high majority of Ward Helpers had adequate knowledge while high majority of sweepers in Hospital (I) had knowledge, with none of the Group D employees in Hospital (II) having knowledge regarding red coded waste (infectious waste). Statistically, the difference in the knowledge scores was highly significant for Ward Helpers and sweepers.

Hence the sub sub hypothesis stands partially accepted.

ii) The Group D employees in Hospital (III) had better knowledge regarding yellow colour coding as compared to other two hospitals.

All the Group D employees in select hospitals had cent per cent knowledge regarding yellow coded waste (human anatomical waste) as described in Table 5.8.

Hence the sub sub hypothesis stands rejected.

iii) The Group D employees in Hospital (III) had better knowledge regarding blue colour coding for as compared to other two hospitals.

High majority of Ward Helpers and sweepers in Hospital (III) had knowledge regarding the colour code for plastic i.e. blue coded waste as depicted in Table 5.8.

Hence the sub sub hypothesis stands accepted.

iv) The Group D employees in Hospital (III) had better knowledge regarding black colour coding for as compared to other two hospitals.

All the sweepers in Hospital (III) and Hospital (II) had adequate knowledge while all the Ward Helpers in Hospital (I) and Hospital (II) had adequate knowledge followed by high majority of Ward Helpers in Hospital (III). Thus, the sweepers in Hospital (III) had better knowledge scores regarding black coded (general waste) while the Ward Helpers had comparatively lower scores.
Hence the sub sub hypothesis stands partially accepted.

v) The Group D employees in Hospital (III) had better knowledge regarding colour coding of waste container for as compared to other two hospitals.

The data in Table 5.8 shows that both the Ward Helper as well as sweeper scored better for yellow coded container in Hospital (II). The Group D employees of Hospital (I) had better scores related to blue coded or plastic waste. While analyzing the red coded waste, it was found that the sweepers of Hospital (III) scored better while the scores of Ward Helpers of Hospital (II) were better. All the Group D employees in the select hospitals had cent per cent knowledge for black coded i.e. general waste.

Hence the sub sub hypothesis stands rejected.

vi) The Group D employees in Hospital (III) had better knowledge regarding waste type in all colour coding for as compared to other two hospitals.

The data in Table 5.8 describes that high majority of doctors in Hospital (III) had adequate knowledge about container to be used for red and yellow waste, majority for black coloured waste while high majority of doctors in Hospital (I) had adequate knowledge regarding black coloured container (general waste). The knowledge scores were found adequate in three out of four colour codings for container.

Hence the sub sub hypothesis stands partially accepted.

vii) The doctors in Hospital (III) had better knowledge regarding disposal of different colour coded waste as compared to other two hospitals.

The data in Table 5.8 describes that the knowledge scores regarding disposal of waste was found to be better for yellow and red coded waste in Hospital (II) better for black and blue coded waste in Hospital (III).

Hence the sub sub hypothesis stands partially accepted.

The above sub hypotheses i) to vii) were tested to test hypothesis 4 (f). It was found that one sub hypothesis tested in favour of Hospital (III) and four partially in its favour and two were rejected.

Hence the hypothesis that the Group D employees in Hospital (III) had better knowledge regarding colour coding for BMWM as compared to other two hospitals stands partially accepted.
Hypothesis 4(g)

The Group D employees in Hospital (III) had better knowledge regarding use of universal precautions in BMWM as compared to other two hospitals.

The Ward Helper in Hospital (III) scored better than other two hospitals while the sweepers in Hospital (I) had better scores regarding use of universal precautions in BMWM as shown in Table 5.11. None of the Group D employees in Hospital (II) had adequate knowledge regarding it. Statistically this difference in knowledge was found to be highly significant.

Hence the sub hypothesis stands partially accepted.

Hypothesis 4(h)

The Group D employees in Hospital (III) had lower perception of risk to health from BMWM as compared to other two hospitals.

It was observed in table 5.11, that the risk scores were comparatively higher for Hospital (II) and Hospital (I) while the Ward Helpers and sweepers of Hospital (III) perceived much less risk from BMWM in their hospitals. Statistically, this difference in risk perception was found to be highly significant.

Hence the sub hypothesis stands accepted.

Hypothesis 4(i)

The Group D employees in Hospital (III) had better waste segregation practices compared to other two hospitals.

The researcher observed the Group D employees for their waste segregation practices in the ward on three consecutive observations, the observations being non participatory observations depicted in Table 5.14. The waste segregation practices of Group D employees of Hospital (I) were found to be better followed by Hospital (III) and least in Hospital (II). Statistically, the difference was highly significant.

Hence the sub hypothesis stands rejected.

The over all hypothesis 4 was tested as follows:

The knowledge and practices of BMWM among the Group D employees of Hospital (III) was more than other two hospitals.

The testing of the above hypothesis is based on the secondary data. The above hypotheses were tested, knowledge of Group D employees in various aspects of BMWM were assessed and tabulated as being adequate and inadequate. Adequate knowledge in various parameters was
given a scoring of 1 and inadequate scored as zero as described below:

<table>
<thead>
<tr>
<th>BMWM parameters for scoring</th>
<th>Hospital (I)</th>
<th>Hospital (II)</th>
<th>Hospital (III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policies</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
</tr>
<tr>
<td>Waste segregation</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
</tr>
<tr>
<td>Waste transport</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Waste treatment</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Final disposal of waste</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
</tr>
<tr>
<td>Colour coding</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Red (Infectious)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Yellow (Infectious)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Blue (Plastic)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Black (General)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
<td>Adequate (1.0)</td>
</tr>
<tr>
<td>Use of universal precautions</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
<td>Inadequate (0.0)</td>
</tr>
<tr>
<td>Perceived risks</td>
<td>High(0.0)</td>
<td>High(0.0)</td>
<td>Low(1.0)</td>
</tr>
<tr>
<td>BMWM Practices</td>
<td>Correct (1.0)</td>
<td>Incorrect (0.0)</td>
<td>Correct (1.0)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>6/12</td>
<td>5/12</td>
<td>8/12</td>
</tr>
</tbody>
</table>

The Group D employees in Hospital (III) scored a total of 8 out of 12, Hospital (I) scored 6 out of 12 and Hospital (II) scored 5 out of 12. Hence the knowledge and practices of BMWM by Group D employees in Hospital (III) was found to be better than other two hospitals.

Hence the hypothesis 4 that the knowledge and practices of BMWM among the Group D employees of Hospital (III) was more than other two hospitals stands accepted.

Major findings on knowledge and practices of patient and patient attendants regarding BMWM in select hospitals

In a health-care facility, patients and their caregivers or their attendants also play an important role in waste segregation. A patient is any recipient of healthcare services. During general care, the attendants often come into close contact with patients and his wastes. The caregivers are neither trained nor aware of the intricacies involved in BMWM and hence contribute unknowingly to its poor segregation. The patients and their attendants were assessed regarding their knowledge and practices related to BMWM in the wards in which the patient was admitted. The findings are presented as follows:

Knowledge of patients and patients attendants regarding BMWM segregation

- In all the three hospitals, the knowledge of the patients was found to be poor while the knowledge of their attendants was found to be better regarding waste segregation.
- Moderate proportion of patients attendants had adequate knowledge about segregation in Hospital (III) followed by fair proportion in Hospital (I) and poor proportion in Hospital (II).
The hospital where the nurses took the time and effort to orient the patients and the ones where the patients were not involved in invasive procedures like assisting in throwing blood soaked cotton or gauze or plastic cannulas were found to have better knowledge scores.

The attendants of newly admitted patients who had less than one week of hospitalization were found to have better knowledge scores than those above one week of hospitalization.

Patients attendants aged between 15 to 45 years were found to have better knowledge than those above 45 years of age.

Surprisingly, illiterate attendants were found to have marginally better knowledge scores as compared to educated attendants.

Attendants whose patients had undergone surgery were found to have better knowledge scores in Hospital (II) and (III) while in Hospital (I) those attending to their patients in Medical wards were found to have better knowledge scores.

Knowledge of patients and patients attendants regarding colour coding in BMWM

It was found that scores for black coded waste (general waste) was more followed by Blue coded waste (plastic waste) in all three hospitals.

The patients attendant in Hospital (III) had better knowledge scores regarding black and red coded buckets and bins followed by Hospital (II), while for blue coded bins, Hospital (I) had better knowledge scores as compared to other two hospitals.

A high majority of patients attendants in Hospital (III) had adequate knowledge regarding disposal of waste in general waste bin and hence were segregating it better than in other two hospitals. They were not asked about segregation of sharps as they were not found handling it in all the three hospitals.

Responses on information being provided to patients and their attendants regarding waste segregation.

A high majority (70 per cent) of the patients attendants were informed and educated about the waste segregation while moderate proportion were informed in Hospital (III) and fair proportion were informed in Hospital (II).

Moderate proportion of patients in Hospital (III) were informed about waste segregation, this was followed by patients attendants in Hospital (II) and then Hospital (I).
The patients and patients attendants in Hospital (III) were better informed than the other two hospitals suggesting that the health care staff in Hospital (III) took more interest and were more involved in the management of the biomedical waste in their ward. It was further seen that the patients attendants who had stayed for more than one week had better knowledge than those who stayed less than one week; also Hospital (II) scored less than other two hospitals.

Age wise the attendants both in 15 to 45 years and more than 45 years category scored better than other two hospitals.

Education wise, high majority of attendants in Hospital (I) who were educated above Matric verbalized better information followed by majority in Hospital (III).

Attendents of patients undergoing medical and surgical treatments in Hospital (I) scored better than other two hospitals, followed by surgical patients in Hospital (III).

The association between information being provided to patients attendants regarding BMWM and the segregation of waste in wards by them was calculated and it was found that there is a direct relationship between the two.

The attendants in Hospital (I) who were better informed as compared to other two hospitals had better knowledge regarding waste segregation followed by Hospital (III).

In Hospital (II), lesser number of attendants expressed that they had been informed by ward nurse or doctor and were found to have lesser knowledge scores as compared to other two hospitals.

Knowledge of patients and patients attendants regarding health hazards due to BMWM

Majority proportion of patients and their attendants in Hospital (III) had adequate knowledge regarding health hazards due to biomedical waste handling, followed by moderate proportion of patients attendants in Hospital (I) and poor proportion in Hospital (II).

In all the three hospitals, there was a direct relationship between knowledge of health hazards and perceived risk due to BMWM among patients and their attendants with patients and their attendants in Hospital (III) perceiving highest risk from BMWM.

In Hospital (II), poor proportion of patients attendants had adequate knowledge of health hazards and perceived lesser risk due to biomedical waste management.

In Hospital (III), more number of patients had knowledge regarding health hazards due to
biomedical waste handling and segregation and perceived higher risk among three hospitals.

- In all the three hospitals, health hazards due to BMWM were assessed and it was found that patients attendants who had less than one week of stay with their patients in the hospital had more knowledge than those who had stayed more than one week.
- Age wise, patients attendants who were aged 15 years to 45 years were found to have better knowledge scores.
- Interestingly, it was seen that as the educational status increased, the knowledge scores reduced among the patients attendants.
- There was no difference observed in the knowledge scores of patients attendants vis-à-vis the medical and surgical management of their patients.

Observations made on patients and patients attendants regarding their BMWM practices

- Three consecutive observations were made by the researcher on patients and their attendants to evaluate correct segregation practice of the biomedical waste generated or handled by them. On analysis it was seen that the three observations revealed similar findings.
- Majority of the patients in Hospital (III) were following correct biomedical waste segregation practices followed by fair proportion in Hospital (I) and in Hospital (II). Hence more patients in Hospital (III) were following proper waste segregation. The observation made on patients attendants in three hospitals too had similar findings.

The knowledge of the Group D employees was assessed along with their waste segregation practices in the present study. The objectives and hypotheses are described as follows:

Objective 5

To assess the knowledge and practices of biomedical waste management among the patients and patient attendants in the three hospitals.

This objective was attained by testing the following hypothesis.

Hypothesis 5

The patients and patient attendants in Hospital (III) had better knowledge and practices related to BMWM as compared to other two hospitals.

Further this hypothesis was divided into various sub hypothesis as follows:
5 (a) The patients and patient attendants in Hospital (III) had better knowledge regarding waste segregation as compared to other two hospitals.

5 (b) The patients and patient attendants in Hospital (III) had better knowledge regarding colour coding as compared to other two hospitals.

5 (c) The patients and patient attendants in Hospital (III) were better informed about BMWM in the ward as compared to other two hospitals.

5 (d) The patients and patient attendants in Hospital (III) had better knowledge regarding health hazard due to BMWM as compared to other two hospitals.

5 (e) The patients and patient attendants in Hospital (III) had lower perception of risk due to BMWM as compared to other two hospitals.

5 (f) The patients and patient attendants in Hospital (III) had better waste segregation practices compared to other two hospitals.

**Hypothesis testing**

**Hypothesis 5(a)**

The patients and patient attendants in Hospital (III) had better knowledge regarding waste segregation as compared to other two hospitals.

A moderate proportion of patients attendants had adequate knowledge about segregation of waste in Hospital (III) followed by fair proportion in Hospital (I) and poor proportion in Hospital (II). The knowledge of the patients was found to be comparatively better in Hospital (III) as depicted in Table 6.4. Statistically, the difference in knowledge scores of patient attendants was found to be highly significant.

Hence the sub hypothesis stands accepted

**Hypothesis 5(b)**

The patients and patient attendants in Hospital (III) had better knowledge regarding colour coding as compared to other two hospitals.

Further that-

i) The patients and patient attendants in Hospital (III) had better knowledge regarding red colour coding as compared to other two hospitals.

It was found in Table 6.5 that moderate proportion of patients and their attendants had adequate knowledge regarding red coded waste i.e. infectious waste in Hospital (III). Statistically, the difference in the knowledge scores was found to be highly significant.
Hence the sub sub hypothesis stands accepted

ii) The patients and patient attendants in Hospital (III) had better knowledge regarding black colour coding as compared to other two hospitals.

It was found in Table 6.5 that high majority of patients and their attendants had adequate knowledge regarding black coded waste i.e. general waste in Hospital (III). Statistically, the difference in the knowledge scores was found to be highly significant.

Hence the sub sub hypothesis stands accepted

iii) The patients and patient attendants in Hospital (III) had better knowledge regarding blue colour coding as compared to other two hospitals.

It was found in Table 6.5 that fair proportion of patients and their attendants had adequate knowledge regarding blue coded waste i.e. plastic waste in Hospital (I) followed by Hospital (II) and least knowledge scores in Hospital (III). Statistically, the difference in the knowledge scores was found to be highly significant.

Hence the sub sub hypothesis stands rejected

The testing of the above sub hypothesis 5(b) tested through sub sub hypotheses i) to iii) revealed that two out of three sub hypotheses supported the hypothesis and hence the hypothesis that the patients and patient attendants in Hospital (III) had better knowledge regarding colour coding as compared to other two hospitals stands partially accepted.

Hypothesis 5(c)

The patients and patient attendants in Hospital (III) were better informed about BMWM in the ward as compared to other two hospitals.

The data in Table 6.7 revealed that majority of patient attendants in Hospital (I) had been informed about the BMWM in the ward followed by moderate proportion of patient attendant in Hospital (III). More number of patients in Hospital (III) were informed about BMWM in the ward as compared to other two hospitals. Statistically, the difference in information scores was found to be highly significant

Hence the sub hypothesis stands partially accepted.

Hypothesis 5(d)

The patient and patient attendants in Hospital (III) had better knowledge regarding health hazard due to BMWM as compared to other two hospitals.

The information in Table 6.9 reveals that majority of patients and their attendants in Hospital
(III) had adequate knowledge regarding health hazards from BMWM followed by Hospital (I) and then Hospital (II).

**Hence the sub hypothesis stands accepted.**

*Hypothesis 5(e)*

The patient and patient attendants in Hospital (III) had lower perception of risk due to BMWM as compared to other two hospitals

The data in Table 6.9 indicated that though in none of the hospitals, the patients and their attendants expressed high risk from BMWM, yet the patients and their attendants in Hospital (III) expressed moderate risk followed by Hospital (I) and then Hospital (II).

**Hence the sub hypothesis stands rejected**

*Hypothesis 5(f)*

The patient and patient attendants in Hospital (III) had better waste segregation practices compared to other two hospitals

It was highlighted in Tables 6.12 and 6.13 that a high majority of patients attendants in Hospital (III) were segregating waste correctly followed by Hospital (II) and then Hospital (I). While considering the practices of the patients, it was noted that majority of patients in Hospital (III) were having correct segregation practices, followed by Hospital (I) and then Hospital (II). Statistically, this knowledge difference was found to be highly significant.

**Hence the sub hypothesis stands accepted.**

The hypothesis 5 was tested as follows:

The knowledge and practices of BMWM among the patients and patients attendants of Hospital (III) was more than other two hospitals.

The testing of the above hypothesis is based on the secondary data. The above hypotheses were tested, knowledge of patients and patient attendants in various aspects of BMWM were assessed and tabulated as being adequate and inadequate. Adequate knowledge in various parameters was given a scoring of 1 and inadequate scored as zero as described below:
The patients and patients attendants in Hospital (I) scored a total of 3 out of 7, Hospital (III) scored 4 out of 7 and Hospital (II) scored 1 out of 7. Hence the knowledge and practices of BMWM by patient and patients attendants in Hospital (III) was found to be better followed by Hospital (I) and then Hospital (II).

**Hence the hypothesis 5 that the knowledge and practices of BMWM among the patients and patients attendants of Hospital (III) was more than other two hospitals stands accepted.**

**Recommendations**

The need for the present study is indeed befitting with the times as matured decisions on the pernicious issue of BMWM is the need of the hour. The existing methods of disposal of hospital waste (incineration, hydroclave, autoclave) are either very costly, energy guzzlers or injurious to environment. The recommendations for the present study are based on the findings as per the BMWM cycle in the three hospitals. These are organized according to the various components of the cycle as follows:

**Issues and Recommendations related to policy implementation**

**Problems related to BMWM policies**

The findings of the study suggest that a waste management policy exists in all the select hospitals. However some flaws in its implementation were noted. There was an inadequate incinerator in Hospital (I), no deep burial practices for sharps in Hospital (I) and (II) and no vermiculture in Hospital (II) and (III).

**Suggestion**


It is recommended that the hospitals follow these rules in...
accordance with the Bio-Medical Waste (Management and Handling) Rules, 1998 and the amendments issued in the year 2000 for technology acquisition by converting them into well planned policies, procedures translated into daily, weekly and monthly routines. Hence, strict adherences to the policies are recommended.

- The hospitals should have proper segregation, handling and disposal of infectious waste to reduce the hazards of (re)use and disposal. Managing health care related waste in an environmentally sound way can also be a cost saving management strategy for the hospitals in the future.
- The provision of appropriate and fully functional terminal waste disinfection infrastructure in the form of incinerator, shredder, hydroclave and vermiculture should be procured by the Hospital Waste Management Committee.

*Hospitals do not have an active BMWM committee*

The hospitals in the present study though had a BMWM committee on papers, it was not found active and functional in all aspects of BMWM.

*Suggestions*

- The BMWM committee should play the role as per the laid down aims and objectives of the policy of the hospital. It should organise infection control meetings routinely. The committee should also assist in research project in the area of infection control. Pre-vaccination screening and Hepatitis-B vaccination among the staff members and monitoring the health records of all health workers must be made mandatory by the committee.
- The waste management committee should strictly monitor any lapses noted in the BMWM cycle and take corrective actions promptly. Establish a ‘Green team’ made up of administrator, nurses and house keeper who are responsible for waste handling. Conduct a waste audit by examining what comes into the hospital and what leaves. Use the results of the audit to identify wasteful practices and develop a waste management strategy that incorporates waste reduction, reuse and recycling measures. The following quality control measures can be undertaken by BMWM committee:
  - Swab cultures and air cultures are to be taken monthly to monitor surface cleaning and air colonies simultaneously.
  - Biological indicators are to be used to monitor the efficacy of the autoclave machines twice a month.
Maintaining records of distribution of disinfectants, immunization register, sharp injury register, culture reports, records of infectious patients admitted in wards and performance of various wards.

Quality control monitoring register and Nosocomial infection register.

There are no clear policies on Infection Control Committee

It was found in the three hospitals that there were no guidelines on the infection control committee and its role in BMWM in the hospital.

Suggestions

It is recommended that an Infection Control Committee which is formulated in the hospitals but remains largely in the papers be made active. The Infection Control Committee should be an important part of the health care institute and the management has to give complete support for its effective and efficient functioning. The recommended formulation of the committee is as follows:

Chairman : D.M.S. (Director Medical Services)
Coordinator : HOD (Head of Department), Microbiology
Secretary : ICN (Infection Control Nurse)
Members : O.T. Superintendent
           : Matron
           : In charge of ICU, OT, CSSD
           : Supervisor House Keeping with one representative of Group D employees
           : One Physician
           : One Surgeon

The recommended aims of Infection Control Committee are as listed below:

1. Surveillance of hospital infections.
2. Institution of the preventive measures for control of hospital acquired infections.
3. Conduction of surveillance for specific infection to formulate infection control policies.
4. Education of health care workers and patients regarding universal precautions.
5. Conduction of regular in-service education programmes for health care workers to keep them abreast with new trends in infection control.
6. Assurance of protective measures for the health care workers.
7. Implementation of effective infection control programme based on the policies through adequate supervision and quality assurance tests.

8. Review of the infection control policies periodically to incorporate new protocols.

9. The ICN should randomly check (at least twice a month) for concentration of various disinfection solution kept in various departments.

10. The infection control program in the hospitals should be based on the following principles of waste management:

   Reduce
   - Use of physical rather than chemical cleaning.
   - Adopt practices which prevent wastage of products (nursing and cleaning).
   - Avoid use of mercury based equipment plastics and disposables in routine work.

   Reuse
   - Linen caps, masks, gowns, diapers (autoclave, sluicing)
   - Bedpans, urinals, sputum cup, mattresses; careful disinfection
   - Glassware, Petri-dishes, syringes, needles, sharp containers, dialysers, angiography disposables, suction catheters, blood collection vials etc., after careful disinfection and sterilization should be reused.

   Recycle
   - Glass, paper, cardboard, cartons, plastics, news paper, magazines, batteries, toner cartridges, aluminum foils, bulbs should be recycled.
   - Chemicals like Formalin, Xylene, Mercury, Expired drugs, Lot of solvents, Developing solution, X-ray films should be recycled.

• The study recommends a post of Infection Control Nurse in all the Hospitals for the supervision over infection control procedures, carried out in the ward, compilation of records of infectious patients from laboratory and ward rounds and participation in teaching and practical demonstration of infection control techniques to Health Care Workers.

• It is further recommended that there should be prompt information of notifiable diseases caused by biomedical waste management to concerned health authorities and medical record department.

*There are no clear policies on education of the waste handlers*
It was found in the three hospitals that there were no laid down policies for induction training, in-service training or periodic training of the waste handlers.

**Suggestion**

- It is recommended to conduct the orientation programme for the new inducted staff members and organizing continuous awareness programme amongst the staff members.

- The present study strongly recommends periodic in-service education programmes for the various category of health personnels in the hospital i.e. doctors, nurses and Group D employees as all lacked knowledge on different aspects of waste management. Visit to incinerator, shredder area, pathology laboratory and deep burial sites will improve the practices of health workers. The study brought out alarming results that none of the doctors in the three hospitals had complete knowledge regarding the policies of BMWM in the three hospitals. While none of the doctors were found to be completely ignorant regarding waste treatment, their knowledge was found lacking in areas like treatment of plastics in shredder, disposal of expired and unused medicines, cytoxic and radioactive waste etc. and these deficient knowledge areas need to be targeted for the doctors.

**There were no hand washing facilities for the Group D employees**

- It was found that the three hospitals did not have proper handwashing facilities for the use of Group D employees.

**Suggestion**

- Proper handwashing facilities should be made available in the sluice room or separate bathrooms for the Ward Helpers and the sweepers. There should be use of alcohol scrub in biomedical waste management as alcoholic hand rub is more effective than traditional hand wash. Alcoholic hand rub drastically reduces bacterial flora.

**Poor recording and reporting of waste was noted in the hospitals.**

- Waste quantification was poor in all the three hospitals.

**Suggestions**

- Waste Management record should be maintained by the Sanitary Inspector and the ANS and should include daily weight of municipal waste, record of State Pollution Control Board Inspections, incinerator and shredder maintenance book and attendance book of
workers. The Sanitary Inspector should be directly responsible for management of biomedical waste in wards and departments.

Waste transportation methods differed in the hospitals

It was brought out from the analysis in this study that the method of waste transportation wherein different workers were assigned to collect different coloured bins from all areas of the hospital as was being done in Hospital (I) and Hospital (III).

Suggestions

- This type of system of collection of different types of waste bins by different workers led to better waste segregation in Hospital (I) and (III) whereas in Hospital (II), same workers who were segregating the waste in the wards and departments were tying and transporting it, leading to waste mixing at terminal end points in waste management cycle. Hence collection of waste from the wards as per the colour coding by different waste transporters is recommended.

Observation by the researcher

- In Hospital (III) and (I), the collection part of the waste management cycle was outsourced to a civil vendor while there was no such outsourcing in Hospital (II). The overall scores for BMWM the hospitals that had outsourced their cleaning were better and hence outsourcing is recommended within the financial constrains of the hospital.

Issues and Recommendations related to waste segregation and colour coding

Common procedural errors/issues noted in BMWM segregation practices in select hospitals

The common procedural errors found in the present study are as follows:

- Many categories of waste handlers were not following the colour codes
- Errors noted in the segregation of the sharps were as follows:
  - Not burning the needle after use
  - Recapping of needle
  - Discarding needle in needle cutter
  - Container for sharps without disinfectant
  - Discarding syringe without removing the needle
- Used syringes, gloves are not being soaked in disinfectant solution.
- Disposing syringes without clearing blood inside.
- Not removing the needle from IV sets.
• Not mutilating the nozzle of syringe.
• Disposal of swabs in corridors and toilets by patients.
• Keeping the food waste uncovered.
• Not segregating the waste as per policy and leaving everything mixed up.
• Throwing waste out of container or over the lids of container
• Not wearing the protective clothing.
• Disregard for colour codes.
• Mixing of waste in one container only to economise on bags.
• Spilling of waste in corridor and enroute during transportation.
• Delay in collection due to lack of coordination between ward staff and collection team.
• Leaving the collected waste unattended in passages and near the kerb site.

Recommendations

• Segregating of the waste at the point of generation, before treatment or disposal is critical. The present study brought out that there was an inverse relation observed between age and knowledge level regarding waste segregation, hence the senior nurses and doctors should be more involved in waste segregation through in- service education programmes and through their participation in Waste Management Committees in the hospitals and in their departments.

• As nurses had more knowledge regarding waste segregation, they could be given more responsibilities and authorities in their own wards to ensure better waste segregation

• It is strongly recommended that same coloured plastic should be put in same coloured waste bin e.g. a blue plastic bag in a black coloured bin leads to confusion in waste segregation- both by the Group D employees and the patient attendants.

• The permanently employed Group D employees in the middle age group should be motivated to segregate the waste better as their scores were found to be low in the present study.

• In all the three hospitals, the knowledge of the patients was found to be poor hence patients should not be involved in helping nurses in waste segregation.

• There was a direct relationship between the information being provided to patients attendants regarding BMWM and their knowledge regarding waste segregation, hence the patients attendants should be made aware of waste segregation practices in the ward for
better waste management in the ward.

- Disposable needles must be disposed off in puncture proof container to avoid needle injuries to health workers.\textsuperscript{11} Disinfection and mutilation of sharps at source was considered essential before the waste was sent outside the hospital for final disposal. Most health care workers felt that the use of simple devices like needle cutters or destroyers for mutilation of sharps were important in waste segregation.\textsuperscript{12}

- The concept of Auto Disabled (AD) syringes can be introduced as pilot projects in few departments like Emergency in the hospitals. AD syringes will help in minimizing the spread of infections.\textsuperscript{13, 14}

- Wooden contraption for placing biomedical waste containers in the ward as was being practiced in highly infectious wards of Hospital (III) was found to reduce segregation errors. Its further use can be explored in the future. (\textit{Shown below})

<table>
<thead>
<tr>
<th>Recommended wooden contraption</th>
<th>Recommended containers</th>
<th>Recommended bags</th>
</tr>
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- It is recommended to have open type of the waste bins as they are easy to use and the waste remains well covered (\textit{Shown above}). The use of bio degradable bags as shown above is recommended for dry hospital waste instead of plastic bags. (\textit{Shown above})
Recommendations related to waste treatment

Low knowledge scores of health workers

It was brought out in this study that all the categories of health workers had low scores regarding the various treatment modalities for waste management in their hospitals.

Suggestion

• Periodic in service education programmes and visits to terminal waste treatment sites are recommended, not only in their own hospitals but in other hospitals with good infrastructure.

• It was found that the age was inversely proportional to knowledge among the Group D employees, hence refresher courses and capsule training workshops for the elderly Group D employees is recommended.

Issues and Recommendations related to waste transport and disposal

Health workers in all the three hospitals had very low scores on adequate knowledge regarding waste transport

Suggestions

• Transportation of sharps should be in secure, closed containers. The transportation pathway should be well established. There should be well painted hand carts for transporting different types of waste, a fixed path to take waste to the kerb area and all waste transporters should be educated about this through induction training and in service programmes.

• Nurses in all the three hospitals had very low scores on adequate knowledge regarding waste treatment as the nurses were not responsible for treatment or transport. The involvement of the ICN in the waste transport from the ward and through her supervision, the involvement of the ward nurses can be improved in the hospitals.

• It is recommended to place signage at the point of waste disposal for the easy identification.

• The collection of hazardous and recyclable waste at periodic intervals should be centralized in the hospitals. This site should be secured to prevent pilferage.
• Specifications of sharp pit used for burial of sharps should be used by all the hospitals as indicated in the above diagram.

Issues and Recommendations related to use of universal precautions

Inadequate use of universal precautions

There was an inverse relationship between the use of universal precautions like wearing gloves, mask, washing hands while handling waste and perceiving the waste handling as hazardous. There was an inverse relationship between knowledge regarding use of universal precautions in BMWM and risk of harm for it. In Hospital (III) doctors had better knowledge regarding use of universal precautions while handling BMWM and had low risk perception.

Suggestion

• Occupational safety issues need to be addressed by the institutions along with introducing vaccination for staff and post-prophylaxis measures. The use of universal precautions is strongly recommended.
• In the hospitals where the contract workers were found cleaning the hospital, it was found that the cleaning material, dress of Group D employees and the gloves, shoes etc. were being provided by the contractors.
• It is recommended that a study be undertaken to study the hazards associated with healthcare waste.
• There should be provision of proper handwashing facilities for the Group D employees as the practice of proper hand hygiene is recommended.
• It is recommended that all the blood specimens should be taken out in a stainless steel container and should be autoclaved and the empty containers with residual blood should be treated in sodium hypochlorite for half an hour before washing and...
then sample containers can be reused or disposed off.  

- Barrier clothing should be provided to waste handlers and they be made aware of its use and of universal precautions applicable to them. Long gum boots, heavy duty gloves and plastic aprons and masks should be provided to the waste handlers and transporters.

- Health care workers, involved in collection, sorting, transportation and washing of soiled linen need to be trained. All health care workers must wear mask, plastic apron and gumboot during the laundry process. All the infected and soaked (blood and body fluids) linen to be collected separately. Maintaining of proper washing cycle, hot water, temperature and time of washing process are the key points to be remembered. Hot water provides an effective means of destroying microorganism, 700°C temperature and 15 to 20 minutes washing time is recommended for each cycle. All the stained linen to be passed through liquid hypochlorite, which is better than bleaching powder as it also helps in removal of stain from white sheet. After washing, linen should be shifted to hydro extractor for 15 minutes for linen drying. ICN should submit the effluent sample from washing machine at least once a month to microbiology lab and ensure absence of viable bacterial pathogens.

Conclusion

The BMWM has to have a multidisciplinary approach involving active participation of not only of doctors of various disciplines but also of nursing, paramedics and waste handlers. It will function to bring together all those involved in health care delivery under a roof. Effective on-the-job and off-the-job training cannot be emphasised enough. The issue of Biomedical waste management has far too many facets to be handled by single agency or individual authorities. Participation of the municipal and administrative bodies seems essential if the healthcare institutions in a town or city is to find a rational disposal solution. The community in addition has to be sensitized to the technical needs of the hospitals and their cooperation obtained for the entire spectrum of activities—from reducing the quantum of waste generated to the final disposal mechanism.

In the end, which is the most difficult to subsume, the researcher would feel amply rewarded if the present study stimulates serious thinking in some of the crucial areas of BMWM. As this field is quite ripe for more detailed investigations and there are many gaps visible where no systematic enquiry has been attempted. Some of the researchers may like to take up those
issues, which are imminent to BMWM and can take these inferences drawn from the present study for future generalization. The spectrum of challenges that confront us will have to be tackled in due course.

‘We must create the world of the future....In a very real sense tomorrow is now.’

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316