Quantification and Characterization of Solid Waste Generated In The Department of Prosthodontics : An Observational Study

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Abstract

Dental laboratories are an integral part of Prosthodontic practice, where various hazardous waste, potentially detrimental to the health and environment is generated during fabrication of restoration.

Non-infectious toxic wastes are devoid of human fluids contamination but potentially toxic in nature. It includes mainly gypsum waste, acrylic resin scraps, metal alloys, metal dust, porcelain, and acids used in electrolytic polishing of metal frameworks. Domestic type wastes are comprised of plastics & sand papers etc.

In clinical procedures, different types of impression materials, waxes & occlusal records routinely come in contact with human saliva and blood. Researchers demonstrated presence of bacteria and fungi over the dental impression (Infectious waste) on their arrival to the laboratory.

Waste generated in Dental Institutions is categorized as Bio-medical waste and has to be managed as per existing Regulation, Biomedical Waste Management Rules 2016. Scientific and appropriate waste management warrant precise quantification and characterization of the waste. It not only helps in efficient management of Solid Waste, but also reveals the opportunities for reuse and recycle within the framework of regulations.

In this context, this proposal envisages precise quantification and characterization of different solid wastes generated in Department of Prosthodontics Ranjit Deshmukh Dental college & Research Centre, Nagpur in collaboration with SHWMD & CSIR-NEERI, Nagpur.

Key Words: Dental, bio medical waste management, Prosthodontics, awareness.

Introduction

The dental specialty of prosthodontics is in charge of diagnosing, treating, rehabilitating, and maintaining patients who have lost teeth and the structures that go along with them utilising biocompatible replacements. Students in the Department of Prosthodontics get training and education to enable them to treat and manage patients who need complete replacement of missing teeth and maxillofacial structures. Students receive intensive instruction in complete dentures, maxillofacial and implant prostheses, fixed and removable partial dentures, and laboratory operations.

Indirect restoration fabrication produces a variety of hazardous pollutants that could be harmful to human health and the environment. Dental laboratories are an essential component of prosthodontics practice. Infectious waste, non-infectious toxic waste, and domestic garbage are the three categories for solid waste from dental laboratories. Infectious waste is defined as waste that is suspected of containing a pathogen in a concentration high enough to cause disease in vulnerable hosts.[1] Different kinds of impression materials, waxes, and occlusal records frequently come into touch with human blood and saliva during the production of dental prosthesis. When the researchers arrived at the lab, they showed that fungi and bacteria were present on top of the dental impression. According to certain research, there are even microorganisms on the wheels and pastes used for polishing dentures.[2]

The non-infectious hazardous wastes have the potential to be dangerous but are not contaminated with human bodily fluids. It primarily consists of ceramic, acids, discarded metal alloys, acrylic resin scraps, gypsum debris, and metal dust from the electrolytic polishing of metal frameworks. Paper cups, plastics, sandpaper, and other household wastes are examples of wastes classified as domestic.[3] "Any waste generated during diagnosis, treatment, or immunisation of humans or animals, or in the research activities pertaining to or in the production or testing of biological materials" is what is meant to be understood by the term "biomedical waste," which also includes the categories listed in schedule I of the Government of India's Biomedical Waste (Management and Handling) Rules 1998.[4,5]

Hazardous biomedical (BM) waste is subdivided into dental waste. Large volumes of cotton, plastic, latex, glass, sharps, extracted teeth, and other materials are produced by dental offices; many of these products may be tainted with bodily fluids. Two primary categories of hazards can be identified from dental clinics' disposal of waste. Two primary concerns are the environmental impact of various hazardous items and the potential health hazards that waste handlers may face due to potentially infectious materials.[6,7] Hospital or BM waste should not be disposed of carelessly, as this puts human health and the environment at grave risk. Before being disposed of in the end, BM waste needs to be managed and treated specifically.

The severity of the threat is further compounded by the high prevalence of diseases such as human immunosuppressive virus (HIV) and hepatitis B and C. [8,9,10]

Such garbage must be treated in accordance with the current Regulation, the Biomedical garbage Management Rules 2016, and must be classified as biomedical waste produced in dental care institutions. Nonetheless, this Department's solid waste contains a number of products, such as metal alloys and polymeric polymers, that are suspected of containing heavy and hazardous metals. Accurate waste classification and measurement are necessary for scientifically sound waste management. In addition to aiding in the effective management of solid waste, it also makes chances for recycling and reuse within legal constraints apparent.

This proposal, in this regard, aims to precisely quantify and characterise various solid wastes produced in the prosthodontics department. As a waste management specialist, the Solid and Hazardous Waste Management Division (SHWMD), CSIR-NEERI, has graciously offered to oversee this effort. This exercise's primary goal is to rationally determine the best solid waste management strategy.

Background of the proposal

Currently the waste products of the department of Prosthodontics are first distributed into different categories. Afterwards, these waste products are transported to super hygiene company for further degradation procedure without quantification.

Aim: Quantification and Characterization of Solid Waste Generated in Department of Prosthodontics.

Objectives:

The **principal objectives** of this proposed study were:-

1. To create awareness about Bio-medical waste management among students, teaching & non-teaching staff working in Department.
2. To create pollution free environment.
3. Quantification of the Solid Waste.
4. Physico-chemical characterization of the Solid Waste in Dept. Of Solid & Hazardous waste Management, NEERI.

Other Objectives

1. To display the educational charts regarding Bio-medical waste (BMW) management for the under-graduate & post-graduate students, interns, teaching & Non- teaching staff in different sections of Prosthodontic. (Figure 1)

Fig.1: Educational Chart for dental BMW Disposal in the color coded bags

Color-coding / type of container	Type of waste
Yellow (non-chlorinated plastic bag)	Extracted Teeth, excised tissues, biopsy specimen, material contaminated with blood/saliva (cotton, gauze, dressing), impression material (compound, alginate, shellac), waste from laboratory cultures, soiled dental casts (disinfected), discarded medicine, expired dental materials
Red (non-chlorinated plastic bag) Puncture proof container for sharps	Microbiological & Biotechnology waste, solid waste (items contaminated with blood / saliva including cotton, dressings, solid plaster casts) other solid disposable items other than sharp waste.
Blue (non chlorinated plastic bag)	Sharp wastes (needles, syringes, blades, endodontic reamers, files, broken glass, etc.) Plastic (suction tips, tubing, celluloid strips, radiographic films), metal (crowns, orthodontic bands and brackets, matrix bands), glass bottles, lead foils, gloves
Black (non chlorinated plastic bag)	Discarded medicines & cytotoxic drugs & chemicals used for disinfection (Municipal waste)

2. Make efforts to reduce quantity of waste by keeping control over issuing the material required for clinical & laboratory procedures.

Methodology

As MUHS (Maharashtra University of Health Science, Nasik) had sanctioned LTRG (Long Term research Grant) for this project, initially approval from IEC (Institutional Ethics committee) was taken and official project proposal was sent to the university.

I. Increase awareness about rules, regulations and procedures regarding this vital issue was organised:- For this reason, interns, teaching and non-teaching staff, technicians, and undergraduate and post-graduate students were all invited to participate in continuing education programmes. The department's pre-clinic, clinic, service clinic, post-graduate section, and technician's section all had charts that instructed staff members to dispose of dental waste in the proper color-coded bags. Every attempt was made to limit the amount of waste that was disposed of by maintaining control over the supply of the supplies needed for laboratory and clinical operations.

II. Quantification of the Solid Waste

1. Different dental treatment processes were described and documented, and the kind of solid waste produced in different sections of the Prosthodontics department was determined.
2. The department produced systematic solid waste segregation and planned physical waste characterisation including kind, size, shape, weight, volume, material data (as provided by the material source), and material safety information, among other things.
3. A representative sample was carefully chosen, preserved and stored in order to allow for a thorough chemical analysis.

III. Chemical Characterization (Under the Guidance of SHWMD, CSIR-NEERI)

1. Delineation of analytical protocol.
2. Sample preparation by size reduction, extraction, solution etc.
3. Chemical analysis as per the Internationally accepted methods on GC (Gas Chromatography), GCMS (Gas Chromatography mars Spectrography), ICP (Inductive Coupled Plasma), and so on.

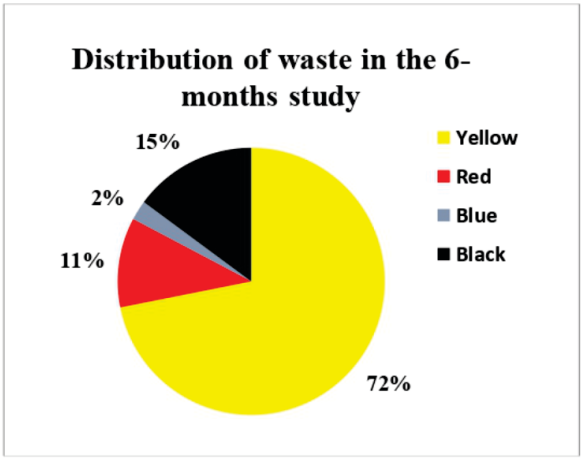
IV. Report preparation

Compilation of data on quantification

The results of statistical analysis indicate that, of the waste generated by laboratory cultures, soiled dental casts (disinfected), discarded medications, and expired dental materials, comprise 72% of the yellow waste (teeth, excised tissues, biopsy specimen, material contaminated with blood/saliva (cotton, gauze, dressing), 15% of black waste (mostly municipal waste), and waste from laboratory cultures should be managed more carefully. Being a clinical section, 11% of red waste is also produced, with the majority of it being sharp waste (needles, syringes, blades, files, broken glass, etc.). Glass bottles, lead foils, gloves, metal (crowns, orthodontic bands and brackets, matrix bands), plastic (suction tips, tubing, celluloid strips, radiographic films), and plastic are thrown away after clinical usage.

There was a trace of 2% blue trash created. The department's undergrad and graduate students, as well as employees in the service clinic and technician's section, were given access to the materials needed for clinical and laboratory procedures, which resulted in a decrease in the amount of waste disposed of after awareness campaigns were organised in various departments. (Figure 2)

Fig.2: Pie Diagram



1. Compilation of Data on Chemical analysis:- The following dental materials were assessed in the study and are frequently used in clinics and labs for patient work: acrylic resins (chemically and heat-polymerized), gypsum products (plaster of Paris, dental stone plaster, die stone, gypsum bonded, phosphate bonded, and silica bonded investment materials), impression materials, specifically impression compound, zinc oxide eugenol impression paste, reversible and irreversible hydrocolloid, polysulphide, silicon rubber, and polyether elastomeric impression materials; various dental waxes, such as base plate wax, processing wax, impression waxes, and pattern waxes; additionally, various dental cements were collected in very small amounts, including zinc phosphate cement, calcium hydroxide, zinc oxide eugenol After all of these elements were combined, the finished product was once more cleaned and disposed of as it was.

2) Report on dental wastes characterization and disposal type of sample composition, mode of disposal or reuse

<table>
<tr><th>Type of Sample</th><th>Composition</th><th>Mode of Disposal or Reuse</th></tr>
<tr><td>1. Metal Components</td><td>The complete metal analysis of the samples were carried out by digesting the sample in acid mixture followed by analysis using ICPM (The best available technique for metal analysis):
The Results of metal analysis are shown below:
<table>
<tr><td>Metal</td><td>Concentration (mg/l)</td></tr>
<tr><td>Al</td><td>132.0</td></tr>
<tr><td>Ag</td><td>ND</td></tr>
<tr><td>As</td><td>ND</td></tr>
<tr><td>B</td><td>ND</td></tr>
<tr><td>Cd</td><td>ND</td></tr>
<tr><td>Co</td><td>0.13</td></tr>
<tr><td>Cr</td><td>28.2</td></tr>
<tr><td>Cu</td><td>0.99</td></tr>
<tr><td>Fe</td><td>18.8</td></tr>
<tr><td>Mn</td><td>0.23</td></tr>
<tr><td>Ni</td><td>0.30</td></tr>
<tr><td>Pb</td><td>ND</td></tr>
<tr><td>Zn</td><td>ND</td></tr>
</table>
ND: Not detected</td><td>It has been observed that besides aluminium and iron, chromium is present in significant quantities and can be recovered for further recycling before disposal.</td></tr>
<tr><td>2. Gypsum products</td><td>The powder X-Ray diffraction analysis of these moulds was undertaken and it was observed that major fraction of these moulds contains gypsum phases.</td><td>Since these wastes majorly contains gypsum phases and are generated in significant quantity, these after proper disinfection can be further used and recycled for other similar items.</td></tr>
<tr><td>3. Acrylic products</td><td>The composition of these wastes is Poly (methyl methacrylate polymer)</td><td>Since this category of waste contains significant calorific value, it can be incinerated or used for energy recovery with control of emissions and ash disposal.</td></tr>
<tr><td>4. Impression Materials</td><td>Maximum set products of impression materials are irreversible.</td><td>These set products can be incinerated or used for energy recovery with control of emissions and ash disposal.</td></tr>
<tr><td>5. Dental Waxes</td><td>Some waxes are contaminated with plaster, acrylic and various types of impression materials while few are evaporated during casting procedure.</td><td>Contaminated waxes can be reused after disinfection and separation from various contaminated materials and recycled for other uses.</td></tr>
<tr><td>6. Dental Cements</td><td>Set products are found in traces.</td><td>Incineration and ash disposal is recommended.</td></tr>
</table>

3. **Delineation of appropriate waste management strategy:** The department generates infectious and non-infectious waste, which is to be managed as per the provisions of Bio medical waste (Management and Handling) rules, 2016, issued by Ministry of Environment, Forests, and climate Change, New Delhi.

i. The infectious trash typically consists of cotton swabs, bags, and other related items that have come into touch with any kind of bodily material from humans. This needs to be disposed of safely by being separated, kept in a yellow bag, and sent to Nagpur's common biomedical waste facility on a payment basis.

ii. Plastic needs to be separated from other recyclable material and placed in blue bags. It can be donated to a shared facility, or the institute can create procedures for recycling or reusing it after thoroughly disinfecting it with hypo.

iii. Metal wastes must be gathered in white bags and delivered to a shared facility. There are precious metals that are recoverable. The facility must receive the waste containing mercury.

iv. The department also has denture and finishing, among other workshop facilities. These produce mostly gypsum products and clean ceramic waste that can be separated and added value to tiles, boards, pavements, flower pots, and other items after being disinfected with a 0.5% sodium hypochlorite solution.

v. Home garbage, such as food scraps, papers, and magazine clippings, should be divided into dry and wet waste receptacles and delivered to corporations' waste management departments.

vi. The institution must separate and give its e-waste—which includes switches, boards, bulbs, CFLs and LEDs, tube lights, electrical devices, and electronic gadgets—to an approved recycler. Plastic trash requires the adoption of a similar approach.

vii. The institute may start an internal initiative to determine how to recycle and reuse garbage in collaboration with VNIT or NEERI or any such Institute.

Summary

The project fulfilled the aim & objectives.

The project's goals and objectives were met.

1. A greater understanding of the policies, guidelines, and practices pertaining to this crucial matter was formed.
2. Because the employees have grown more sensitive, they are able to enforce rigorous policies for interns and students.
3. Every attempt was made to decrease the amount of waste that was disposed of.
4. A yearly protocol for continuing education programmes pertaining to BMW management is arranged for newly accepted students (UGs & PGs).
5. The BMW management chart must be shown in every departmental division, and the same policy is followed by the institute's other departments.
6. A significant decrease in the amount of waste material was achieved by maintaining control over the supply of the materials needed for clinical and laboratory processes.
7. The department now has a pollution-free atmosphere thanks to all of these efforts.
8. A greater understanding of the need to analyze the potential for material reuse following chemical analysis was developed among students, technicians, and teaching and non-teaching personnel.

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