KNOWLEDGE AND ATTITUDES TOWARDS DENTAL MATERIALS WASTAGE BY UNDERGRADUATE STUDENTS AT THE UNIVERSITY OF NAIROBI CONSERVATIVE AND PROSTHETIC CLINICS

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BDS LEVEL III

A research project report submitted in partial fulfillment for the award of the degree of Bachelor of Dental Surgery at the University of Nairobi.

2013
Declaration:

I, Dolphine Adhiambo Minai, declare that this research report is my original work and it has not been submitted by any other person for any other degree to any other university.

Signature .................................

Date .................................
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We certify that this proposal has been submitted for examination with our approval as university supervisors.

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DEDICATION

To my niece, Etta Amor, I hope this inspires you to become a dentist like me.
ACKNOWLEDGEMENTS

I would like to thank the Almighty God, for His grace in my life, without which I would never have come this far.

I am especially thankful to my two supervisors, Prof. F. G. Macigo and Dr. B. K. Kisumbi. Your constant supervision, guidance, wisdom, time and encouragement throughout this research project were invaluable.

I would also like to give my great gratitude to my parents, Mr. Jim Minai and Mrs. Margaret Minai for their constant encouragement, financial support and love.

Finally, I thank all the dental students in the School of Dental Sciences University of Nairobi who took part in this research. You made the study possible.
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**List of abbreviated words**

UON – University of Nairobi

Kshs – Kenya shillings

VC – Vice Chancellor

DVC – Deputy Vice Chancellor

A&F – Administration and Finance

BDS – Bachelor of Dental Surgery

MPH – Masters in Public Health

SPSS – Statistical Package for Social Sciences
ABSTRACT

Background: Dental material wastage is the use of dental materials in a way that results in losses. This wastage has consequences such as: material shortage and therefore delays in the deliveries of oral health services to patients. Secondly, increased amount of disposed waste creates difficulty in managing the waste therefore, more pollution to the environment that negates the efforts put in infection control and if this is to be well managed, then more cost and effort will have to be put in. Fourth, imbalances in the university’s budget may occur as efforts are made to ensure continuous supply of materials for learning by students. Little knowledge and negative attitude towards the prevention of dental material wastage will result in students wasting such materials. This study aims at providing an up to date analysis of the knowledge and attitude related to dental materials wastage by the undergraduate students in the Prosthetics and Conservation clinics.

Objective: To describe the knowledge and attitudes towards dental materials wastage among students at the University of Nairobi (UON) Dental Hospital Prosthetics and Conservation clinics.

Study design: This study was a descriptive cross-sectional study using student population based study groups.

Setting: This study was conducted at the UON Dental Hospital Conservative and Prosthetic Clinics.

Subjects: UON second, third and fourth year dental undergraduate students attending Prosthetic and Conservative clinics.
**Materials and Methods:** A self-administered questionnaire was administered to the respondents and collected upon completion for data analysis. The respondents were undergraduate dental students in second, third and fourth year. The total number of students was 86, and this study included all students attending the prosthetics and conservative clinics. The variables collected were; the gender of the students and their year of study as the socio-demographic variables. The knowledge and attitude of the students towards dental materials wastage were determined as the independent variables and amount and type of wastage as the dependent variable. The data collected from the questionnaires were then analyzed using SPSS 16.0 software. The information obtained from the study was organized and presented as descriptive statistics using charts, frequency tables, average values and percentages.

**Results**

Among the 79 tested students, 38 (48%) were female and 41 (52%) were male.

Fifty (64.6%) students had not undergone training on consequences of wastage of dental materials. Forty seven (58.2%) students had not undergone training on avoiding dental materials wastage. Fifty (63.3%) of the students indicated the best excuse of dental material wastage to be lack of more accurate methods of measuring the amount of materials required for a procedure. 10 (12.7%) said it was due to lack of understanding of the biomaterial science of the dental materials, 9 (11.4%) indicated it was due to inadequate training on causes and consequences of wastage of dental materials and another 9 (11.4%) indicated it was because there are poor rules and regulations put in place to regulate wastage of the dental materials. A large number, 62 (78.5%) of students indicated that the factor that frequently leads to dental materials wastage by undergraduate dental students was mixing more amount of materials than required for a procedure. Twenty five (31.6%) of the students reported the main consequence of wastage is that students who waste materials become uneconomical clinicians in the long run. 22 (27.8%) indicated that the main consequence was that it leads to material shortage and then delays in delivery or oral health services to patients.

Thirty seven (48.1%) of the students reported that the best way they would prevent wastage of dental materials among undergraduate students in Prosthetic and Conservative clinic was to
introduce more accurate methods of measuring materials required for a procedure. Sixteen (20.3%) of the students reported awareness of legislations, regulations and rules put in place to stop wastage.

Regarding attitude towards prevention of wastage of dental materials. Seventy four (93.7%) of the students felt that wastage of dental materials should be discouraged. Seventy one (89.9%) of the students thought that the concern with dental materials wastage was justified. Fifty seven (72.2%) of the students would advice someone to specialize in dental biomaterials.

Zinc oxide eugenol cement was found to be most wasted material, 41 (51.9%) of students reported having wasted it.

Conclusions

Based on the findings of this study, it was concluded that; awareness of the consequences of dental materials wastage is low among the students. Training on consequences of wastage and ways of preventing wastage was also low. However, majority of the students felt that wastage of dental materials should be discouraged. The most wasted dental material was zinc oxide eugenol cement.

Recommendations

Based on the findings of this study it was recommended that the school should incorporate better ways of educating students to make them quite aware of the causes of the wastage, consequences and ways of preventing it. Strict rules and regulations should be put in place to ensure complete elimination of dental materials wastage.
CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

Dental materials are a specific group of what is generally described as biomedical biomaterials. These are synthetic materials designed to interact with biological systems. Dental materials wastage is therefore the use or utilization of these materials in a way that results in loss. The word wastage here must not be confused with wastage that means loss by deterioration (1). This study therefore is seeking to investigate the knowledge and attitudes of undergraduate students towards the use of dental materials carelessly but not their knowledge and attitudes towards their loss by deterioration. The dental materials covered will include dental amalgam, dental cements, resin composites and impression materials, the most commonly used materials by students in Conservative and Prosthetics clinics.

Most researches have focused almost entirely on dental waste management. This is most likely due to dental waste products contribution to environmental and health pollution and the problems they cause in prevention, control and management of cross-infection, the aseptic technique. Dental materials wastage and dental materials waste products management are very closely related since the much waste created by wastage will need to be managed. Waste reduction (prevention) is the preferred approach to waste management because waste that never getscreated doesn’t have waste management costs. The higher the wastage the higher the waste to be disposed of and the higher the cost and effort of managing it. Therefore, dental materials wastage is equally a problem and should be the focus of most researches. Unfortunately this is not the case. Literature on wastage of dental materials is scanty.

Dental material wastage at the University of Nairobi (UON) Dental Conservative and Prosthetic clinics by students may be caused by poor knowledge of their biomaterial science. This includes knowledge on working times, mixing times and setting times, the formulation, the applications, setting reactions, among others. Another cause is lack of approximating the appropriate quantities to be mixed therefore ending up mixing excessively large amounts of materials more than required. This mostly occurs in the Prosthetic lab. This is most probably due to what is
termed as `trial and error`. This is characterized by repeated, varied attempts to create for example cast models from plaster of Paris and then students try to choose the best and throw the rest away. Students also waste materials by leaving bottles, tins and other packaging forms of these materials open. This way, volatile liquids evaporate, hence reduces in volume and materials presented in paste form harden and have to be disposed of. Students may also lack awareness of the economical implications wastage of dental materials.

The UON dental hospital is assured of continuous supply of materials being a government teaching hospital, a statement confirmed by the prosthetics laboratory technicians. The head of department identifies the need for a particular material and raises a request to the Purchase Authorizing Officer (PAO) who approves it and then forwards it to the procurement office. The procurement officer forwards sources of quotations to the user department to raise requisition and Authority to Incur Expenditure (AIE). If funds are committed, a local purchase order is raised then there is procurement and supply of goods. The procurement is done in accordance with to the Public Procurement and Disposal Act, 2005\(^2\) and the UON Finance Regulations as per the Procurement Plan.

The English novelist and poet, Thomas Love Peacock (1785-1866) in his quote said, the waste of plenty is the resource of scarcity\(^3\). However much these materials are, their careless wastage especially if not addressed will ultimately result in material shortage and consequently delay in delivery of dental restorative services to patients, an event that has actually happened, again confirmed by the same laboratory technicians. As mentioned earlier, the higher the wastage the higher the amount being disposed of. This increased waste, if not properly managed, will result in environmental pollution and problems in infection control.

Dental material wastage bears with it consequences that should not be ignored. These include: material shortage and therefore delays in the deliveries of oral health services to patients, increased amount of disposed waste and therefore more polluted environment that negates the efforts put in infection control and if well managed then more cost and effort will have to be put in. Although it has not been determined, these clinics seem to be assured of continued supply of materials and hence the delay of services is rarely caused by material wastage. Another consequence is problems with the university budget. The wastage of dental materials by students result in unwanted and unplanned for changes in original budgets in order to meet the continuous supply of materials in clinics to facilitate learning, being a teaching hospital.
The issue of protection of the environment represents the heart and soul of infection control and should be addressed thoroughly and taken with utmost seriousness. The dental care professionals have an extraordinary opportunity to help protect and restore the nation’s rivers and lakes with simple reduction in the amount of wastes that they dispose of from the clinics. The aim of the method of data collection is that, as the research progressed and the students were answering the questionnaires that were delivered to them, they would be awakened to the importance of dental material wastage prevention and ultimately be guide to run an environmentally responsible dental office. It was intended to give them simple ideas for changes that can go a long way in preventing the release of increased amounts of harmful mercury-containing materials and other potentially harmful contaminants to our nation’s streams, lakes and rivers. Elemental mercury is among the most common hazardous materials in the dental office. It is a toxic substance that threatens the health of humans and wildlife throughout Kenya. Mercury is particularly threatening because it “bio accumulates” in the food chain, collecting and building up in the tissues of small fish and other species and then accumulating in ever-increasing amounts as those creatures are consumed by others higher up the chain. Humans, as well as wildlife, can suffer severe health effects from consuming mercury contaminated fish. Dental amalgam contains mercury in an inter-metallic compound. Dentistry has been shown to contribute 1% of global mercury burden to the environment. Although mercury is a known toxic, its use in dentistry is safe as the dental amalgam is triple distilled and it is reacted and not presented in any of its toxic forms. However, in large amounts, for example large accumulation of waste dental amalgam, can access the environment and contribute to the overall anthropogenic contribution to mercury burden in the environment. Therefore, the reduction in waste will contribute immensely to the professionals’ contribution to a greener environment. Sensitive populations such as pregnant women, women of child bearing age and young children are at higher risk of such effects. Such populations may be warned of such fish or advised to avoid fish altogether but this approach poses problems for people who eat fish as a mainstay of their diets and for local economies that depend on the fishing industry for local jobs (4). A far better solution is to end the contamination at its source and that is what this study will focus on.
The consequences of dental material wastage, the major being increased waste deposition to the environment, demonstrates how crucial it is that the students are knowledgeable and have good attitude towards its prevention. This is because wastage is directly related to both lack of knowledge and poor attitudes. The student’s amount of knowledge and the type of attitude, whether positive or negative has not been determined. These two variables however, if are both negative and put together make the students waste dental materials. Therefore the knowledge and attitudes towards dental material wastage by these students should be described and will be the main objective of this study.

Technology has also found this issue of wastage of dental materials important enough to be addressed. This has been by developments of use of unit doses, command set materials, and improved competency of materials and improved handling techniques by introduction of application tips, measuring swaps and cylinders. Others are the developments of premeasured and sized amalgam capsules. Although this has reduced wastage, it has not completely eliminated it. For example, dental materials like sized amalgam in capsules may still be more than enough when the prepared cavity is small resulting in wastage.

This study aims at evaluating the level of knowledge and the attitude of students towards wastage and will end up awakening them up to face the problem. This will solve other issues that come with it like material shortage, delay in service delivery, and imbalances in the university budget and increased waste materials to be disposed of. Despite incredible progress in addressing some of the most visible consequences of dental material wastage, others like pollution of the environment by harmful elements of dental materials like mercury remain a significant threat. Addressing such threats and ensuring a healthier world for humans and wildlife begins with knowledge and understanding, followed by action of students with good attitude. The attitude and the knowledge of the students towards wastage of dental materials have not been determined yet and this study will seek to address this gap. If both negative, and therefore results in increased wastage of materials among students, then this study will rectify this by ensuring that the type of data collection, in this case the questionnaires, have questions that provoke critical thinking by the students on their participation in dental material wastage.
1.2 Literature review

Most procedures in all disciplines of dentistry require utilization of dental materials applied to arrest diseases, restore morphology, restore aesthetics and therefore restore function. Economical use of these materials reduces wastage, increase profit by reducing waste management costs, reduces the occurrences of cross-infections and encourages the training of economical clinicians.

According to the Pre-waste organization that is aimed at improving the effectiveness of waste prevention policies in European Union territories, preventing waste means reducing the amount of waste generated, reducing the hazardous content of that waste and reducing its impact on the environment. It also states that it is important to note that individuals and businesses can often save a significant amount of money through waste prevention: waste that never gets created doesn't have management costs (handling, transporting, treating and disposing of waste). Waste prevention includes strict avoidance of waste generation, qualitative and quantitative reduction at source, and reuse of products. It does not include recycling of materials and separate waste collection (5). Another literature shows that the Swedish view has been that the volume and hazardousness of waste can only be influenced to a limited degree by measures taken at the waste stage. Measures to reduce the hazardousness and volume of waste should be primarily taken as part of work on products and chemicals. An important condition to be met to enable the risks to be reduced at the waste stage is that the actors concerned are aware which substances can be hazardous to the environment and health and which of these hazardous substances are contained in the articles they manufacture, handle or buy (6). This literature demonstrates that knowledge is key. The actors in this current research are the students. If they are aware or have the knowledge that some substances they handle are hazardous to the environment and health then they can develop positive attitudes towards preventing their wastage and hence reduce the amount disposed of to the environment. A review done on clinical solid waste management practices and its impact on human health and environment agrees with the previous literature. In its abstract, it states that although, significant steps have been taken on matters related to safe handling and disposal of the clinical waste improper management practice is evident from the
point of initial collection to the final disposal. In most cases, the main reasons of the mismanagement of clinical solid waste are the lack of appropriate legislation, lack of specialized clinical staffs, lack of awareness and effective control (7).

Most researches done have focused on the knowledge and attitudes of dental practitioners on dental waste management but not their knowledge and practice towards dental materials wastage. A study done to determine the knowledge, attitudes and practice on management of dental wastes among dental practitioners in Nairobi, Kenya in public hospitals that included Kenyatta National hospital, University of Nairobi Dental Hospital and Lady Northeys clinic, found out that 42% of the respondents worked in public institution while the rest were in private practice. Only 48.7% of the practitioners were aware of the existence of waste management guidelines. Only 64% felt it was important to follow the set guidelines, 5% thought it was wasteful, 2% said they were not practical the rest were not interested in the guidelines. 78% felt it was necessary to pay a reputable company to dispose off the waste, 12% said it was expensive while 5% felt it was not necessary (8). Results from a study done in Bangkok indicated few dentists complied with all recommendations for disposal of wastes with most waste being disposed into domestic rubbish stream indicating a need to recommend an alteration in behavior of the practitioners (9). In New Zealand qualitative interviews with practitioners indicated a lack of concern about disposal of contaminated waste into the general waste with the existence of legislation governing waste disposal not being sufficient to motivate many practitioners to comply with guidelines (10). Another study done to determine the attitudes of some dental undergraduate students to the placement of direct restorative materials in posterior teeth in final year dental students in Cardiff, Dublin and Malmo, the results were as follows: In relation to potential damage to the environment, there is geographical diversity of opinion, with 85% of Malmo students, 30% of Cardiff students and 25% of Dublin students regarding amalgam as being harmful to the environment. Thirty per cent of Malmo students, and 20% of Dublin students and Cardiff students, respectively, considered resin composite to be harmful to the environment (11).

Dental solid waste was classified in three main categories: (1) Infectious and potentially infectious waste, accounting for 94.7% by weight. (2) Non-infectious waste accounting for 2.0%. (3) Domestic-type waste, accounting for 3.3% by weight. The category of infectious waste is classified as hazardous and includes components containing metal (8.51%), components without
metal (91.18%) and amalgam (0.33%). According to the World Health Organization, infectious waste is the waste type suspected to contain pathogens (bacteria, viruses, parasites, or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts. The wastage of dental materials and the resultant increase in dental laboratory solid waste therefore difficulty in management of the wastes in terms of efforts and costs will result in poor managements of such dental solid wastes. The safe management of such waste is necessary to avoid environmental and public health problems, especially related to transmission of infectious disease such as HIV infection and hepatitis.

A study was done in Xanthi, Greece to demonstrate the composition and rate of solid wastes from dental laboratories. Solid waste was categorized into three major categories: (a) infectious and potentially infectious waste, (b) non-infectious toxic waste and (c) household type solid waste. Dental laboratories solid waste (DLSW) was produced at a rate of 0.059 g/cap/day (or 22 g/cap/year) at the time of the study. Household type waste, infectious and potentially infectious waste and non-infectious toxic waste comprised approximately 74%, 26% and less than 0.5% of the total DLSW weight produced, respectively. DLSW was estimated to be approximately 0.007% of the amount of municipal solid waste produced in the Prefecture of Xanthi. Another study was done in Brazil to determine the count, quantity and antimicrobial susceptibility of bacteria recovered from dental solid wastes. A total of 766 bacterial strains were isolated and identified during the study period. Gram-positive cocci were the most frequent morphotype isolated (48.0%), followed by Gram-negative rods (46.2%), Gram-positive rods (5.0%), Gram-negative-cocci (0.4%), and Gram-positive coccobacillus (0.1%). Only two anaerobic bacteria were isolated (0.3%). The most frequently isolated species was Staphylococcus epidermidis (29.9%), followed by Stenotrophomonasmaltophilia (8.2%), and Enterococcus faecalis (6.7%). Both of these studies illustrate how hazardous and contaminated wastes from dental laboratories are therefore need to reduce their deposition to the environment.

The dental material that has most effects on the environment and health due to its toxic nature is dental amalgam. This is because it contains mercury that is the toxic substance. Therefore numerous studies have been done in many regions to determine how dental amalgam waste is being managed and most have recommended prevention of wastage as the major waste
management technique\(^{(15)}\). A study done in India among an Indian community investigating waste management in dental office pointed out mixing only required amalgam amounts or using premeasured amalgam capsules reduces wastage and this was mentioned as a way of dental amalgam waste management \(^{(16)}\). As summarized in table 1, the American Dental Association provides a table that shows the number one action in dental amalgam best management practice is use of precapsullated alloy and stock a variety of capsule sizes to prevent amalgamating large quantities of amalgam needed to pack small cavities and the first action as don’t use bulk mercury \(^{(17)}\).

**Table 1; Best management practice for amalgam waste**

<table>
<thead>
<tr>
<th>Do</th>
<th>Don’t</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Do</strong> use precapsulated alloys and stock a variety of capsule sizes</td>
<td>Don’t use bulk mercury</td>
</tr>
<tr>
<td><strong>Do</strong> recycle used disposable amalgam capsules</td>
<td>Don’t put used disposable amalgam capsules in biohazard containers, infectious waste containers (red bags) or regular garbage</td>
</tr>
<tr>
<td><strong>Do</strong> salvage, store and recycle non-contact amalgam (scrap amalgam)</td>
<td>Don’t put non-contact amalgam waste in biohazard containers, infectious waste containers (red bags) or regular garbage</td>
</tr>
<tr>
<td><strong>Do</strong> salvage (contact) amalgam pieces from restorations after removal and recycle the amalgam waste</td>
<td>Don’t put contact amalgam waste in biohazard containers, infectious waste containers (red bags) or regular garbage</td>
</tr>
<tr>
<td><strong>Do</strong> use chair-side traps, vacuum pump filters and amalgam separators to retain amalgam and recycle their contents.</td>
<td>Don’t rinse devices containing amalgam over drains or sinks</td>
</tr>
<tr>
<td><strong>Do</strong> recycle teeth that contain amalgam restorations. <em>(Note: Ask your recycler whether or not extracted teeth with amalgam restorations require disinfection.)</em></td>
<td>Don’t dispose of extracted teeth that contain amalgam restorations in biohazard containers, infectious waste containers (red bags), sharps containers or regular garbage</td>
</tr>
<tr>
<td><strong>Do</strong> manage amalgam waste through recycling as</td>
<td>Don’t flush amalgam waste down the drain or toilet</td>
</tr>
</tbody>
</table>
much as possible

**Do** use line cleaners that minimize dissolution of amalgam

**Don’t** use bleach or chlorine-containing cleaners to flush wastewater lines

Composites also have toxic substances as their constituents that are harmful to human health and to the environment. Composite waste management protocols should therefore be undertaken and this should include first reducing their wastage. Such toxic substances are shown in table 2 (18). This shows that increasing the amount of waste of such materials means increasing their toxic effects to the environment and should therefore be discouraged.

**Table 2: Typical composites fabrication processes, products used and wastes**

<table>
<thead>
<tr>
<th>Processes and primary products used</th>
<th>Primary wastes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mold preparation</td>
<td>Dirty rags-hazardous if contaminated with certain solvents. Can be recycled by approved laundry.</td>
</tr>
<tr>
<td>Release agent-nonhazardous wax or polymer</td>
<td></td>
</tr>
<tr>
<td>Gel coating. Laminating. Resin-often hazardous because it is flammable and contains styrene monomers</td>
<td>Air emissions-styrene and other volatile organic compounds are commonly regulated by local air authorities.</td>
</tr>
<tr>
<td>Initiators- often hazardous because they are flammable and reactive due to peroxide content. Reinforcement- nonhazardous glass fiber; aramid and carbon fibers are also sometimes used.</td>
<td>Spent solvent and still bottoms often hazardous if the solvent product was flammable or toxic. Nonhazardous water base wastes are often disposed of through local sewer.</td>
</tr>
<tr>
<td>Tool and equipment cleanup solvent- often hazardous because of low flash point or chlorine content. Acetone, toluene, xylene and various alcoholics are flammable. Emulsifiers</td>
<td>Overspray solids, trim-ends and cut-outs- nonhazardous; often disposed in landfill.</td>
</tr>
</tbody>
</table>
and citrus-based solvents may be toxic and chlorinated solvents are toxic.

Some dental cements also have toxic constituents and knowledge of such cements should be improved to prevent their wastage. A guidance document is aimed at improving dentists’ awareness of the environmental impact of wastes from dental facilities in Massachusetts states that some cements used in dental procedures are derived from zinc phosphate and zinc is a toxic water pollutant (19).

Literature has a lot of information concerning dental waste management and the knowledge, practice and attitudes of dental practitioners and dental students towards this topic. However, researches specifically related to dental materials wastage; the causes, the implications and the assessment of knowledge and attitudes of dental practitioners and dental students towards the topic have not been done. This is the gap that the present study seeks to fill.
CHAPTER 2: STATEMENT OF PROBLEM AND JUSTIFICATION

2.1 Research problem

Dental material wastage bears with it consequences that should not be ignored. These include; material shortage and therefore delays in the deliveries of oral health services to patients. In addition, increased amount of disposed of waste therefore difficulty in managing the waste hence more pollution to the environment that negates the efforts put in infection control and if this is to be well managed, then more cost and effort will have to be put in. Third, wastage of dental materials leads to imbalances in the university budget. This shows how great a need it is that students in UON prosthetics and conservative clinics need to be aware of causes of dental material wastage and the importance of its prevention in order to develop positive attitudes towards the prevention of wastage. The conservative and prosthetics clinics were the chosen study areas because they are the clinics that involve the use of dental materials the most when restoring aesthetics, function and health of teeth of patients visiting the dental hospital therefore most implicated where dental materials wastage is concerned as compared to other clinics. Students with little knowledge and negative attitudes towards dental materials wastage will waste materials more. Therefore determination of these two variables, knowledge and attitudes, was to help determine the amount of wastage.

2.2 Justification of the study

The primary purpose of this study was to evaluate the level of knowledge and the attitudes toward dental materials wastage among dental students in UON Dental prosthetics and conservation clinics. No such studies have been done to evaluate this. This reason together with the consequences of wastage of dental materials provides more need to describe the knowledge and attitude of undergraduate students towards dental materials wastage. The cost of dental materials has escalated in the recent past. Dental materials are quite expensive and their wastage results in huge amounts of loss. The disease burden that causes loss of teeth, dental caries and periodontitis, is real. Such diseases especially dental caries are treated by restorative materials that arrest the disease process, restore morphology of the teeth and therefore their restore function. Successful completion of this study was also to help in offering the first understanding of the problem, providing literature to be reviewed when a similar research is conducted in future and enable formulation of strategies to reduce the wastage among undergraduate dental students.
2.3 Objectives of the study

2.3.1 General objective

To describe the knowledge and attitudes towards dental materials wastage by undergraduate students at the UON Dental Hospital prosthetics and conservation clinics.

2.3.2 Specific objectives

a) To describe the awareness of the consequences of dental materials wastage among students
b) To evaluate the attitudes of students towards dental materials wastage
c) To determine the types of material most wasted as perceived by the students
d) To describe efforts made to stop wastage

2.4 Hypotheses

- Less than 50% of the students are aware of consequences of dental materials wastage
- Less than 50% of the students have positive attitudes towards prevention of wastage
- Less than 30% of the students make effort to reduce wastage
2.5 Variables

Socio-demographic variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male or Female</td>
</tr>
<tr>
<td>Year of study</td>
<td>Level 2,3,4</td>
</tr>
</tbody>
</table>

Independent variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge on dental materials wastage</td>
<td>Factors that lead to wastage</td>
</tr>
<tr>
<td></td>
<td>Consequences of the wastage</td>
</tr>
<tr>
<td></td>
<td>Ways of preventing wastage of dental materials</td>
</tr>
<tr>
<td>Attitude towards dental materials wastage</td>
<td>Agrees on need to avoid wastage</td>
</tr>
<tr>
<td></td>
<td>Makes effort to stop wastage</td>
</tr>
</tbody>
</table>

Dependent variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastage of dental materials</td>
<td>Amount (slight, medium or large)</td>
</tr>
<tr>
<td></td>
<td>Type (solid or liquid)</td>
</tr>
</tbody>
</table>
CHAPTER 3: MATERIALS AND METHODS

3.1 Study area

This study was conducted at UON Dental Hospital prosthetic and conservative clinics. The activities conducted in the prosthetics clinic are students being tutored on how to fabricate complete and partial dentures and therefore main dental materials used are: dental acrylic, impression materials like alginate, impression compound, impression plaster, zinc oxide eugenol, modeling and beading wax, and materials used in fabrication of artificial teeth like acrylic and porcelain. The activities conducted in the conservative clinic include students being tutored on how to fabricate restorations on physically damaged teeth. The main materials used here include: lining materials like calcium hydroxide cement, materials used as bases such as zinc oxide eugenol cement, zinc polycarboxylate cement, glass ionomer cements, materials used as restorative materials such as, dental amalgam, glass ionomer cement, and zinc oxide eugenol cement. Both clinics may involve fabrication of indirect restorations that cannot be fabricated by the chair side and need fabrication in the lab. Here, materials like gypsum products like plaster of Paris and dental stone, and impression materials like dental acrylic are the main materials. Comparing these two clinics to the other clinics present in the hospital like periodontology and oral diagnosis clinics where trays with instruments are the main equipments required, they show the core of dental materials wastage by students. This explains why this study chose these two clinics as the study area.

3.2 Study population

This study comprised of second, third and fourth year undergraduate dental students attending prosthetics and conservative clinics at the UON Dental Hospital. The total population was 86.

3.3 Study design

This study was a descriptive cross-sectional study, using student population based study groups.
3.4 Sample size

The study population included all the second, third and fourth year undergraduate dental students attending prosthetics and conservative clinics at the UON Dental Hospital.

The total population of students attending prosthetics and conservative clinics in:

- Second year is 23
- Third year is 28
- Fourth year is 35

Bringing a total of: \(23+28+35 = 86\).

3.5 Sampling methods

The study population included all undergraduate dental students attending prosthetics and conservative clinics at the UON Dental Hospital. This therefore included all students in their clinical years, hence the second, third and fourth year students, only those attending these two clinics with no need for any sampling methods.

3.6 Inclusion criteria

All students taking Bachelor of Dental Surgery in the University of Nairobi and are in there clinical years therefore attending prosthetic and conservation clinic. This therefore included the second, third and fourth year students, only those attending these two clinics.

All the second, third and fourth year undergraduate dental students attending Prosthetic and Conservative clinics and who gave consent to participate in the study.
3.7 Exclusion criteria

Undergraduate students taking Bachelor of Dental Surgery and had not yet started their clinical years hence, the first years.

Undergraduate students in second, third or fourth year who were repeating other subjects that are not prosthetics and conservative dentistry.

Students who did not give consent to participate in the study.

3.8 Data collection, instruments and techniques

A self administered questionnaire designed by investigator was used to collect data (appendix 1). The questionnaire was used to evaluate the knowledge and attitude of second, third and fourth year undergraduate students in UON dental prosthetic and conservative clinic towards dental materials wastage, factors that lead to wastage, the consequence and the ways of prevention. The variables to be collected was; the gender of the students and their year of study as the socio-demographic variables, knowledge and attitude of the students towards dental materials wastage as the independent variables and amount and type of wastage as the dependent variable.

The questionnaires were delivered to students in their classes where they could be found gathered in one place and given to them by hand by the investigator and collected immediately upon completion. This controlled sharing of ideas regarding the study tool among study participants especially those in the same year of study.

3.9 Data analysis

The data from the questionnaires was checked for completeness and consistency on the same day of receipt and then statistically analyzed with SPSS 16.0 software. The information obtained from the study organized and presented as descriptive statistics using charts, frequency, tables, average values and percentages.
3.9.1 Logistical consideration

Absent respondents due to illness or other personal reasons in the day of data collection.

3.9.2 Ethical consideration

Approval to carry out the research was sought from the Kenyatta National Hospital / University of Nairobi Research, Ethics and Standards Committee. Permission to collect data was be sought from Dean of Students, UON Dental Hospital. During questionnaire distribution, the study was clearly described to the participants and any doubts and questions dealt with. A cover page on the questionnaire briefly described what was required of the participants. Participation was voluntary and confidentiality was guaranteed. Participants were freed to terminate their participation in the study at any time without any consequences on their part.

3.9.3 Benefits of the study

1. The knowledge and attitudes of undergraduate students towards dental materials wastage in UON Dental prosthetic and conservative clinic will be determined
2. The information obtained in this study will be used to change policy in dental materials wastage prevention
3. The information in this study will help minimize costs and efforts of dental waste management
4. The information will also be used for reference in relevant studies in the future
5. Research report will be submitted in for partial fulfillment of the requirements for the degree Bachelor of Dental Surgery
Study limitations

1. Only 79 (91.86%) of the original number of questionnaires distributed, 86, were filled and returned to the investigator.
2. The responses given were not able to be confirmed through observation of the students in the labs and clinics.
3. The results were only of 79 students but not the intended 86, it is therefore not possible to make inferences beyond this.
CHAPTER 4: RESULTS

A structured self administered questionnaire was distribute to 86 undergraduate dental students; 23 to second year students, 28 to third year students and 35 to fourth year students, enquiring their knowledge and attitude towards dental materials wastage in UON Conservative and Prosthetic clinics. 21 (91.30%) questionnaires from second year students, 28 (100%) questionnaires from third year students and 30 (85.71%) questionnaires from fourth year students were filled and returned to the investigator. Therefore, a total of 79 questionnaires were studied. Table 3 illustrates the total number of questionnaires that were filled and returned to the investigator from each level of study.

Table 3: Distribution of questionnaires and response rates by level of study.

<table>
<thead>
<tr>
<th>Level of study</th>
<th>Number distributed</th>
<th>Number filled</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>23</td>
<td>21</td>
<td>91.30</td>
</tr>
<tr>
<td>III</td>
<td>28</td>
<td>28</td>
<td>100</td>
</tr>
<tr>
<td>IV</td>
<td>35</td>
<td>30</td>
<td>85.71</td>
</tr>
<tr>
<td>TOTAL</td>
<td>86</td>
<td>79</td>
<td>91.86</td>
</tr>
</tbody>
</table>

Socio-demographic information

The study involved 79 undergraduate dental students from second to fourth year, those attending Prosthetic and Conservative clinics in UON Dental School. Among the 79 students 38 (48%) were female and 41 (52%) were male. 21 (27%) from second year, 28 (35%) from third year students and 30 (38%) from fourth year.
Knowledge on dental materials wastage:

Seventy two (91.9%) of the students agreed that there was wastage of dental materials in the Prosthetics and Conservative clinics while 7 (8.9%) disagreed on the presence of wastage.

Training

Majority of the students 50 (64.6%) had not undergone training on consequences of wastage of dental materials. Of the 29 (35.4%) students who had undergone training, 25 (86.2) reported mention by lecturers and nurses in the clinics during clinical and laboratory procedures, 3 (10.3%) had attended seminars on the topic and 1 (3.5%) was by officials hired by the university (Fig. 1).

Forty seven (58.2%) students had not undergone training on avoiding dental materials wastage. Of the 32 (41.8%) trained students, 27 (84.4%) was by mention by lectures and nurses during clinical and laboratory procedures, 1 (3.1%) underwent training in seminars and 4 (12.5%) was by officials hired by the university (Fig. 2).

Figure 1: Training on the consequences of wastage of dental materials
Factors that lead to the wastage

Fifty (63.3%) of the students indicated the factor that lead to wastage of dental materials the most to be lack of more accurate methods of measuring the amount of materials required for a procedure. 10 (12.7%) said it was due to lack of understanding of the biomaterial science of the dental materials, 9 (11.4%) indicated it was due to inadequate training on causes and consequences of wastage of dental materials and another 9 (11.4%) indicated it was because there are poor rules and regulations put in place to regulate wastage of the dental materials. 1 (1.3%) student did not provide a response to this question (Fig. 3).

A large number, 62 (78.5%) of students indicated that the factor that frequently leads to dental materials wastage by undergraduate dental students was mixing more amount of materials than required for a procedure. 7 (8.9%) said it was due to students leaving containers with material open after procedures while 10 (12.7%) said it was because students do not check manufactures instructions on paste/paste or powder/liquid ratios of the materials (Fig. 4).
Figure 3: Best excuse for wastage of dental materials

Figure 4: Factor that most frequently leads to wastage of dental materials
Consequences of the wastage

Twenty five (31.6%) of the students reported the main consequence of wastage is that students who waste materials become uneconomical clinicians in the long run. 22 (27.8%) indicated that the main consequence was that it leads to material shortage and then delays in delivery or oral health services to patients, 20 (25.3%) reported it increases costs and efforts of dental waste management while for 10 (12.7%), it has negative effects on the university’s budget. 2 (2.6%) students did not provide any response to this question (Fig. 5).

![Figure 5: Consequences of wastage of dental materials](image)

Ways of preventing wastage

Thirty seven (48.1%) of the students reported that the best way they would prevent wastage of dental materials among undergraduate students in Prosthetic and Conservative clinic was to introduce more accurate methods of measuring materials required for a procedure. 26 (32.9%) indicated they would train students on methods of avoiding wastage, 12 (15.2%)
indicated they would educate students on the demerits of wastage while 2 (3.8%) would punish those who waste. 1 (1.3%) student did not respond to this question (Fig.6).

![Figure 6: Best way of preventing wastage of dental materials](image)

Sixteen (20.3%) of the students reported that they were aware of legislations, regulations and rules put in place to stop wastage. All of these students agreed that they would establish legislations, regulations and rules were they not there. All these students also indicated that they had read such rules on notices on the walls of Prosthetic laboratory and also manufacturer’s instructions.

When asked for their opinion on how the school could control dental materials wastage by undergraduate students, students provided responses that included; introduction of more accurate methods of measuring the amount of materials required for a procedure and education of students to ensure awareness of consequences of wastage and ways of prevention. Others asked for nurses and dental assistants who would dispense materials for them, especially in their first days in the Conservative and Prosthetic clinics.
Attitude towards dental materials wastage

When asked if wastage of dental materials should be discouraged, 74 (93.7%) students agreed while 4 (5%) students did not provide an answer. When asked if the concern with dental materials wastage was justified, 71 (89.9%) thought it should be while 4 (5%) students did not provide an answer. When asked if they would advice someone to specialize in dental biomaterials, 77 (72.2%) reported they would while 4 (5%) students did not provide an answer.

Fifty nine (74.7%) of the students admitted having mixed excess amounts of materials than needed to fabricate a model in the laboratory, 71 (89.9%) on having mixed excess amounts of material than needed for packing in the clinics, 52 (65.8%) for having left a container with a material open after use and 71 (89.9%) for having seen a fellow student do any of the above mentioned (Fig. 7).

Figure 7: Wastage of materials in different areas
Type of dental material and frequency of wastage

Type

Zinc oxide eugenol cement was found to be most wasted material, 41 (51.9%) of students reported having wasted it. Agar and polyether impression material was the least wasted both by 4 (5.1%). Table 4 below shows the percentage of students that had wasted different materials.

Table 4: Types of dental materials and percentage of students with a history of wastage

<table>
<thead>
<tr>
<th>Type of material</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental amalgam</td>
<td>20</td>
<td>25.3</td>
</tr>
<tr>
<td>Anterior resin composite</td>
<td>13</td>
<td>16.5</td>
</tr>
<tr>
<td>Posterior resin composite</td>
<td>11</td>
<td>13.9</td>
</tr>
<tr>
<td>Zinc oxide eugenol cement</td>
<td>41</td>
<td>51.9</td>
</tr>
<tr>
<td>Glass ionomer cement</td>
<td>32</td>
<td>40.5</td>
</tr>
<tr>
<td>Zinc polycarboxylate cement</td>
<td>8</td>
<td>10.1</td>
</tr>
<tr>
<td>Zinc phosphate cement</td>
<td>11</td>
<td>13.9</td>
</tr>
<tr>
<td>Zinc oxide eugenol impression material</td>
<td>22</td>
<td>27.8</td>
</tr>
<tr>
<td>Impression compound</td>
<td>28</td>
<td>35.4</td>
</tr>
<tr>
<td>Alginate</td>
<td>25</td>
<td>31.6</td>
</tr>
<tr>
<td>Agar</td>
<td>4</td>
<td>5.1</td>
</tr>
<tr>
<td>Polyether impression material</td>
<td>4</td>
<td>5.1</td>
</tr>
<tr>
<td>Polysulphide impression material</td>
<td>5</td>
<td>6.3</td>
</tr>
<tr>
<td>Silicone impression material</td>
<td>5</td>
<td>6.3</td>
</tr>
</tbody>
</table>
Frequency

A question that provided a table requesting students to indicate frequency of wastage of different dental materials, where the frequency was divided into slightly wasted, medium wastage and highly wasted, provided results as indicated in table 5. The number of students in each division and the percentages are provided.

**Table 5: Types of dental materials and frequency of wastage**

<table>
<thead>
<tr>
<th>Type of material</th>
<th>Slightly</th>
<th>Medium</th>
<th>Highly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>(%)</td>
<td>Number</td>
</tr>
<tr>
<td>Dental amalgam</td>
<td>43</td>
<td>54.4</td>
<td>18</td>
</tr>
<tr>
<td>Anterior resin composite</td>
<td>45</td>
<td>59.5</td>
<td>16</td>
</tr>
<tr>
<td>Posterior resin composite</td>
<td>43</td>
<td>54.4</td>
<td>13</td>
</tr>
<tr>
<td>Zinc oxide eugenol cement</td>
<td>19</td>
<td>24.1</td>
<td>27</td>
</tr>
<tr>
<td>Glass ionomer cement</td>
<td>24</td>
<td>30.4</td>
<td>23</td>
</tr>
<tr>
<td>Zinc polycarboxylate cement</td>
<td>31</td>
<td>39.2</td>
<td>8</td>
</tr>
<tr>
<td>Zinc phosphate cement</td>
<td>34</td>
<td>38.2</td>
<td>7</td>
</tr>
<tr>
<td>Zinc oxide eugenol impression material</td>
<td>30</td>
<td>38.0</td>
<td>19</td>
</tr>
<tr>
<td>Impression compound</td>
<td>36</td>
<td>43.0</td>
<td>13</td>
</tr>
<tr>
<td>Alginate</td>
<td>32</td>
<td>40.5</td>
<td>11</td>
</tr>
<tr>
<td>Agar</td>
<td>1</td>
<td>1.3</td>
<td>1</td>
</tr>
<tr>
<td>Polyether impression material</td>
<td>1</td>
<td>1.3</td>
<td>1</td>
</tr>
<tr>
<td>Polysulphide impression material</td>
<td>1</td>
<td>1.3</td>
<td>1</td>
</tr>
<tr>
<td>Silicone impression material</td>
<td>1</td>
<td>1.3</td>
<td>1</td>
</tr>
</tbody>
</table>
CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

The main objective of this study was to determine the knowledge and attitudes towards dental material wastage by undergraduate students at the UON Conservative and Prosthetic clinics. Determination of knowledge included assessment of knowledge on factors that lead to wastage, consequences of the wastage and ways of preventing wastage of dental materials, by finding out the type and quantity of training the students have underwent. Determination of attitude included assessment of the students’ agreement on need to avoid wastage and willingness to put efforts to stop the wastage of dental materials. The study was also carried out to determine the types of materials being wasted and the frequency of wastage of the various types of dental materials. The Prosthetic and Conservative clinics were chosen because the use of dental materials for restorative purposes occur most in these clinics as compares to others in the UON Dental Hospital.

The main consequences of wastage of dental materials are increase in costs and efforts in dental materials waste management. This is proven by the many researches done that have focused entirely on dental waste management. Such researches include the study done to determine the knowledge, attitude and practice on the management of dental waste among dental practitioners in Nairobi public hospitals (8). However, in the present study, 31.6% of the students thought the main reason they would discourage wastage was because students that waste materials become uneconomical clinicians in the long run, 27.8% said it was because it leads to material shortage and the delays to deliveries of oral health services to patients and only 25.3% thought it was because it affects the cost and efforts of dental waste management. This might be explained by the low percentage of students that have undergone training on the consequences of wastage (32.9%) and on ways of avoiding wastage (35.4%). 86.2% and 84.2% of these trained students, on consequences of wastage and ways of prevention respectively, were trained by mere mention by lecturers and nurses during clinical and laboratory procedure. These findings prove no concern to the environment by the students. They also prove the hypothesis predicting that 50% of the students are aware of the consequences of dental material wastage. This clearly shows the need for the university to hire officials that would train students on ways of minimizing wastage. More seminars on
dental material waste prevention as a major way of dental material waste management should also be conducted and students invited to listen and participate.

An open question allowing students to give opinions on ways of preventing wastage by undergraduate students in the Conservative and Prosthetics clinics provided answers that showed that majority of students requested better training and education on ways of prevention of and consequences of wastage. This shows that even the student themselves are aware of their little knowledge on the subject and are in need of finding ways of widening their knowledge. However, only 11.4 % of the students felt that the best excuse of dental materials wastage by students was that there is inadequate training on causes and consequences of wastage of dental materials. A large percentage (64.6%) thought it was because there lacked more accurate methods of measuring the amount of materials required for a procedure. However, scoops for some dental materials like GIC, premeasured amalgam capsules and manufactures instructions on the bottles and tubes used to present the materials are often provided. This shows that the students may be ignorant of the different ways of accurately measuring these materials and are unaware that they are actually present. This was again supported by the fact that the largest percentage of students (48.1%), claimed that the best way of preventing dental materials wastage by students was to introduce more accurate methods of measuring materials require for a procedure while only 15.2% felt the best way was to educate the students. The students answers were surprising in that, most if not all dental materials are presented with manufacturer’s instructions. Students are also taught in class about the paste/paste and powder/liquid ratios of these materials. Addressing the issue of providing the best way of preventing wastage will therefore be more effective if students are educated on ways of preventing wastage rather than manufacturers instructed to indicate more accurate methods of measuring the materials, which they already have. Educating these students should emphasize always reading manufacturer’s instructions before using any dental material because most of them clearly they do not. Studies that prove that education is key in dental materials wastage have not been done. However, several website pages indicate that, the key to waste prevention is education of the people using the wasted products on consequences of their actions (19).
Only 20.3% of the students were aware of legislations placed to stop wastage by reading them from posters and notices in the prosthetic laboratory and yet 91.1% of the students were aware of the presence of dental materials wastage by undergraduate students in Prosthetic and Conservative clinics. This shows that almost all the students are aware that they and their fellow students waste materials but very little measures are taken to stop this. Recommendations that such legislations, regulations and rules be established was proposed and 84.8% of the students agreed.

89.9% of the students felt that the concern with dental materials wastage is justified and 72.2% of them would advice someone to specialize in the subject of Dental Biomaterials. These results show that the students are actually concerned and might be willing to make efforts and undertake better practices that minimize if not totally eliminate wastage. These results refused the hypothesis that predicts that less than 50% of the students have positive attitudes towards prevention of wastage. Introduction of ways of preventing wastage that include, training by officials hired by the university, seminars held to address issues on wastage and waste prevention among others, should therefore be encouraged because the students are willing to receive them.

Fifty nine (74.7%) of the students admitted having mixed excess amounts of materials than needed to fabricate a model in the laboratory, 71 (89.9%) on having mixed excess amounts of material than needed for packing in the clinics, 52 (65.8%) for having left a container with a material open after use and 71 (89.9%) for having seen a fellow student do any of the above mentioned. These results agree with the hypothesis that predicts that less than 30% of the students make efforts to stop wastage.

The types of dental materials used in the Prosthetics and Conservative clinics were also assessed and percentage of students who wasted them determined. The most wasted material was zinc oxide eugenol (zoe) cement by 51.9% of the students. This is because, zoe cement is applicable in many procedures especially in the Conservative clinic. These include as a liner, a base and a temporary filling amongst others. Other materials that are also applicable in many procedures and have shown high percentages in wastage are; glass ionomer cement, impression compound (mostly used in the Prosthetic clinic), alginate, zinc oxide eugenol impression paste and dental amalgam by 40.5%, 35.4%, 31.6%, 27.8% and 25.3%
respectively. Dental amalgam is not among the very highly wasted materials by the students. This is good news because of the concern with dental amalgam contributing up to 1% of global mercury burden to the environment (4). This low wastage, despite dental amalgam being the most common restorative material, may be attributed to the presentation of amalgam in premeasured and sized amalgam capsules. One capsule contains enough amalgam to fill most sizes of cavities cut by students in the Conservative clinic. This therefore shows that technology is actually solving the problem of dental materials wastage and may completely eliminate it. Recommendations that other materials be presented in presentations that encourage elimination of wastage such as the use of unit doses, command set materials, and improved competency of materials and improved handling techniques by introduction of application tips, measuring swaps and cylinders, should be made.

The least wasted materials; agar, polyether impression material, polysulphide impression material and silicone by 5.1%, 5.1%, 6.3% and 6.3% respectively. This is because these materials are rarely used during prosthetic and conservative procedures by the students.
CONCLUSIONS

Based on the findings of this study, the following conclusions were made:

1. Knowledge on the presence of wastage of dental materials is high with only a few of the student not aware of presence of wastage of dental materials in Conservative and Prosthetic clinics proving the hypothesis that stated that less than 30% of the students make efforts to reduce wastage.

2. Training on consequences of and ways of avoiding wastage is low (26% and 28% of the students respectively) proving the hypothesis that predicted that less than 50% of the students are aware of the consequences of dental materials wastage.

3. The factor that leads to wastage of dental materials the most is lack of proper education of the students on the consequences of dental material wastage and ways of preventing it.

4. The attitude towards prevention of dental material among students is good with more than half of the student stating that the concern with dental materials is justified rejecting the hypothesis that predicted that less than 50% of the students have positive attitudes towards prevention of wastage.

5. The most wasted material is zinc oxide eugenol cement with half of the students reporting to have wasted it and a quarter reporting to have wasted it highly.
RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

1. The School of Dental Sciences should set up programs for continuous education on dental materials wastage to improve the students’ knowledge on consequences of and ways of preventing wastage. There should be considerations for incorporating a topic in the syllabus which will look at all aspects of dental materials wastage.

2. The school should establish strict legislations, regulations and rules to ensure appropriate and accurate methods of measuring materials as per the manufacturer’s instructions and the lectures to avoid wastage by students.

3. Students should take the prevention of wastage of dental materials as their personal mission and warn fellow students whenever spotted wasting.

4. Information on wastage of dental materials: how it occurs, its consequences and how to avoid it should be channeled to the students through pamphlets, workshops and curriculum activities to ensure that this information is instilled in them.

5. The students should be made quite aware that the key to success as future clinicians is to be economical by their lecturers and the nurses in the clinics.
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Appendix I

KNOWLEDGE AND ATTITUDES TOWARDS DENTAL MATERIALS WASTAGE BY UNDERGRADUATE STUDENTS AT THE UON CONSERVATIVE AND PROSTHETIC CLINICS

QUESTIONNAIRE

This questionnaire is part of Community Dentistry research project. Please answer the following questions by ticking/circling the correct response(s) or filling in the blank spaces provided.

1. Level of study: II.......... III........ IV........
2. Sex: F........ M........
3. Is there wastage of dental materials by undergraduate students in prosthetic and conservation clinics?
   a) YES
   b) NO
4. Have you ever had excess material left after a procedure?
   a) YES
   b) NO
5. Have you undergone any training on consequences of wastage of dental materials?
   a) YES
6. If YES; what kind of training was it?
   a) A seminar
   b) Training done by officials hired by the university
   c) Mention by lecturers during class and lab works
   d) Nursing staff in the clinic
   e) Technologists in the lab
   f) During phantom head course

7. Have you undergone any training on avoiding or controlling wastage?
   a) YES
   b) NO

8. If YES; what kind of training was it?
   a) A seminar
   b) Training done by officials hired by the university
   c) Mention by lecturers during class and lab works
   d) Nursing staff in the clinic
   e) Technologists in the lab
   f) During phantom head course
9. Give opinions on how you would control wastage of dental materials by undergraduate students

                                                             .............................................................
                                                             .............................................................
                                                             .............................................................

10. Circle the statement that **BEST** excuse your wastage of dental materials

a) Lack of understanding of their biomaterial science
b) Inadequate training on causes and consequences of wastage of dental materials
c) Poor rules and regulations put in place to prevent the dental materials wastage
d) Lack of more accurate methods of measuring the amount of materials required for a procedure

11. Circle the statement that **BEST** state the factor that lead to wastage of dental materials the **MOST** by undergraduate students

a) Mixing amount of materials more than the amount needed for a model fabrication or packing of cavities
b) Leaving tubes, bottles or any container with a material open
c) Not checking manufacturer’s instructions on paste/paste or powder/liquid ratios of the materials

12. Circle the **BEST** way you would prevent dental materials wastage among undergraduate students in prosthetics and conservation clinics

a) Educating them on the demerits of wastage
b) Train on methods of avoiding wastage

c) Introduction of more accurate methods of measuring materials required for a procedure

d) Punish those who waste

13. Are you aware of any legislations, regulations or rules placed in your school to stop wastage

   a) YES
   b) NO

14. If YES, state where you read it from

   ........................................................................................................................................................................
   ........................................................................................................................................................................
   ........................................................................................................................................................................
   ..............................

15. If there were no such legislations, regulations or rules, would you recommend that these be established?

   a) YES
   b) NO

16. Do you agree that wastage of dental materials should be discouraged?

   a) YES
   b) NO

17. If your answer in 15 above is a), circle the main reason why
a) It increases costs and efforts of dental waste management
b) It affects the university's budget
c) It leads to material shortage and then delays in the delivery of oral health services to patients
d) Students that waste the materials will become uneconomical clinicians in the long run

18. If your answer in 15 above is b), give the main reason why

..............................................................
..............................................................
..............................................................

19. Is the concern with dental materials wastage justified?

a) YES
b) NO

20. Would you advice anyone to specialize on the subject, Biomaterials

a) YES
b) NO

21. Have you ever...

a) Mixed excess amounts of material than needed for fabrication of a model in the lab? YES/NO
b) Mixed excess amounts of material than needed for packing in the clinics? YES/NO
c) Left a tube, a bottle or any container with a material open after use? YES/NO
d) Seen a fellow student doing a) YES/NO
22. Which of the following categories of dental materials have you found yourself wasting?

a) Dental amalgam........................................YES/NO

b) Resin composites-anterior..................................YES/NO
   - posterior..........................................YES/NO

c) Dental cements-zinc oxide eugenol....................YES/NO
   - glass ionomer cement..............................YES/NO
   - zinc polycarboxylate...............................YES/NO
   - zinc phosphate...................................YES/NO
   - calcium hydroxide.................................YES/NO
   - endodontic sealer cement.........................YES/NO
   - gutta-percha points...............................YES/NO

d) Impression materials-zinc oxide eugenol..............YES/NO
   - impression compound..........................YES/NO
   - alginate..........................................YES/NO
   - agar..............................................YES/NO
   - polyether.........................................YES/NO
   - polysulphides....................................YES/NO
23. Please tick in the box on the frequency of wastage or leave a blank where material has never been used.

<table>
<thead>
<tr>
<th>Dental material</th>
<th>Slightly wasted</th>
<th>Medium wastage</th>
<th>Highly wasted</th>
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</thead>
<tbody>
<tr>
<td>Dental amalgam</td>
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<td>Composites ;anterior</td>
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<td>posterior</td>
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<tr>
<td>Dental cements;</td>
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<td>Zinc oxide eugenol</td>
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<td>Zinc polycarboxylate</td>
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<td>Zinc phosphate</td>
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<td>Impression materials;</td>
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<td>Zinc oxide eugenol</td>
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<td>Impression plaster</td>
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<td>silicone</td>
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</table>
Appendix II

KNOWLEDGE AND ATTITUDES TOWARDS DENTAL MATERIALS WASTAGE BY UNDERGRADUATE STUDENTS AT THE UON CONSERVATIVE AND PROSTHETIC CLINICS

Consent Form

I am an undergraduate student at the School of Dental Sciences, university of Nairobi. I am carrying out a community dentistry research project that is part of the requirements I need to fulfill for the degree of Bachelor of Dental Surgery. I would like to request for your participation by filling in a questionnaire whose results will be recorded and analyzed for research purposes only. Confidentiality of information given is guaranteed and you are free to withdraw from the study at any time without adverse consequences. Your participation will be highly appreciated and greatly valued.

Thank you

DOLPHINE ADHIAMBO MINAI

PARTICIPANT’S SECTION
I consent to participate in this research by filling in a questionnaire whose results will be recorded and analyzed for research purposes only.

Signature ........................