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NEW CLASSIFICATION AND COLOUR CODE DEVELOPMENT FOR AN EFFICIENT MEDICAL WASTE SEGREGATION

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Abstract

Medical waste poses serious threat to the environmental health without comprehensive guidelines and efficient management as it contains highly toxic chemicals, pathogenic viruses

and bacteria. Therefore, proper handling of medical waste with specialised treatment from its source to final disposal has been a primary concern among medical institute, public and private agencies. The existing medical waste classification in many countries does not contain clear and appropriate segregation, which has created confusion among the medical staff in handling medical waste. It is pertinent to mention that, World Health Organisation (WHO) guidance recommends different countries to conduct assessments prior to any decision-making process and improve their own guidelines incorporated with recent technologies. Therefore, the objectives of this research are: 1) to develop a new classification of medical wastes by identifying the gaps in the current classes and 2) to suggest colour code for the medical waste segregation that is adopted from the WHO's colour code with few amendments as per the recent technological development. Due to the challenge in managing medical waste, there is an urgent need in developing and adopting comprehensive medical waste segregation classification to separate the medical waste at the source itself. The methodology of classification is aimed at applying a source separation practiced by the medical personnel on the spot and given them awareness on the segregation process. The proposed new classification of medical waste is based on Malaysia's Scheduled Waste Regulations together with European Waste Code. By extracting the best classification from these two regulations and by overcoming the lacuna in them, a new classification is developed for current use. The developed medical waste classification and its colour codes must provide a better segregation and achieve cost saving at waste disposal. The current methods of classification could be extended to research on application of such classification to other parts of the world.

Keywords

Medical waste, Hazardous waste, Waste Classification, Segregation of waste, Environmental pollution, Occupational Health

1. Introduction

There is no exact definition for medical waste given by any country. The definition for medical waste based on respective countries purposes and objectives the waste has been generated. Apart from this, there is inconsistency in the terms used for medical waste. Therefore, for a solid waste to be categorized as a medical waste, it has to meet the following requirements: The waste is produced because of medical activity such as immunization and diagnosis of human

beings or animals, or any research related to these activities (Fraiwan et al., 2012). Medical and healthcare institutional can be the source of the lifesaving medical interventions but it also plays a significant role as a vital energy hogs. At the same time, healthcare and medical institutional, conduct different kinds of therapeutic activities, which result in the production of infectious waste, sharp objects, radioactive wastes and chemical materials (Coote, 2006). In order to this, the medical waste management has become a blooming issues among public all over the countries after few medical institutional reported on ecological footprint that 384 times greater than the plot of land on which medical institutional located. In 2002, the assessment conducted by a WHO among 22 developing countries showed that from 18% to 64% proportion of healthcare facilities do not use waste disposal method according to the regulations and guidelines (WHO, 2004). A research conducted by Yoan-Kagoma, the medical director has been concluded that the proper waste segregation is the single most effective cost saving measure. Therefore, he has suggested that all the hospital should compulsory adopt this into practise (Kagoma et al., 2012). Addition to this, a hospital should reduce their ecological footprints by having comprehensive medical waste segregation and adopt "reduce, reuse, recycle" concept into medical waste management system (Kralji and Markic, 2008). Moreover, without designated medical waste segregation, enormous waste from medical institutional especially operation room is being classified as 'biohazard waste'.

1.1 Literature review for gap identification

Thus, 'biohazard waste' is a category of waste that required expensive handling, packaging and incineration which has been estimated to cost eight times more per tonne compare to solid wastes for the disposal process. According to the literature studies, a single method of biomedical waste treatment or disposal could not totally eliminates all risks to the environment or to humans (Stamenkovic and Kralj, 2007; Kralj and Stamenkovic, 2006). Thus, being aware of this environmental health risk issues associated with medical waste management, WHO is providing support tools to respective countries. Since each and every health care establishment could not have own treatment and disposal system, common treatment and disposal facilities under the coordination of medical head and guidance of the civic authority are required (Celikyay and Uzun, 2007). The WHO's available tools facilitate the respective countries with the analysis and decision-making process in developing comprehensive guidelines and policies. This effort will be a foundation that will have access to well-design and comprehensive medical-

waste management. This Afloat Medical Waste Management Guide contains current information gathered from sources in the U.S. Navy, the U.S. Environmental Protection Agency (EPA), and the Occupational Safety & Health Administration (OSHA). The guide also includes pertinent aspects of OSHA's Blood borne Pathogens Standard as it applies to ships (e.g., personal exposure preventive measures, personal exposure control measures, and training requirements). (Chief Of Naval Operations Environmental Protection, 1999).

The energy value of selected biomass (dry garden leaves) and two plastic materials, low density polyethylene (LDPE) and polystyrene (PS) collected from an educational campus in Varanasi, India is analysed. Cow dung which is still used as domestic fuel in dry cake form in many parts of the country has also been included. Two pellet batches of biomass, one each of Ashoka (Saraca Asoca) tree leaves and Cow dung, two pellet batches of plastic, one each of low density polyethylene (LDPE) and polystyrene (PS); and twelve biomass-plastic blended pellets had been prepared and tested. Proximate analyses and higher heating values (HHVs) were measured and compared with the gross calorific values (GCVs) of various grades of Indian non-coking thermal coals. The results indicated that on blending of biomass materials with plastics in 1:1 ratio, the HHV of mix exceed GCV of grade A non-cooking coal. A 2:1 ratio gives material with heating values higher than grade C coal. Other tested mix proportions also produced heating values exceeding D grade coal. The experiments prove the amount incineration required for wastes and the energy spent with different proportions of wastes. (Chaitanya Nidhi, 2017)

A “typical” Greek landfill site is examined by forming different alternatives with respect to the objectives of ewaste recovery and processing and, consequently, the cost and benefits of the Landfill Mining (LFM) operations. It is based on the findings of the first pilot project of LFM carried out in Greece, at Polygyros landfill. The results of the study show that the presence of e-waste improves the profitability indices. However, it seems that the adoption of more complex recycling and recovery processes leads to no gain in the financial results. These findings are supported by the uncertainty analysis conducted, which reveals that the price and concentration of plastics are the most significant factors, followed by the non-ferrous metal price and concentration. The conclusions of the study should be seen with caution. However, the international experience shows, the financial success of LFM projects is site-specific and is not assured in all cases. Therefore, it should be clear that further research efforts in the field are warranted to definitely answer the question. (Maria Menegaki, 2017).

A study assessed the environmental and health risk, associated with processes of the current handling of medical waste in hospitals of Sana'a city, Yemen. The observations and follow up the current handling of medical waste were done through frequent visits to the studied hospitals. A preliminary risks analysis (PRA) technique was applied as an analysis tool to identify and to evaluate the potential hazards of the activities and processes of the current handling of medical waste in the studied hospitals. Eighteen events related to containment, segregation, collection, transportation, waste storage, and waste treatment were analysed. The results obtained in this study showed that 89% of the events of waste handling processes, which have been analysed, were in high-risk levels. All events were in high-risk levels, suggesting need to prioritize all these processes' events. For minimizing or interrupting the potential risks of the current handling of hospitals waste, the hospitals' management and the relevant ministries in the Yemeni government should cooperate to develop comprehensive plan for management of medical waste, taking into account the results of this study. (Gawad M. A. Alwabr, 2017).

The biodegradability of bioplastics is highly affected by their physical and chemical structure. On the other hand, the environment in which they are located plays a crucial role in their biodegradation. This review highlights the recent findings attributed to the biodegradation of bioplastics in various environments, environmental conditions, degree of biodegradation, including the identified bioplastic-degrading microorganisms from different microbial communities. (S. Mehdi Emadian, 2017)

Reliable national data on waste generation and composition that will inform effective planning on waste management in Ghana is absent. To help obtain this data on a regional basis, selected households in each region were recruited to obtain data on rate of waste generation, physical composition of waste, sorting and separation efficiency and per capita of waste. Results show that rate of waste generation in Ghana was 0.47 kg/person/day, which translates into about 12,710 tons of waste per day per the current population of 27,043,093. Nationally, biodegradable waste (organics and papers) was 0.318 kg/person/day and non-biodegradable or recyclables (metals, glass, textiles, leather and rubbers) was 0.096 kg/person/day. Inert and miscellaneous waste was 0.055 kg/person/day. (Kodwo Miezah, 2015).

A strong concern with medical waste recycling is its infectious nature and that makes sorting by humans a very hazardous activity. By medical waste recycling program we may

decrease illegal reuse and recycling (Patwary et. al., 2011) and thereby reducing the chances of spreading infection.

2. Background of study: Environmental issues due to medical waste disposal

Blood bags and fluid (IV) bags are the common items in medical waste that may contain dioxins and furans. Apart from this, smaller amount of dioxins also present in bleached paper products such as disposable diapers, tissues and paper towels, and**.** The main issue in this is, instead of recycling them, the medical institution burns plastic and paper products using medical waste incinerator. Thus, during incineration dioxins and furans formed and released into air. Once dioxins and furans released into the air**,** they enter the ecological system as followed: (1) dioxins and furans released into the air (2) travel long distances through air currents and diffuse into land and plants (3) Animal such as cows and goats eat this dioxins and furans contaminated soil (4) Dioxins and furans also absorbed by algae in surface waters which will be eaten by the fish (5) people eat the furans and dioxins contaminated meat and dairy products. This dioxins and furans will get absorb into fat tissue of the human body and be in it for years. Currently, incineration has been method of choice for most hazardous medical waste. Due to heavy pollution caused by this incineration method, newly developed treatment methods have emerged as an alternative to incineration. Proper and well-planned medical waste segregation will be the best solution in selecting the alternative disposal method other than incineration.

3. Problem Statement

The key elements, which are lack in existing classification system, in many countries, are there is no proper medical waste segregation. Two important elements that should be emphasized in medical waste segregation are (1) characteristics of the medical waste and (2) collection of the waste into a separate bin at the initial generation point itself. For an example, sharp wastes have been sort apart from the infectious waste group while it should be assigned under infectious category. Despite that, there are three different types for the same infectious waste product which are blood and body fluid waste, infectious waste and other infectious wastes. According to World Health Organisation's guidelines, all this three categories should be assigned under the same type called 'bio hazardous waste'. Besides that, pharmaceutical and cytotoxic pharmaceutical waste did not be classified as a hazardous waste as the handling and disposal for the hazardous class pharmaceutical waste is different from the general category pharmaceutical waste. Furthermore,

waste types such as chemical and radioactive have been omitted from the classification which are the threaten substances to the environmental health. Another significant waste that has been left out from the classification is recyclable waste, which is the crucial aspect, in reducing the waste management cost.

4. Methodology

Therefore, to overcome all the weaknesses in the existing classification, a new medical waste classification based on the following criteria's has been developed. The main advantages of the new classification would serve for the following purposes:-

- Decrease the carbon foot print by improving medical waste management
- Reduce and prevent the waste generation
- Proper and effective waste segregation
- Reduce greenhouse gas emissions and other problem associated with the transport of medical waste
- Find best available technology for onsite treatment of medical waste
- Reduce the medical waste disposal cost
- Health care of employees at the hospital
- Occupational health and safety considerations
- Properties, characteristics and health impacts of the medical waste

4.1 Medical Wastes as Infectious Wastes

Medical wastes are highly infectious and can contaminate the living being and things very quickly. Mainly they are:-

- Contaminated waste from patients known to have blood-borne infections undergoing hemodialysis.
- Materials from microbiological laboratories
- Pathological specimens such as tissues, blood elements, excreta and secretions from patients or animals.
- Disposable materials and instruments from the outpatient clinics
- Any other material that has been in contact with infected persons or animals (Fraiwan et al., 2012).

Further, based on the consequences and contamination caused they are classified into many classes as shown in Figure 1, namely,

I. Biohazardous Waste

- Pathogenic and clinical wastes and quarantined materials

II. Hazardous Waste

- Pharmaceutical waste including cytotoxic and cytostatic medicines, radioactive substances, chemical and hazardous properties.

III. Biohazardous Waste has been divided into three subdivisions as follows:-

- **Microbiological wastes:-** live or attenuated vaccines, waste from biological testing, disposable culture dishes, culture and stocks of infectious agents from clinical laboratories, tissues (swabs) from infected patients, specimens from medical laboratories
- **Pathological wastes:-** - blood, serum, plasma and other blood components, human foetuses, body fluids, cloth containing blood stains, blood coated cotton balls, plasters, bandages, surgical dressings

IV. Hazardous waste has been divided into three subdivisions in the current classification as follows:-

- **Pharmaceutical waste:-** expired pharmaceuticals, unused pharmaceuticals, bottles or boxes containing pharmaceuticals, drugs, vaccines, sera, gloves with pharmaceutical residues, masks, drugs connecting tubes and drug vials.
- **Chemical waste:-** chloroform, trichloroethylene, film developer, xylene, methanol, acetone, isopropanol, formaldehyde, photographic chemicals, methylene chloride, toluene, ethyl acetate and acetonitrile
- **Radioactive waste:-** unused liquids from radiotherapy, radioactive substances contaminated glassware or packages, sealed sources.

V. Non-infectious waste has been divided into two categories as followed:-

- **Non-recyclable waste: -** food waste, used paper towels, napkins, tissues, aerosol spray cans, styrofoam (cups, plates, packing materials), light, bulbs, mirrors
- **Recyclable waste: -** paper, paperboard, glass, metal, cardboard, aluminium can, plastic soda, juice bottles, milk jugs and detergent bottles.

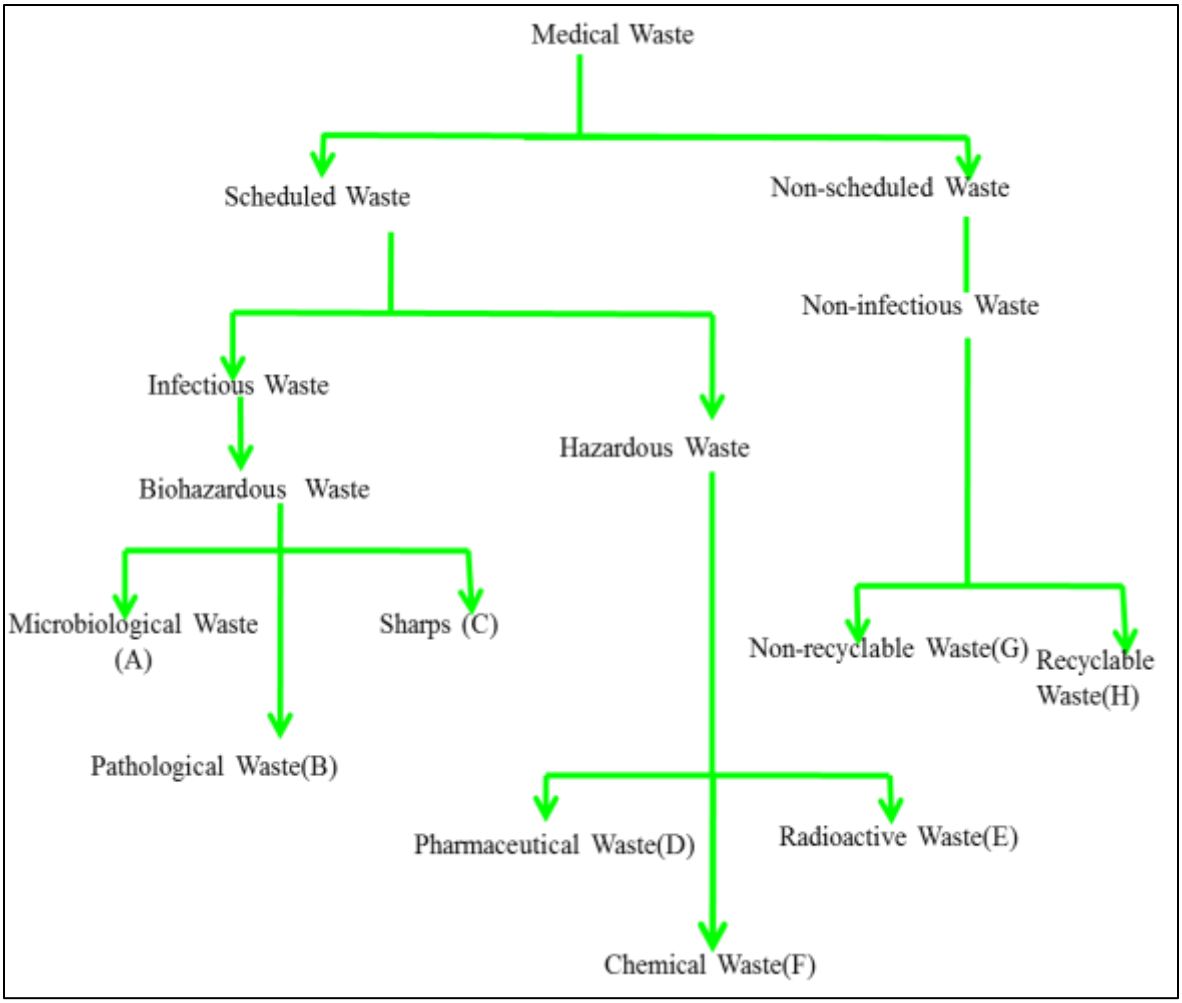

Figure 1: *Flow chart on classification of medical wastes*

4.2 Colour Coding for Effective Medical Waste Segregation

Surveys have showed that an appropriate method of identifying and segregating the waste is by sorting the waste into different colour code. However, there is no standard colour code to follow by all countries for the medical segregation. The element that is a deficiency in the existing colour coding system for the medical waste segregation is, unavailable of different containers for the subdivisions of medical waste. The subdivision of medical wastes is as followed: microbiological waste, pathological waste, sharps, pharmaceutical waste, chemical waste, radioactive waste, non-recyclable waste and recyclable waste. Therefore, different colour coding has to be assigned to different waste for effective segregation. Thus, suggested colour code that is recommended by WHO with few amendments is shown in Table 1. This has been originated from the Malaysian Ministry of Environment guidelines published by Department of

Environment, (Ministry of Natural Resources and Environment, Malaysia, 2009 and WHO, 2011). All the waste must be collected at the point of generation and all the containers must bear international symbols with appropriate wording. The containers should never be filled, nor filled above the full line indicated on the box.

Table 1: *Suggested colour code for different types of medical wastes*

Colour Coding	Medical Waste
Red	**Microbiological Waste**
Yellow	**Pathological Waste**
Blue	**Sharp Waste (in a leak-proof and puncture-resistant container)**
Brown	**Pharmaceutical Waste**
Orange	**Chemical Waste**
Silver	**Radioactive Waste**
Black	**Non-recyclable Waste**
Green	**Recyclable Waste**

5. Conclusion

This is also a challenge faced by medical staffs and of doctors to dispose properly according to the classification of medical wastes. To be familiar with the medical waste classification and colour coding is the key element for the following processes such as handling, transportation, storage and disposal safely. Medical waste can be very harmful to the public health and environment due to the reasons as shown below: (1) can spread diseases when contaminated with blood or body fluids from sick patients (2) needles or sharps can cause injury as well as disease spreading (3) chemicals are poisonous to water supplies, soil and air. Thus, proper handling of medical waste is in a need of an urgent attention and comprehensive action plan to protect the environment from the growing environmental problems. In order to achieve this, the medical waste segregation section need to be drastically changed and develop based on the comprehensive guidelines. Therefore, it is a critical initiative to develop comprehensive

guidelines based on the literature reviews and surveys on the other countries guidelines. Following the medical waste segregation, a standard colour coding system should be developed to facilitate the handling process without further complication among the medical staff. Other than this, a factor that requires an observation is recyclable waste that can minimise one third of the disposal cost. For that, more attention should be given on 3R procedure, which includes reduce, reuse and recycle the medical waste as much as possible under safety measure.

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