International Journal of Current Research and Review
DOI: http://dx.doi.org/10.31782/IJCRR.2022.141001

Review Article

IJCRR
Section: Healthcare
ISI Impact Factor (2021-22): 2.176
IC Value (2020): 91.47
SJIF (2020) = 7.893

Assessment of Knowledge, Attitude, Practice and Safe Disposal of Biomedical Waste: The Darker Side of Healthcare

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ABSTRACT

Medical waste operation is one of the numerous complex and demanding challenges facing humanity as the global population swells and the demand for medical services increase. Medical waste product in the developing world is rising quickly due to bettered access to medical services which allow ever lesser figures of admit modern medical care. Contradictory methods of waste measurement used by researchers leave these variations questionable. Objective of biomedical waste management (BMW) operation generally involves preventing diffusion of illness from patient to medical expert to forestall injury to the health care employee and staff in support services, whereas handling medicine waste, to forestall general exposure to the harmful effects of the cytotoxic, geotaxis and chemical drug waste generated in hospitals. The main objectives of this paper were to analyse the status of medical waste generation and treatment in recent years, and also address the discussion on waste risks and the impact on health and environment. The study indicates that greater training for healthcare personnel and standardising the categorization of medical waste streams are important steps toward more efficient waste management in hospitals.

Key Words: Biomedical waste management, Cytotoxic, Environment, Healthcare, Waste treatment, Geotaxis

INTRODUCTION

Medical waste operation is a global concern. All healthcare activities induce waste, which when inadequately managed can affect the environment, the community, domestic and wild animals. It's an issue of growing concern as the number of healthcare facilities is adding while population growing reduces space for waste disposal.[1] Medical waste is classified by the world health organization (WHO) as waste that generated in the diagnosis, treatment or immunization of mortal beings or creatures.[2]

The rapid population and industrialization have raised the quality of waste generation. Among wastes, medical waste has become a critical issue as they induce potential health problem and damage the terrain.[3] The problem of processing and utilizing wastes of various origins, including healthcare waste, is still very important.[4]

Pooroperation of health care waste is a potential risk to patients; healthcare workers and the general public as well as to the environment. A methodical review of 150 papers published since 2000 revealed that at least 50% of the world population is threatened by environmental, occupational and public health risks due to poor health care waste operation.[5]

Studies have reported that before the COVID-19 pandemic, over half of the world's was formerly at risk of threats from environmental pollution and public health due to unsafe disposal of health care waste. Also, unsafe disposal of medical waste in countries with economies in transition is also considered to be a severe cause of contagious conditions responsible for 0.4-1 million deaths each time.[6] Acceptable medical waste operation is therefore necessary to avoid environmental pollution as well as to reduce the aseptic risks associated to the transmission of contagious diseases.[7]

The operation of bio medical waste is still in its immaturity each over the world. There's a lot of confusion with the problems among the generators, operators, decision-makers and the general community about the safe operation of bio-medical waste because of lack of awareness. Hence resource material on the environment for hospital administrators, surgeons,

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ISSN: 2231-2196 (Print) **ISSN:** 0975-5241 (Online)

Received: 23.03.2022 **Revised:** 19.04.2022 **Accepted:** 02.05.2022 **Published:** 20.05.2022

doctors, nurses, paramedical staff and waste retrievers is the need of the hour.[8]

The objective of this article is to review the previous research conducted on biomedical waste management and to identify the key issues related to this topic. Firstly, the sources of medical waste in multiple jurisdictions around the world will be addressed. This will be followed by a discussion of bio-medical waste classifications, medical waste risks and impact on health and environment with specific focus on fundamental principles of waste management programs. Going forward, we will focus on schedule for bio-medical waste followed by alternate treatment possibilities and the need for reducing the quantity of non-infectious medical waste in the infectious medical waste stream. This review will guide researchers and other concerned authorities to identify the numerous issues in healthcare waste management and to find the best possible solutions to them.

MEDICAL WASTE DEFINITIONS

Medical waste also called health care or healthcare waste or biomedical waste refers to all the waste generated by healthcare conditioning and related sources, including hospitals, clinics, nursing homes for senior, animal exploration and testing laboratories, blood banks and collection services, and biomedical exploration centers and laboratories.[9]

Waste in general is any substance (solid, liquid or gas) that has no direct use and is discarded permanently. A waste is considered dangerous if it exhibits any of the characteristics similar as being flammable, reactive, explosive, sharp, radioactive, contagious, prickly, sensitizing or bio-accumulative.[10]

Medical Waste Generations

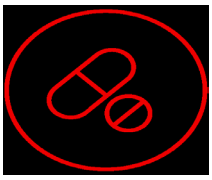
The amount of medical waste generated at different healthcare installations is of obvious interest, with numerous studies done on the subject. The volume and composition of medical waste generated is dependent on numerous factors, with a medical waste study focusing on Italian hospitals finding that the type of aseptic service offered greatly impacts the amount of contagious waste produced. The study found that as important as (52%) of overall infectious medical waste comes from patients, followed in descending order by logical laboratories (23%), surgeries (14%) dialyses (7%) and first (4%). An analogous study done in Taiwan found the dialysis unit to induce the topmost amount of contagious medical waste (23%), followed by the intensive care unit (17%), the emergency care unit and the outpatient clinic (12 each). In assessing medical waste generation, it's helpful to use a common base for quantification, so that from different regions can be compared.[11]

BIOMEDICAL WASTE CLASSIFICATION[12]

Table 1: Classification of biomedical waste management

Waste Type	Descriptions	Examples	Symbols
Infectious waste	Waste contaminated with blood and other bodily fluids. Culture and stocks of infectious agents from laboratory work or. Waste from patients with infection	e.g.: from discarded diagnostic samples, waste from autopsies and infected animals from laboratories swabs, bandages and disposable medical devices	
Pathological waste	Waste from human excreta or fluids and fetuses including body parts	e.g.: Blood, body fluids	
Sharps waste	Waste from sharp materials	e.g..: Needles, blades, broken glasses or plastics, syringes etc....	

Table 1: ***(Continued)***

Waste Type	Descriptions	Examples	Symbols
Chemical waste	Solvents and reagents used for laboratory preparation, disinfectants, sterilant and heavy metals contained in medical devices	e.g.: Mercury in broken thermometers	
Pharmace-utical Waste	Unused, expired pharmaceutical and containing used pharmaceuticals	e.g.: Bottles, boxes, vaccines, vials	
Cytotoxic waste	Waste containing substances with genotoxic properties	e.g.: Highly hazardous substances that are mutagenic, teratogenic or carcinogenic	
Heavy metals containing waste	Waste containing metals	e.g.: Batteries, broken thermometers, blood pressure gauges, and other equipment	

MEDICAL WASTE RISKS AND IMPACT ON HEALTH AND ENVIRONMENT

Health impacts of medical waste

Medical waste is considered as a source of impurity of land and water sources if not rendered harmless before it's buried in land or disposed in water. Poor medical waste operation causes environment pollution, unwelcome smell, typhoid, cholera, Aids, growth and addition of insects, rodents and hepatitis through injuries from sharps contaminated with blood.[13] There are potential risks to environment and health from indecorous running of solid waste, direct health risks concern substantially the workers who need to be protected far as possible from the direct contact with various toxic and hazardous waste, uncontrolled and dangerous waste generating from various industries are mixing up with external untreated waste and produce high potential risks to human health.[14] UNEPA stated that wastes aren't managed duly especially solid waste from homes and the community are a serious health hazard and lead to the spread of contagious condition.[15](Figure 1)

Persons at risk

The main groups at risk are following:

- Medical doctors, nurses, health care auxiliaries, and hospital maintenance personnel;
- Patients in health care establishments or entering home care establishment;
- Workers in support services confederated to health care establishment, similar as laundries, waste handling and transportation;
- Workers In waste disposal installations (similar as landfills or incineration), including scavengers.[16]

All persons exposed to dangerous hospital waste are potentially at risk which includes all those who either handle the waste at any stage or are exposed to it as a consequence of careless operation.[17]

Hazards from infectious waste and sharps

Through blood borne virus (BBV) transmission is the foremost risks; the literature records a substantial list of pathogens causing infection following accidental exposure to blood and body fluids. Sharps or needle stick injury, a cut or perforation wound performing in penetration the skin by a hypodermic needle, surgical blade, scrap of glass or metal or other sharp item including rigid plastic, is the primary hazard for those working with health care wastes.[18]

Hazards from chemical and pharmaceutical waste

The long-term experience of lower concentration of complex pharmaceutical fusions on stream biota may affect in acute

and chronic damages, behavioral changes and accumulation in tissues, reproductive damage and inhibition of cell proliferation. Several studies have demonstrated that fish exposed to trace situations of birth control pharmaceuticals in the range of concentration found in the environment should dramatically decreases in reproductive success, suggesting population position impact are possible.[19]

Expired drug does not pose a serious trouble to other living being but indecorous disposal maybe dangerous if it leads to impurity of water interiors or original sources used by near communities or wildlife. These wastes appear from medicine products generated during manufacturing and also through several other route like health care installation e.g., methanol, methylene chloride, xylene, acetone, toluene. Other common ones include acutely toxic metals and compounds like Arsenic and Cyanide. They're excreted or introduced into the environment by pharmaceutical companies, from domestic sewage, through agricultural activities, leaching and metabolized oral medicinal excreted through urine or excreta. Common example includes pharmaceutical products similar as medicine, antibiotics, hormones, vaccine, steroids and oncogenic substances.[20]Most of the expired pharmaceuticals are less efficient and veritably many of them may develop a different adverse medicine response profile. Pharmaceuticals and personal care product have been found as pollutant in water and the environment.[21]

Hazards from Genotoxic waste

Exposure to genotoxic substances in healthcare may also during the medication of or treatment with particular medicines or chemicals. The main pathway of exposure are inhalation of dust or aerosols, immersion through the skin, ingestion of food accidentally pollutant with cytotoxic medicines, chemicals or wastes, and ingestion as a result of bad practice, similar as mouth pipetting. Exposure may also do through contact with body fluids and secretion of patients undergoing chemotherapy.[22]

Hazards from Radioactive

- Radiation from alpha particles loses energy veritably snappily when passing through matter as result. Alpha particles travel only a few inches in air and can easily be stopped by the outer layer of human skin. But they're dangerous to humans if they're ingested and can damage body organs specially the lungs.
- Beta radiation trip further as compared to alpha radiation. These can access several layers of humans' skin. The human body can be damaged by exposure to a source of beta radiation or by ingesting it.
- Gamma radiation has a much lower wavelength and can thus access much deeper. It can pass fully through the humans' body damaging cells or can be absorbed by tissue and bones. Damage to humans' health is thus much larger.[23]

Environment risk

Healthcare waste also contaminates the environment with biodegradable (these are the wastes that come from our kitchen and include food remains, garden waste; these also known as moist waste and non-biodegradable waste (these are the waste which includes: newspaper, plastic, broken glass, pieces. known as dry waste).

The treatment of healthcare wastes with chemical detergents results in the release of chemical substances into the environment if those substances aren't handled stored and disposed in an environment sound manner. The dumping of healthcare waste in an unbridled manner in public areas can pollute soil, air water and have an indirect effect on health of living organisms in surrounding areas.[24]

The following are the main environmental enterprises with respect to indecorous disposal of bio-medical waste operation

- Spread of infection and diseases through vectors (fly, mosquitos, insects) which affect the in house as well as girding population
- Spread of infection through contact (injury among medical) non-medical held and sweepers rag selectors, especially from sharps (needles, blades.)
- Spread to infection through unauthorized recycling of disposable particulars similar as hypodermic needles, tubes, blades, bottles. response due to use of discarded drugs

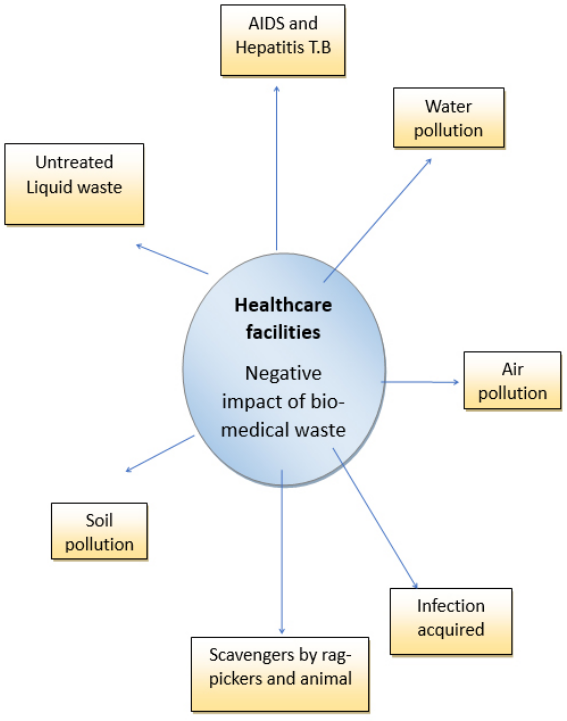


Figure 1: Negative impact of improper Bio-medical waste management system.

FUNDAMENTAL PRINCIPLES OF A WASTE MANAGEMENT PROGRAMME

Healthcare facilities are primarily responsible for management of the healthcare waste generated within the facilities, including activities undertaken by them in the community. The health facilities, while generating the waste are responsible for segregation, collection, in-house transportation, pre-treatment of waste and storage of waste, before such waste is collected by Common Waste Treatment Facility Operator (CWTFO). Thus the technical requirements of waste handling are needed to be understood and practiced by each category of the staff.

Steps of Biomedical Waste Management:

The management of biomedical waste at health care facilities can be summarized in the following seven steps. First six steps are the responsibility of Health Care Facility (HCF). While the last step has the responsibility of Common Biomedical Waste Treatment Facility (CBMWTF) (Figure 2.)

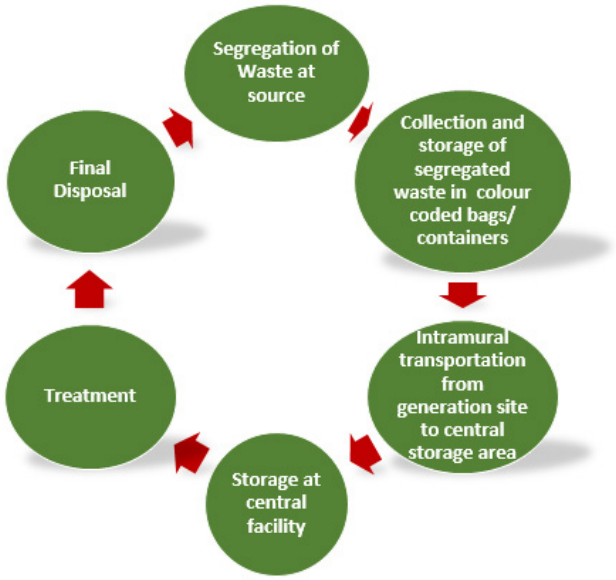


Figure 2: Steps of Bio-medical waste management. (Source: Central Pollution Control Board)

a. Biomedical waste should be segregated in accordance with Schedule 1 at the point of generation in designated colour coded bags or containers.
b. Waste must be segregated at the point of generation of source and not in later stages.
c. Adequate number of colour coded containers and bags must be provided with proper label as per Bio-medical waste management rule 2016.
d. Biomedical waste and general waste should not be mixed.
e. No secondary handling or pilferage of waste shall be done at healthcare facility.
f. Only laboratory or highly infectious waste shall be pretreated onsite before sending for final treatment or disposal through a CBMWTF.
g. All bags or container containing segregated bio-medical waste shall be labeled (including bar code) before such waste goes for final disposal through a CBMWTF.

Assigning Responsibilities

The proper operation of medical waste depends on good association sufficient funding and the active participation of informed and trained help. These are the preconditions for the harmonious operation of measures throughout the waste chain (from where it is generated to where it's ultimately disposed off.[25]

Duties of the hospital project manager

- Setting up a working group in charge of drafting the waste operation plan;
- Appointing the original waste director, who'll supervise and coordinate the waste operation plan on a daily basis;
- Assigning duties, drawing up job descriptions;
- Allocating financial and human resources;
- Enforcing the waste disposal plan;
- Conducting audits and continuously streamlining and perfecting the waste operation system.[26]

Duties of nursing in charge of ward

- Icing good waste isolation practices;
- Maintaining hygiene and good nursing practices in the ward;
- Monitoring septic ways similar as hand washing and insulation practices;
- Reporting any case of infection development incontinently to the concerned;
- Limiting patient exposure to infections from visitors, hospital staff or other patient or equipment used for diagnosis.

Duties of Head of hospital

- Forming a waste management team to develop a written waste management plan for the hospital;
- The plan should easily define the duties and liabilities of all members of staff, both clinical and non-clinical in respect of the running of health care waste and establish lines of responsibility;[27]
- Designating a waste management officer (WMO) to supervise and coordinate the waste operation plan;
- The head of hospital retains overall responsibility for icing that healthcare and other wastes are disposed of in agreement with public guidelines;
- Keeping the operation plan up to date;
- Allocating sufficient financial and personnel resources to ensure effective operation of the waste management plan;[28]

BIOMEDICAL WASTE MANAGEMENT RULES (SCHEDULES)[29]

Safe disposal of biomedical waste is now a legal demand. The biomedical waste management and handling rules, 1998 came into force on 1998. In agreement with these rules, it is the duty of every "occupier" i.e. a person who has the control over the institution or its premises, to take all way to ensure that waste generated is handled without any adverse effect to human health and environment. It consists of six schedules:

Schedule	1998	2016
Schedule I	Categories of waste	Color code and type of waste with treatment and disposal
Schedule II	Color/code type of waste, waste category, treatment option	Standard for treatment of disposal of BMW (Autoclaving/Microwaving/deep burial/dry heat sterilization/chemical disinfection)
Schedule III	Label of BMW category/bags	List of prescribed authorities and their duties
Schedule IV	Label for transport of BMW	Part A – label for container/bag Part B – label for transportation of BMW bag/container
Schedule V	Standard for treatment and disposal of BMW	Added to schedule II
Schedule VI	List of prescribed authorities and their duties	Added to schedule III

HANDLING, STORAGE AND TRANSPORTATION OF HEALTHCARE WASTE

Waste Segregation

Isolation of waste is one of the most crucial phases of waste operation. Proper segregation of HCW at (or near) to the point of production is one of the most essential factors in safe, sustainable waste management. According to the standard original rules of these developing countries, healthcare waste is supposed to be contained in color codes and labelled bags or containers. These issues are substantially caused by the lack of finances, awareness, ignorance of handling staff and somewhat owing to lack of maintaining records.[30](Figure 3).

Figure 3: Segregation of biomedical waste in colour coded bags.

ON SITE COLLECTION, TRANSPORT AND STORAGE OF WASTE

Collection

Waste collection to be done by aseptic staff on daily base, and transferred to central waste storehouse, facility of the institute. Medical waste collection practices should be designed to achieve an effective movement of waste from points of generation to storehouse or treatment while minimizing the risk to personnel. The waste collected should be weight ever time to know whether waste collected is equal to the waste dispose in final disposal.[31](Figure 4)

Figure 4: Collection of medical waste.

Storage and accumulation of medical waste

Waste accumulation and storage is generally done near the point of its origin or the place where these wastes are to be treated and disposed. Though accumulation refers to the temporary holding of small amounts of waste near the point of generation, storage of waste is distributed by longer holding periods and large waste amount. Storage areas are generally located closed to where the waste is treated. Any offsite holding of waste is also considered storage.[32]

Transportation

The waste should be transported for treatment either in trolleys or in covered wheelbarrow. Manual loading should be avoided as far as possible. The bags or container containing biomedical wastes should be together before the transportation. Ahead of transporting the containing biomedical waste, it's supposed to be accompanied with an inked composition by Nurse or Doctor mentioning appointment, shift, measure and target. Especially vehicles must be used to avoid access to and direct contact with the waste by the transportation drivers, the scavengers and the public.[33]

TREATMENT AND DISPOSAL OF MEDICAL WASTE

The purpose of medical waste treatment is to reduce or exclude the waste risks. The are several treatment methods that can achieve the goals of this process.[34]

Disposal

The ultimate goal of waste treatment is to turn the waste into harmless material through reducing its volume, infection risk, and the disposal organic compounds. Waste disposal is an essential part of waste operation and developed countries around the world have been observed to use different styles for waste disposal, some of which are veritably high tech and expensive. Experimenters from different part of the world are continually working on discovering new and more effective ways of waste treatment as it is directly related to the issue of environmental protection.[35]

Incineration

Incineration is the process of destructing waste by burning it at elevated temperatures in furnaces. The process removes dangerous materials, reduces the mass and volume of the waste and converts it into ash that's harmless. It is a high heat treatment technology used to convert waste materials in a noncombustible residue (ash) and exhaust gases.[36] Incineration is suitable for pathological and contagious waste or sharp wastes. Incineration has a significant advantage of decreasing the volume of the waste; still its disadvantages include high costs, smoke generation and pollution risks.[37]

Another advantage of incineration is that it can be operated in any weather, faults or other disadvantages of incinerators are its expensive to build, maintain and operate. High energy is needed for the process and also requires skilled personnel and continuous maintenance.[38]

Autoclaving

Autoclave it's a low heat process, which uses steam or hot water and specific pressure to disinfect the hospital waste. Autoclave is effective for disinfecting sharps, blood contaminated entities, bandages, gowns, gauzes, non-clinical material and the suchlike. For the hospital waste that's meant to be disposed of, autoclaving is done to clean the material of bacteria before landfilling.[39]

Microwave radiation

Microwave treatment or microwaving of medical wastes is basically a steam based detergent process whereby moist heat and steam generated by microwave energy sterilize wastes and destroy contagious agents and pathogenic organisms present in the waste steam. The types of waste generally treated in microwave systems are equal to those operated in autoclaves. Microwave technology has certain benefits; similar as the absence of dangerous air emissions, no demand of chemicals, and reduced volume of waste. Still, the investment costs are high presently.[40]

Chemical disinfectant

Chemical disinfection is the favored treatment for liquid contagious waste. Consider the following: type of microorganism, degree of impurity, amount of proteinaceous material present, and type of detergent, contact time, other applicable factors similar as temperature, pH, mixing requirements and the biology of the microorganism. ultimate disposal of chemically treated waste should be in agreement with state and local requirements.[41] Chemical disinfection, similar as through the use of chlorine compounds, has been extensively used to exclude the microorganism in medical waste, as well as oxidizing dangerous chemical constituents. Another example of chemical disinfectant compound is ethylene oxide treatment, which is used to disinfect materials and occasionally to treatment of medical waste.[42]

Sorting

The ideal of sorting is to separate the pharmaceuticals into orders that require different disposal styles. The applicable safe disposal system recommended on the pharmaceutical dosage form of the drugs. Insulated temporary storage areas or receptacles must be provided for each sorted order.

The sorting process includes:

- Identifying each item;
- Making a decision on whether it is usable;
- If usable, leaving packaging complete;

- If not usable, making a judgment on the optimal system of disposal and sorting;
- Leaving package and boxes complete until reaching their location, prior to definitive disposal or transport to an institution for use.[43]

DISCUSSION AND CONCLUSION

In safe and complete operation of waste is not only a legal specification, but also a social liability. Lack of nervousness, stimulation, reaction and cost factor are some of the problems faced in the proper hospital waste operation. Easily there's a need for education as to the hazards associated with indecorous waste disposal. Need of unresponsiveness to the conception of waste operation is a major confuse to the practice of waste disposal. Suitable anthology and isolation of biomedical waste are important. At the same time, the volume of waste generated is equally important. A lower amount of biomedical waste means a less significant burden on waste disposal work, cost saving and a more effective waste disposal system. Hence, health care providers should always try to reduce the waste generation in day-to-day work in the clinic or at the hospital. If we want to cover our environment and health of community, we must sensitize ourselves to this important issue not only in the interest of health managers but also in the interest of community. With increasing population, biomedical waste is also growing in volume. Thus, proper supervision and treatment of biomedical wastes is a high concern. To minimize the problem of biomedical waste, it becomes crucial to follow preventive measures and avoid any dangerous consequences to the nature.

ACKNOWLEDGMENT

The authors are thankful to Lovely professional university for providing the resources for completion of this work.

SOURCE OF FUNDING:

There is no funding from any agency for this work.

AUTHOR CONTRIBUTIONS

All of authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; MOM, GS and UBN took part in drafting the article or revising it critically for important intellectual content; RP agreed to submit to the current journal; MKS gave final approval of the version to be published.

CONFLICTS OF INTEREST

None

ETHICAL APPROVALS

Not applicable

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