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OUR PLANET'S HEALTH IS OUR WEALTH: SUSTAINABLE HEALTH CARE SOLUTIONS FOR BUILDING A GREEN HOSPITAL FROM THE INDIAN PERSPECTIVE

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ABSTRACT

Notwithstanding the directly proportional relationship between human health and the state of the environment, it is ironic that hospitals are one of the largest consumers of natural resources and among the deadliest generators of waste.

We aim to identify the major causes of pollution and to devise a new system to counter this adversity. While laws in India focus on the issue of biomedical waste management, we shall attempt to build a "green hospital" in light of all three phases of the system, namely production, service and output management. A shift towards renewable sources of energy and modifications in the structural design of the hospital, administrative functions and waste disposal methods, among others, will substantially contribute to the reduction of the hospital's collective environmental footprint. Concerted efforts to adopt this model will thereby alleviate the burden on public health.

Key Words: Green Hospital, Renewable resources, Waste Management, Green Procurement

INTRODUCTION

With a population of over 1.3 billion people and a rapidly growing annual expansion of 7.5%, India ought to embrace the concept of development through the lens of environmental, economic and social sustainability. In this paper, we shall focus on the development of the health care sector in India and shall endeavour to build a model of a Green Hospital to address the issues caused by the present system, while recommending solutions for uniform healthcare throughout the nation.

India has confined its environmental legislations in the health care sector to the management of biomedical waste. However, the operation of health care facilities 24/7 for 365 days a year and the use of high-energy goods and services have turned these facilities into ozone depletion epicentres. The seriousness of the problem posed by the health care industry does not receive adequate recognition on account of the notion that healthcare is of primary concern and thus cannot be compromised, even in the light of adverse environmental impact. On the contrary, it is the lack of adequate regulation and the emission of large quantities of pollutants that cause harm to human health.

For identifying and addressing the major issues associated with health care set-ups, this paper divides the functioning of a healthcare set-up into three distinct phases. Phase 1 deals with the management of input resources, including the architecture of the hospital and the energy and water requirements of the facility. Phase 2 highlights changes that can be made in the daily operations of the hospital to improve efficiency while minimising the waste generated. Finally, phase 3 deals with the issue of output management, since waste generated by healthcare activities can be hazardous or toxic, carrying different types of diseases which can infect the major stakeholders in any healthcare set-up. This stage of the paper looks to

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identify some of the legislation in force and to analyse its implementation to provide sustainable solutions. Building a model for a green hospital will thus contribute positively towards the need to mitigate the pollution of healthcare set-ups, and will also look at sustainable solutions whereby the environment can be protected without compromising on healthcare.

PHASE 1

In the primary phase of the healthcare system, the focus is on the structural components, which includes architecture, the management of input resources and the ancillary facilities integral to its functioning.

Architecture

It must be highlighted at the outset that the structural design of the facility is crucial in not only reducing the carbon footprint of the hospital but also in aiding the recovery of patients. Studies (Ulrich, 1984) support the theory that biophilia, which aims to create strong connections between nature and man-made environments, could influence a patient's emotional state and might accordingly affect recovery. Healthcare design must therefore facilitate maximum sunlight and adequate greenery to incorporate the features of a natural environment. Modern hospitals increasingly make use of electrochromic glass that allows hospitals to program the windows to tint on demand or follow the path of the sun, thereby increasing access to natural light while simultaneously regulating the amount of heat transmitted into the building. The double-glazed glass windows on the north façade and the glazed glass roofs of the CII Sohrabji Godrej Green Business Centre, Hyberabad, allow 90% of spaces to have daylight access and views to the outside with no artificial lights being used till late in the evening.

The Rush University Medical Centre in Chicago, Illinois is a fine illustration of this theory. The unique four-pointed star design maximises the exterior wall surface area, allowing more daylight into each patient room. This structure is placed on a six-story rectangular base building that provides flexibility for future changes, mitigating the detrimental impact of expansion on the environment.

In a developing country like India, however, where nearly 70% of the population (Ministry of Home Affairs, 2011) resides in rural areas, it is vital to recommend low cost solutions. Taking inspiration from traditional architecture, *jaali* windows or perforated stonewalls can be built, as opposed to window spaces, as this enables the diffusion of direct sunlight and the free circulation of air. Proper usage of shutter windows or the construction of cupolas atop small-scale facilities are other techniques to improve air circulation.

Energy

Research shows that health facilities in high- and middle-income countries are among the largest commercial consumers of energy (Franco et al., 2017). In India, while privately run hospitals face the issue of exceedingly high utilisation of electricity, hospitals in the rural sectors have to deal with the complication of inadequate energy supply, which compromises the health of its people. Both these predicaments can be rectified by making the shift towards renewable energy based on the climate of the region. Depending on requirements, hospitals can instal solar panels on the roof to source the energy for various functions, including the operation of medical equipment and the heating of water. Accounting for the high capital cost of solar panels, hospitals in close proximity can also co-invest in energy projects (Cohen, 2016).

Apart from solar energy, reliance can also be placed on wind, and 65% of power from India's renewable sources comes from wind energy (Ministry of Mines, 2013). The viability

of this is attested by the case of the Kohinoor Hospital, Mumbai, which procures 90% of its energy from a windmill installed offsite.

Purchasing hydropower is another viable solution, as India is the 7th largest producer of hydroelectric power, boasting more than 5000 large dams in the country (Banerjee, 2015). Interestingly, in 2016 the Minister of Power stated that India had a surplus of hydropower (Ministry of Power, 2016), so it is time to utilise these resources optimally. It is pertinent to mention that all three forms of renewable energy discussed are currently cheaper than brown energy (Lazard).

For rural healthcare facilities, biomass energy holds strong potential, with about 200 tons of agricultural waste going unused in India (Ministry of Mines, 2013). Additionally, they can also resort to using small photovoltaic (PV) solar systems (alone or in tandem with a fuel-based generator) to power a range of low and medium-power devices efficiently, including refrigerators, small laboratory devices, water pumps and small medical devices.

Energy conservation can be further helped by enhancing greenery, as this reduces the environmental heat stress and in turn the need for air conditioners. A 10% increase in vegetation can reduce the urban heat-island effect by an average of 0.6ºC (Steeneveld, 2011). Incorporating traditional architecture, such as courtyards, would not only reduce the need for artificial lighting but would also improve cross-ventilation (Wu, 2011). The building materials also play a crucial role in alleviating the issue of entrapment of heat. Material such as slag cement, a by-product of the steel industry with an SRI of about 71 (Marceau and VanGeem, 2007); rubber or linoleum flooring, both natural products (Environmental Protection Agency, 2007); and investment in low VOC (volatile organic compounds) anti-bacterial paints are some of the changes that can be considered while constructing a green hospital. Aside from these structural initiatives, energy can be greatly conserved through the idea of green procurement, which will be discussed in detail in the following section.

Water

The climate in India is either tropical wet and dry or humid sub-tropical, where rainfall is unreliable and restricted to a few months in the year. In meeting the requirements for about 500–700 litres of potable water per bed day (Sood, 2016), therefore, it is integral to make optimum use of this limited supply of rainwater by the construction of recharge wells and rooftop harvesting channels. This technique was observed to be effective to recharge the ground water level, as illustrated by the project undertaken by the Marriot Welcome Hotel, Delhi, where at the relatively low cost of Rs 1.5 *lakh*, the building was able to harness a staggering amount of over 8.3 *lakh* litres of water in the semi-arid capital of India.

In addition to regulating the amount of water used for irrigation, ensuring regular maintenance of the plumbing facilities and the reuse of recycled grey water in the cooling towers. Installing sensor and automatic taps not only improves the sanitary level of the premises, but also helps the conservation of water, as these faucets are usually designed with low flow rates. The mechanism for the recycling of grey water and its further use will be explained in detail in the following sections.

Transportation

India's foremost healthcare facility, the All India Institute of Medical Sciences (AIIMS), witnesses an astonishing inflow of over 10,000 patients on a daily basis (Dhaor, 2015). This is merely one of the many examples to substantiate how hospitals have become an epicentre for congestion and traffic, with the high concentration of carbon emissions and the accessibility of transportation becoming a barrier for patients' health. Healthcare facilities must also regulate the vehicles entering their premises and prohibit vehicles running on high pollution fuels barring patients requiring emergency care.

While public transportation amenities do exist, only 20% of patients opt to use these routes (Sankar et al., 2015), as sick and disabled persons find it cumbersome to travel in crowded, confined modes of transportation. Providing for comfortable, adequately spaced, clean energy-fuelled bus shuttles that can transport these patients will minimise the inflow of private vehicles.

As a more long-term solution to decentralise the vehicular pollution near hospitals, the management can also employ alternate means of transport such as cable cars. These traditional systems, once only considered to be used for the purpose of tourism, are coming up as viable solutions for urban mass transit, as it not only offers little environmental disturbance in its construction and operation but is also significantly cheaper than other modes in terms of capital and maintenance cost (Kumar, 2016). Hospitals must thus constantly strive to adopt a greener infrastructure while not compromising on the health of the patient.

PHASE 2

Green Procurement

Round-the-clock operation has turned the healthcare sector into a major hotspot for greenhouse emissions. While patient care is a priority, initiatives in the administration of hospitals can be taken to effectively reduce its carbon footprint.

Hospitals must implement a green procurement policy comprehensively entailing all criteria required to be complied with prior to purchasing, such that the products and services acquired have minimal impact on the environment. This should include green air conditioning systems that are either five-star rated by the Bureau of Energy Efficiency (BEE), or inverter technology ACs that self-regulate depending on the temperature of the incoming air and the level set by the thermostat. Both systems not only save energy costs but also use natural refrigerants like R290 that have zero ozone depletion potential and minimal global warming potential. As an added incentive, the capital cost of these systems has been substantially reduced with the implementation of the EESL five-star AC Scheme, 2017 whereby Energy Efficiency Services Ltd. (EESL), a joint venture company of PSUs of Ministry of Power and the Government of India, sells “super-efficient” ACs to institutional buyers like hospitals at a subsidised rate (Dutta, 2017).

Hospitals must also opt to collaborate with sellers who embody the principle of Extended Producer Responsibility (EPR), as conceptualised under the E-Waste Management and Handling Rules 2011, whereby the responsibility of the manufacturer extends not only to the aspect of production but also with regard to the management at the post-consumer stage. EPR is usually illustrated through the incorporation of take-back provisions within the purchase agreement, where the manufacturer subsequently recycles the end product. Companies that practice Green Supply Chain Management through methods such as sustainable sourcing, pull-back of unused products and remanufacturing processes, among others, must be prioritised in the tendering process (Liu and Chang, 2017).

Other suggestions include the purchase of occupancy sensing lights and LED lights as opposed to traditional fluorescent and incandescent lights, reducing product packaging, switching to safer cleaning products, and purchasing products that are free of latex, polyvinyl chloride, and diethylhexylphthalate (Kwakye, Brat and Makary, 2011).

Another aspect of product management is the issue of reprocessing single-use devices (SUDs). While a few countries like the US, Australia and Saudi Arabia have legalised and regulated this process, India continues to practice the reprocessing of SUDs without a legislative framework in place (Costa, 2016). The framework adopted by the US’s Food and Drug Administration (FDA) has carefully categorised the products based on the risk of harm

to the patients, and subjects each reprocessing manufacturer to the submission of an application for pre-market approval (Food and Drug Administration, 2011). Validation data includes cleaning, sterilisation, and functional performance data, which confirms that each SUD will remain substantially equivalent to a predicate device after the maximum number of times the device is reprocessed (Noble, 2013). Reprocessed SUDs are not only 50% cheaper, but also have a lower adverse impact on the environment. India ought also to have a uniform regulatory framework in place for the reprocessing of SUDs.

Inventory Management

Hospitals must adopt an effective inventory management system through centralised purchasing and storage control to secure investments and reduce the waste generated. The system must track the course of purchased drugs, starting from the date of manufacture to the date of expiry. A clear idea of the life period of each product will enable the pharmacist to rotate the stock such that the earliest labelled stock is utilised first, following the principle of "first in, first out". This mechanism will not only help avoid incidents involving the administration of expired products, but will also assist the purchaser in making more informed decisions based on the actual consumption of the product. The purchaser will be able to efficiently rely on the "Just in time" policy, where he waits to order materials until they have almost run out, thus preventing overstocking and wastage.

Medical Records

With over 88% of the households in India having a mobile phone (Bhattacharya, 2017), it is imperative to ask why healthcare facilities still rely on traditional paper based data recording. Consistent with Prime Minister Narendra Modi's Digital India initiative, all hospitals must endeavour to make the shift towards the adoption of electronic health records, which will include all information beginning from the patient's basic health record and diagnosis history to the doctor's prescription and the data relied on for such a clinical decision (Sharma and Aggarwal, 2016). Drug prescriptions can be sent to the patient via SMS to save costs on the purchase of paper and simultaneously minimise the waste generated by hospitals. It is pertinent to mention that the information system becomes more efficient once it is electronic, as it eases the process of quick searches for diagnostic history based consultations. However, if certain operations mandate the requirement of hardcopies, then it is recommended that hospitals invest in chlorine-free paper made of more sustainable substances like hemp or bamboo.

The Role of Healthcare Professionals

Doctors can serve as a powerful voice for public awareness in transforming information and research into common knowledge. People instinctively take the opinion of doctors with an added seriousness, as doctors are pioneers for health. It is therefore important to involve health professionals in the battle against climate change through collaboration with environmental groups, local governments, NGOs and other community organisations, which educate people about the reality of a dying planet and its impact on human health. An illustration of this may be seen in the women's health department. With an estimated potential of 9000 tonnes of sanitary waste (from 432 million pads) generated annually (Clean India Journal, 2016), gynaecologists can advise their patients to opt for the alternative of silicone menstrual cups, which are more environment friendly, thus reducing the hazardous chemicals utilised in the production of sanitary napkins and minimising the quantity of waste generated.

Furthermore, healthcare professionals can also interact and work closely with experts from the engineering field to devise new or alternate medical technologies that have a lesser adverse impact on the environment.

PHASE 3

For a successful working model of a Green Hospital, output management including the generation, segregation, storage, transport and treatment of waste must be efficiently addressed. WHO classifies healthcare waste into eight distinct categories: general, pathological, radioactive, chemical, infectious, sharps, pharmaceuticals and pressurised containers. Although nearly 75%–90% of healthcare waste is general waste, the concern actually relates to a small portion which comprises the other seven categories, as there is a lack of effective legislation being implemented or of solutions to tackle this output effectively.

The Indian Perspective

The impact of healthcare waste was first recognised in the late 90s through the introduction of the Biomedical (Management and Handling) Rules 1998, which acted as the legislative tool and guide for output management in the healthcare sector (World Bank, 2012). According to the Rules, biomedical waste refers to any waste generated during the diagnosis, treatment or immunisation of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps (India, 2016). These Rules prescribe that every occupier must take all necessary steps to ensure that waste is (i) handled in a manner not causing any adverse effect to human health and environment, (ii) segregated in containers at point of generation, and (iii) handled and disposed of in accordance with prescribed environmental standards. All covered institutions are mandated to either set up treatment facilities like incinerators, autoclaves or microwave systems, or to ensure that all biomedical waste is treated at a common waste treatment facility.

While the Rules permit the incineration of waste without any specified penalties, the 2016 Amendment addresses the plan to phase out the use of chlorinated plastic bags, gloves and blood bags within two years. Pre-treatment of laboratory waste, microbiological waste and blood samples and blood bags through disinfection or sterilisation on-site in the manner prescribed by WHO.

Awareness and Practices

A study conducted in the State of Jammu and Kashmir concluded that average solid waste generated per bed per day was 632.04g, and that even though nearly 61.28 g was biodegradable, the waste was disposed collectively without any segregation (Choudhary and Slathia, 2014). With nearly 85% of primary, 60% of secondary and 54% of tertiary healthcare institutions falling under the Red category of INCLEN (INCLEN Programme Evaluation Network [IPEN] Study Group, 2014), and almost 55% of hospital employees being completely unaware of adequate collection and disposal mechanisms (60% of them did not consider it a major issue), there is a need to tackle output management immediately and raise the awareness of the healthcare professionals (Acharya, Gokhale and Joshi, 2014).

Output Management

As discussed above, the output generated by the healthcare sector can be broadly classified into general waste and biomedical waste.

Biomedical Waste

Categorisation into Internal practices and External practices is necessary for the effective and systematic management of waste. The major internal practices that need to be looked at include Segregation, Storage and Transportation.

The most basic form of segregation is the separation into hazardous and non-hazardous wastes, based on a colour coding system prescribed under the Biomedical Rules 2016. However, colour coding based on highly infectious wastes, other infectious waste, pathological and anatomical waste, sharps, chemical and pharmaceutical waste, radioactive

wastes and general healthcare waste as recommended by WHO continues to be the most effective mechanism. Investment in central storage areas for large hospitals and separate storage areas for infectious, pharmaceutical, chemical and radioactive waste must be made. Even though the Biomedical Rules require facilities to have adequate interim storage areas, the lack of enforcement of penalties has made this provision ineffective (Facility Guidelines Institute, 2010).

Lastly, with regard to the transportation of these wastes, the staff involved must be adequately trained and aware of all hazards, there should be proper labelling indicating the transportation of biomedical waste, and designated safe routes must be devised prior to commencing transportation (United Nations, 2009).

Sustainable Disposal and Treatment Mechanisms

Even though incineration is the easiest and the most widely practiced treatment mechanism, it is not a sustainable solution as it creates a threat to the general public through the emission of mercury and other heavy metals, dioxins and furans by the combustion of plastics such as PVC. The ash generated from incineration is also tainted with heavy metals and other toxic residues. Since the Biomedical Rules have no provisions to prevent the use of incinerators, we must recommend alternatives for a green hospital.

A steam-based treatment called Autoclaving, which has already been used for sterilising medical equipment, is a very effective solution capable of treating infectious waste, sharps, isolation and surgery waste, blood-contaminated materials, etc. with minimal adverse impact on the environment.

Another effective and sustainable technology, microwaving, kills infectious agents through heat and pressure. This has also been prescribed in the Biomedical Waste Management Rules, but the cost associated with implementing this solution is extremely high and it may not be possible to implement it in the public healthcare sector. However, other ancillary solutions of shredding and chemical disinfectants can be used internally by healthcare set-ups.

The Rules provide for the disposal of treated waste through burial pits constructed on the premises. These healthcare pits can be an effective solution when there are only small amounts of waste, but issues arise when hospitals generate larger quantities and there is a lack of land to dispose of the output. Land disposal is usually done in two distinct ways: uncontrolled and controlled disposal. Uncontrolled disposal without any segregation can cause various hazards to human health and the environment. Controlled landfilling systems are to be adopted, whereby a systematic segregation and burial mechanism of waste can be created.

Water Treatment

Wastewater is usually treated externally by the municipal sewage treatment. Larger healthcare set-ups can treat water on site in three stages. The primary stage includes filtering the water to remove large objects; the second stage removes carbon and nitrogen components dissolved in water by microbial digestion; and the last stage is the polishing stage, whereby the water is made ready to be discharged into the environment. The cost associated with this three-tier process is a major hindrance, but new technologies such as disinfectants and membrane biological reactors are reducing the cost associated with this to make it a sustainable solution.

Phase 3 of the green hospital model must include an awareness drive to educate all the stakeholders of this industry regarding the need for sustainable practices of medical waste and methods that can be adopted to reduce generated waste. A focus on segregating waste and adequate investment in environmentally sustainable technologies are also crucial to the effectiveness of this model.

RECOMMENDATIONS

A system through which most of these sustainable solutions can be implemented effectively can result in a substantial difference in the carbon footprint left by any healthcare set-up. Collaboration between the government and private players to create a level of awareness among the people in general would contribute immensely towards better sanitation and human health and would provide a protected environment to live in. Judicial use of all input-related resources and sustainable management of output in a healthcare set-up through the methods highlighted above would ensure better living conditions for all environment stakeholders without compromising on the services provided to patients.

CONCLUSION

With the reality of climate change becoming clearer every day, it is time to mobilise and form a united front for sustainable development. The Indian health sector can start by pledging to pursue initiatives like the 2020 Healthcare Climate Challenge, launched at COP21 Paris, with the aim of creating green and healthy hospitals. It is the duty of all the people of a country, including the government, to bring about sustainable solutions devoted to maintaining the health of our planet by in no way compromising the quality of services provided to its citizens.

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