RISING LEVEL OF HOSPITAL CONSUMPTION AND THE ENVIRONMENT: NEW MAZLOUM HOSPITAL INITIATIVES

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RISEING LEVEL OF HOSPITAL CONSUMPTION AND THE ENVIRONMENT: NEW MAZLOUM HOSPITAL INITIATIVES

Abstract

Nowadays, an acute environmental crisis is leading to an increasing number of health crises worldwide. The healthcare sector itself contributes to this crisis through the waste it produces and the energy it consumes. To address this growing problem, several strategies are being developed that attempt to move away from polluting methods of waste disposal such as incineration to more environmentally friendly methods, such as wind turbines and hydropower. In this paper, I discuss the state of the healthcare sector in Lebanon and refer to the case of the New Mazloum hospital in Tripoli. Lebanon is a country with an aging population and a large healthcare sector reliant on polluting energy provision techniques, in part due to frequent electricity cuts. Waste disposal is problematic but several policies and interventions exist to mitigate pollution. The New Mazloum hospital has applied several interventions to dispose of medical waste in a more environmentally friendly way, through treatment policies, training, ways to avoid using polluting chemicals, and alternative energy solutions like solar energy. This shows that hospitals can at the same time respond to the increasing needs of the population related to climate change, and play a positive role in promoting sustainable energy and waste solutions.

Keywords

Healthcare, hazardous medical waste, sustainability, consumption, environment, alternative energy

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ABSTRACT: Nowadays, an acute environmental crisis is leading to an increasing number of health crises worldwide. The healthcare sector itself contributes to this crisis through the waste it produces and the energy it consumes. To address this growing problem, several strategies are being developed that attempt to move away from polluting methods of waste disposal such as incineration to more environmentally friendly methods, such as wind turbines and hydropower. In this paper, I discuss the state of the healthcare sector in Lebanon and refer to the case of the New Mazloum hospital in Tripoli, Lebanon. Lebanon is a country with an aging population and a large healthcare sector reliant on polluting energy provision techniques, in part due to frequent electricity cuts. Waste disposal is problematic but several policies and interventions exist to mitigate pollution. The New Mazloum hospital has applied several interventions to dispose of medical waste in a more environmentally friendly way, through treatment policies, training, ways to avoid using polluting chemicals, and alternative energy solutions like solar energy. This shows that hospitals can at the same time respond to the increasing needs of the population related to climate change, and play a positive role in promoting sustainable energy and waste solutions.

KEYWORDS: Healthcare, hazardous medical waste, sustainability, consumption, environment, alternative energy

1. INTRODUCTION

Nowadays, an acute environmental crisis is leading to an increasing number of health crises worldwide. Climate change, chemical contamination, and unsustainable resource use are all aggravating illnesses worldwide. These environment-related health problems are increasing pressures and burdens on healthcare systems. Meanwhile, the health sector itself contributes to this environmental crisis. The healthcare sector deploys technologies, constructs and operates buildings, and consumes products through which waste is generated, and unintentionally contributes to significant pollution around the world that undermines public health (Karliner and Guenther, 2011).

The Millennium Ecosystem Assessment, commissioned by the United Nations and conducted between 2001 and 2005, states: “In the last half of the 20th century, humans changed ecosystems more rapidly and extensively than in any comparable period of time in human history. This transformation was carried out largely to meet rapidly growing demands for food, fresh water, timber, fiber and fuel, contributing to substantial net gains in human wellbeing” (Millennium Ecosystem Assessment, 2005).

The Millennium Ecosystem Assessment Report mentioned that since 1750, the atmospheric concentration of carbon dioxide has increased by about 32%. The main reason behind this increase is the combustion of fossil fuels and land-use changes. Approximately 60% of the increase (60 parts per million) has occurred since 1959.

Today, it is becoming evident that almost quarter of all human disease and death is associated to human interaction with their environment. According to World Health Organization, the exposure of human to unsafe water, indoor and outdoor pollution, improper sanitation, climate change, work hazards, mishandling of natural resources and industrial accidents is a main contributor to their health. (Prüss-Üstün and Corvalán, 2006).

“First, do no harm” (or “primum non nocere” in Latin), the Hippocratic Oath taken by medical students to become doctors, is a mandate of the healthcare system intended to prevent and cure disease. Still, the delivery of healthcare services, mostly in hospitals, often unintentionally promotes many risks. Available data confirms the significant environmental impact of healthcare activities. For example, the National Health
Service (NHS) in England has calculated its carbon footprint, the CO₂ released into the atmosphere from certain activities, to be more than 18 million tons each year. This measure accounts for 25% of total public-sector emissions (NHS, 2009). In Brazil, hospitals similarly contribute to more than 10% of the country’s total commercial energy consumption (Szklo, Soares and Tolmasquim, 2004, p. 2086). In the United States, the healthcare sector is one of the largest consumers of chemicals, many of which are cancerogenic. In the same way, Health care sector in China is growing annually by 20%, and spending on healthcare construction exceeds US$10 billion a year, which contributes to a significant consumption of natural resources (Karliner, J. and R. Guenther, 2011).

At the same time, the healthcare sector realizes the consequences of climate change for healthcare delivery. The rise in temperature will affect dense urban areas by aggravating chronic respiratory disorders in the elderly and children. In addition, extreme weather events such as floods, hurricanes, tornadoes, heat waves, and forest fires will require healthcare services to have more resilient emergency-care preparedness infrastructure to recuperate the consequences of these events.

2. HEALTHCARE SYSTEM GROWTH

It has been evident that the demand for healthcare has increased in the last few years, due to many factors:

- Change in disease patterns: increase in chronic diseases and cancers.
- Change in health-seeking behavior lifestyles, contributing to increase in chronic diseases and obesity rates.
- Change in the environment.
- Demographic changes and shifts. These constitute the main driver of the shift in disease patterns, with diseases affecting the elderly as average life expectancy has increased.

The world expenditure on health reached US$5.3 trillion in 2007. In other words, each person spends US$639 per year on health services, which is equivalent to 8 to 10% of the global Gross Domestic Product (GDP) (WHO, 2010). Expenditure on healthcare services varies between nations. Moreover, the impact of environmental changes vary in scope and intensity, it could range from an infection caused by pathogenic medical waste mistreated by its dumping with regular waste during a vaccination campaign in a rural area, to the toxic pollutants produced by the energy consumption of a tertiary healthcare facility in a large city.

3. HEALTHCARE CONSUMPTION

3.1 Energy

On average, one hospital bed consumes 29,000 kWh heat and 6,000 kWh electricity per year, which is equivalent to average consumption of two new family homes. Furthermore, energy consumption contributes to 25% of a hospital’s operating cost (“What hurts hospital energy efficiency?” 2012). Hospitals’ energy requirements are unique, due to many factors:

- Complexity of building structure.
- Constant occupancy by a large number of people.
- Presence of patients who need special environmental conditions.
- Medical requirements that necessitate strict control of the environment temperature and of indoor air parameters, especially in operating theaters, treatment rooms, and nurseries.
- Use of specialized medical and nonmedical equipment in operating theaters, Imaging Unit, sterilization, laundries, and food preparation.

Depending on hospital size and the clinical needs of the served population, the service provision can vary widely, even between hospitals classified as general hospitals.

The forms of energy purchased in hospitals are:

- Natural gas.
- Electricity.
- Diesel oil.

The energy purchased is converted into different internal flows of energy, mainly:

- Heat used in the form of steam, hot water, and heaters.
- High air exchange rates to minimize airborne infections.
- Heating, Ventilation, and Air conditioning systems.
Electricity for lightning, medical and non-medical equipment, circulations pumps, air compressors, computers, and other office equipment, laundry, etc.

Fuel oil for emergency electricity generation.

Compressed air, namely medical and technical gas:
- Medical compressed air, used for patient care and treatment: breathing apparatuses, surgical tools driven by compressed air, and anesthesia gases.
- Technical air, used in HVAC Control systems, workshop applications, and kitchens.

Lightning and heating account for the largest part of energy consumption in hospitals; cooling and hot water represent around 5% of consumed energy. The electricity consumption of medical and office equipment is considered third, after lightning and heating ("What hurts hospital energy efficiency?" 2012).

3.2 Hazardous medical waste

Hospital activities constitute an important source of waste generation. Each hospital department generates different kinds of waste, varying from administrative waste, such as paper, to household waste and hazardous medical waste. 75 to 90% of hospital waste is similar to regular or municipal waste, and does not entail any particular hazard. The remaining 10 to 25% is called hazardous medical waste or special waste. This type of waste carries health risks and is referred to as Hazardous Medical Waste (CIBSE, 1999).

Table 1: Classification of hazardous medical waste.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharps</td>
<td>Waste entailing risk of injury.</td>
</tr>
<tr>
<td>Waste entailing risk of contamination.</td>
<td>Waste containing blood, secretions, or excreta entailing a risk of contamination.</td>
</tr>
<tr>
<td>Anatomical waste.</td>
<td>Body parts, tissue entailing a risk of contamination.</td>
</tr>
<tr>
<td>Infectious waste.</td>
<td>Waste containing large quantities of material, substances, or cultures entailing the risk of propagating infectious agents (cultures of infectious agents, waste from infectious patients placed in isolation wards).</td>
</tr>
<tr>
<td>Pharmaceutical waste.</td>
<td>Spilled/unused medicine, expired drugs, and used medication receptacles.</td>
</tr>
<tr>
<td>Cytotoxic waste.</td>
<td>Expired or leftover cytotoxic drugs, equipment contaminated with cytotoxic substances.</td>
</tr>
<tr>
<td>Waste containing heavy metals.</td>
<td>Batteries, mercury waste (broken thermometers or manometers, fluorescent or compact fluorescent light tubes).</td>
</tr>
<tr>
<td>Chemical waste.</td>
<td>Waste containing chemical substances: leftover laboratory solvents, disinfectants, photographic developers, and fixers.</td>
</tr>
<tr>
<td>Prenatized containers.</td>
<td>Gas cylinders, aerosol cans.</td>
</tr>
<tr>
<td>Radioactive waste.</td>
<td>Waste containing radionuclides used in laboratories or nuclear medicine, urine, or excreta of patients treated.</td>
</tr>
</tbody>
</table>

4. HEALTHCARE CONSUMPTIONS

Fuel burning and electricity use are responsible for atmospheric pollution. Their environmental impact at a local level is reduced air quality, but at a global level. Carbon dioxide emission is major environmental consequence of fuel burning and electricity that has a great impact on global warming and leading to climate change.

In a typical acute hospital, the amount of energy consumed each year is equivalent to 16 tons of CO₂ per bed space, or in total about 8700 m³ of CO₂ (CIBSE, 1999).

4.1 Health risks

Infected waste contains potentially harmful microorganisms that can infect hospital patients, health workers, and the general public if it is not disposed of properly. Moreover, an infectious risk may include the spread of drug-resistant microorganisms from health facilities into the environment (WHO, 2015).

It is estimated that 16 billion injections are administered every year. Unfortunately, not all needles are disposed of in safe manner, which creates a risk of injury and infection. Furthermore, the chance for the reuse of unsafely disposed needles is highly expected. According to WHO reports, in 2010 unsafe injections were responsible for as many as 33,800 new HIV infections, 1.7 million hepatitis B infections, and 315,000 hepatitis C infections (WHO, 2015).

Many chemical products used for cleaning and disinfection are dangerous, and hospitals use them in large quantities. Most of these products have warning tags on their containers related to their properties that entail health risks. These hazards are classified as toxic, carcinogenic, mutagenic, irritant, corrosive, sensitizing, explosive, or flammable. Healthcare workers are exposed to these products through different routes as gas or vapor inhalation, ingestion, and skin, eye, or mucous membranes contact. Another chemical
hazard that may expose the healthcare workers when mishandling the chemicals at work is the mixing incompatibility, as the case when mixing acids and chlorine a toxic gas is produced (WHO, 2015).

Another dangerous and toxic chemical used in hospitals is mercury. It is a heavy chemical element that has liquid state at normal room temperature and pressure. Many medical supplies contain mercury, these supplies may include but are not limited to light tubes, thermometers, sphygmomanometers, dental amalgams, and certain types of battery. Mercury readily evaporates and can remain in the atmosphere for up to a year. The accumulated mercury vapor is converted into, methylmercury, a more toxic chemical derivative. Due to the broad use of mercury containing supplies, healthcare facilities are considered to be the main source of mercury in atmosphere as a result of medical waste incineration. Also, these facilities are also responsible for the pollution of surface water with mercury. It is estimated that 53% of the total mercury emissions is produced as a result of its use in healthcare devices and supplies (WHO, 2005).

4.2 Environmentally friendly options

Many arguments have been raised regarding options for environmentally friendly healthcare waste management technology. One method is incineration, which has been adopted for a long time. However, incineration is becoming less favorable due to its environmental impact. Dioxins, furans, and other toxic air pollutants, such as emissions and fly ash, may be produced by incinerators. Alternative, cleaner methods are encouraged nowadays (WHO, 2015).

It may seem wasteful to dispose medical devices after just one use, but when comparing it to the re-sterilization of reusable devices, the environmental impact of using single use devices is much lower. Re-sterilization requires the use of detergents for decontaminations and others for sterilization. Many supplies need to be reprocessed using sterilization equipment that rely on electricity or steam. If sterilization facility is away from operation facility, transportation of sterilized items is needed which will involve more energy consumption. Reprocessing also involves the use of wrapping packages that creates an ongoing stream of waste, much of which is disposed of in landfills. However, with single-use devices, the only waste is the device itself.

Nowadays, Access to reliable, safe, inexpensive, and sustainable energy is critical for pursuing economic growth, development, and improving quality of living. Healthcare operations are highly dependent on constant supply of reliable electricity and thermal energy supplies (Papadoulos, 2016; Santamouris et al., 1994) for heating, ventilation, lighting, air conditioning and the use of medical and non-medical equipment (WHO and Health Care Without Harm, 2009). Therefore, healthcare facilities are considered as major energy consumers among all industries.

A review of “sustainable energy access and technologies for healthcare facilities in the Global South” (Franco et al., 2017) has shown that diesel generators are considered as main energy source for these facilities. Although this type of energy source has low cost of investment, but this technology is no longer competing with renewable energy sources. These alternative technologies are challenging the conventional ones in terms of levelized cost of electricity (LCOE) and being an environmentally friendly alternative. A typical example is the Photovoltaics (PV) which has an LCOE of 0.09 USD/kWh, as compared to an average 0.25 USD/kWh for diesel generators. Another example is the wind turbines which also have many advantages. However, a drawback of both technologies is the intermittent energy supply. Accordingly, these technologies must be coupled with a storage battery system to provide consistent and reliable electrical supply. Lead-acid batteries are mainly used to store energy nowadays; however, nickel-metal hydride (NiMH), a new nontoxic alternative, is available in market. This type of storage has and of higher energy density (200 Wh/l) compared to Lead-acid batteries (80 Wh/l); therefore, it is advisable to use (NiMH) storage whenever energy density and number of cycles is a priority.

Given the above mentioned points, the ideal energy solution for medium-to-large healthcare facilities is a hybrid system, in which a renewable energy source, coupled with efficient batteries, is combined with a diesel generator to create a reliable constant energy supply with lower impact on environment and lower LCOE.

5. OVERVIEW OF THE HEALTHCARE SECTOR IN LEBANON

5.1 Demographic and health indicators in Lebanon and the need for healthcare services

The Lebanese health sector is one of the most dynamic healthcare markets in the Arab region. Lebanon is ranked as the healthiest Arab country, according to the Bloomberg 2017 Global Health index. Among 163 countries included in Bloomberg’s study, Lebanon came in at 32, ahead of Qatar (36), Bahrain (40), the United Arab Emirates (43), and Oman (48). The study was based on several criteria, such as life expectancy at birth, causes of death, the availability of clean water, and existing health risks (WEF, 2017).
Lebanon’s population is estimated around 5,988,000, with an average growth rate of around 6%. An expanding population offers opportunities for the hospital industry, as more patients will be visiting their premises.

Data published by the United Nations indicated that Lebanon has a relatively old population. The population aged <15 years represents 21%; the population aged >60 years represents 12.0%. When reviewing this age structure, a trend towards an aging population can be observed. This presents an opportunity for the hospital sector, which could benefit from this age group’s need for healthcare and prevention (GHO, 2017).

Data shows that Lebanon currently has a high life expectancy, 80 years, which is mainly attributed to the high per capita spending on healthcare and to the higher-than-average standards of healthcare. However, this increase in life expectancy is associated with an increasing number of chronic diseases and an increasing need for healthcare.

Another important factor that has a direct effect on the demand for healthcare services is the displacement of Syrian refugees (1 million registered by UNHCR) (UNHCR, 2017) to the Lebanese territory, which increased the population by 25%.

Table 2: Lebanon: WHO statistical profile (GHO, 2017)

<table>
<thead>
<tr>
<th>Summary statistics</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface area (km²)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (projected, 000)</td>
<td>2016</td>
<td>5988</td>
</tr>
<tr>
<td>Population density (per km²)</td>
<td>2016</td>
<td>585.4</td>
</tr>
<tr>
<td>Capital city population (000)</td>
<td>2015</td>
<td>2225</td>
</tr>
</tbody>
</table>

Excluding Syrian refugees.

Social indicators

| Population growth rate (average annual %) | 2010–2015 | 6.0 |
| Urban population (%) | 2015 | 87.8 |

| Fertility rate, total (live births per woman) | 2010–2015 | 3.2 |
| Life expectancy at birth (females/male, years) | 2010–2015 | 80.9/77.1 |

International migrant stock (000’s % of total pop.)

| Tourist arrivals at national borders (000) | 2014 | 1355 |
| Refugees and others of concern to UNHCR | mid-2015 | 1189052 |
| Infant mortality rate (per 1,000 live births) | 2010–2015 | 9 |
| Health: Total expenditure (% of GDP) | 2014 | 6.4 |
| Health: Physicians (per 1,000 pop.) | 2013 | 3.2 |

Excluding nationals residing abroad, Syrian nationals, and Palestinians.

Table 2: Lebanon: WHO statistical profile (GHO, 2017)
The biggest and most developed service-providing sector in Lebanon is healthcare. The private sector is dominant and accounts for 90% of this sector.

### 6. LEBANESE HEALTHCARE SECTOR

The biggest and most developed service-providing sector in Lebanon is healthcare. The private sector is dominant and accounts for 90% of this sector.

**Table 3: Number of healthcare facilities (Ministry of Environment, 2014).**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Number</th>
<th>Healthcare Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syndicate of Hospitals, 2009</td>
<td>15</td>
<td>Private hospitals (Long stay)</td>
</tr>
<tr>
<td>Syndicate of Hospitals, 2009</td>
<td>129</td>
<td>Private hospitals (Short stay)</td>
</tr>
<tr>
<td>Ministry of Public Health, 2009</td>
<td>30</td>
<td>Public hospitals</td>
</tr>
<tr>
<td>Syndicate of Biologists, 2006</td>
<td>171</td>
<td>Private Medical Laboratories</td>
</tr>
<tr>
<td>Syndicate of Biologists, 2006</td>
<td>110</td>
<td>Medical Laboratories in hospitals</td>
</tr>
<tr>
<td>Syndicate of Biologists, 2006</td>
<td>25</td>
<td>Blood Banks</td>
</tr>
<tr>
<td>Lebanese Dental Association, 2008</td>
<td>3,807</td>
<td>Practicing Dentists</td>
</tr>
<tr>
<td>Ministry of Public Health, 2009</td>
<td>118-133</td>
<td>Primary healthcare centres</td>
</tr>
<tr>
<td>Ministry of Public Health, 2009</td>
<td>900</td>
<td>Dispensaries</td>
</tr>
<tr>
<td>Syndicate of Pharmacists, 2009</td>
<td>2,130</td>
<td>Pharmacies</td>
</tr>
<tr>
<td>[CDR &amp; ERM, 1998]</td>
<td>680</td>
<td>Dental laboratories</td>
</tr>
<tr>
<td>[CDR &amp; ERM, 1998]</td>
<td>100</td>
<td>Veterinarians</td>
</tr>
</tbody>
</table>

#### 6.1 Energy consumption in the healthcare sector

During the daily Electricité du Liban’s (EDL) power cuts, facilities rely on diesel to generate electricity from private or public generator. In 2012, the amount of diesel oil consumed by the commercial and institutional sectors in Lebanon turned out to be 656,265 tons in order to provide a total of 2,817 GWh. This...
contributed to an overall carbon emission of more than two million tons of CO$_2$. The healthcare sector makes up 15% of the consumption of the commercial and institutional sectors’ diesel oil for backup generators operation in 2012 (Ministry of Environment, 2014).

An analysis of hospital energy consumption was conducted on twenty-four facilities, with capacities ranging from 20 to more than 500 beds. The analysis showed an average energy consumption of around 20 MWh per year, distributed among diesel, EDL, and LPG. There was no relation between electricity consumption pattern and climatic zoning or geographic location of the hospital. However, hospital size, complexity of services, and advanced facilities were more related to consumption rates per bed.

A hospital emits 11.6 tons of CO$_2$ per bed. On average, each hospital bed requires 1,729 liters of diesel per year.
6.2 Waste management in Lebanon

Lebanon has noticed an incremental progress in the management of healthcare waste. However, adequate infrastructure is still lacking. The impact of the accumulated years of unresolved environmental problems in Lebanon is summarized into two major issues:

1) Increased air pollution due to uncontrolled burning of the waste; and
2) Water and soil pollution due to inappropriate disposal of health care effluents and waste.

Decree 8006 on Regulated Medical Waste Management was issued in 2002. This decree classified the different Healthcare Waste categories and identified their disposal requirements. The decree also emphasized the role of healthcare facilities in the management of its generated medical waste. The Ministry of Environment tried enforcing the decree through continuous follow-ups with all these facilities especially hospitals.

As shown in the table above, hospital risk and non-risk waste generation is increasing over time, since the demand on healthcare services is increasing and consequently the consumption of medical equipment, disposables, food, and other material, too.

Health Care Waste Management in Lebanon has improved significantly in recent years. Since 2003, Health Care Waste treatment by wet autoclaving is available through Arc en Ciel (AEC), a Lebanese NGO. In 2004 and 2005, the Ministry of Environment (MoE) granted three licenses for healthcare waste treatment by incineration, which were not renewed until now. Another seven licenses were issued for HCW treatment facilities using autoclaves (Ministry of Environment, 2014).

The healthcare waste treatment initiative of the MoE focuses mainly on adopting the autoclaving alternative for the treatment of medical waste. In this way, 95% of medical waste can be treated through the autoclaving technique instead of incineration. After treatment by an autoclave technique, the medical waste is considered as non-infectious, inert materials and then it can be disposed with the regular waste in landfills. This method will decrease the dioxins, furans, and other toxic air pollutants that are produced as emissions and/or bottom or fly ash.

7. NEW MAZLOUM HOSPITAL CASE

7.1 Overview

New Mazloum Hospital is a private shareholder general hospital that was established in 1968. It is located in Tripoli, North Lebanon. The hospital is medium-sized with 105 beds. The services provided in the hospital are distributed as follows:

<table>
<thead>
<tr>
<th>Services</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory and Blood Bank</td>
<td>Biochemistry, PCR, Biological, etc.</td>
</tr>
<tr>
<td>Medical and Interventional Imaging Department</td>
<td>Digital X-ray, Scanner, Scintigraphy, MRI, Mammography, Cardiac Catheterization</td>
</tr>
<tr>
<td>Operating Theater</td>
<td>3 Rooms</td>
</tr>
<tr>
<td>Emergency Room</td>
<td>5 Rooms</td>
</tr>
<tr>
<td>Central Sterilization</td>
<td></td>
</tr>
<tr>
<td>Surgery and One Day Unit</td>
<td>18 beds</td>
</tr>
</tbody>
</table>
Other supporting services are laundry, dietary, and cleaning departments. The hospital area is 4760m², distributed over five floors.

### 7.2 NMH initiatives to decrease/control consumption

Obviously, surgeons cannot perform surgery without exposure to blood or body fluids, and nurses cannot abide by asepsis without using sterile products. Since healthcare providers cannot completely eliminate the source of medical waste, they must learn to manage and control their use.

Believing in its role in enhancing Public Health and providing safe healthcare, New Mazloum Hospital management has adopted many initiatives to minimize and control the burden of its services on environment:

- A medical waste segregation policy and procedure that is compliant with the MoE Decree was developed in 2008.
- Contract with Arc en Ciel to treat infected medical waste by wet autoclave technique has been signed since 2008.
- Waste management yearly training program was developed.
- A mercury-free hospital policy has been adopted since 2013, and all hospital thermometers were replaced by digital ones.
- Radioactive waste is sealed in special isolating containers and stored above ground in a plumbed container until it has decayed to the point in which it can be disposed of as ordinary waste.
- The X-ray machine was replaced by a digital one, and a PACS system was implemented in June 2017, so that X-ray films and chemical use in X-ray dark rooms were stopped.
- A waste recycling program for plastics and papers was introduced in 2018. The project is still in the pilot phase.
- An inspector to oversee the waste segregation and handling was appointed in 2009.
- Lighting was replaced with led lamps, a project that was developed in 2016. The project timeline is three years.
- An alternative energy solution using a hybrid system of Photovoltaics (PV), coupled with efficient batteries and combined with a diesel generator, has been added to the strategic plan (2018-2021).

The above figures show an incremental increase in infected medical waste generation during since 2016, due to (7.8%) growth in number of surgeries the increase in orthopedic and neurological surgeries. Also, the Infection Control Committee recommendations were to use single-use surgical gowns in orthopedic and neurological surgeries to enhance patient safety measures. Moreover, more isolated patients were admitted to the hospital from the Displaced Syrians who were more prone to infections due to their living conditions. Hence, types of admitted cases during this period relied more on single-use medical supplies.

When electricity consumption is negatively associated with diesel consumption. in year 2017, as electricity consumption rises, diesel purchases decrease due to improved measures in electrical rationing, the

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**Table 6: Data on hospital activities.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Occupancy Rate (%)</strong></td>
<td>72.1</td>
<td>72.1</td>
<td>74.5</td>
<td>74</td>
</tr>
<tr>
<td><strong>Infected medical waste (kg)</strong></td>
<td>6,661</td>
<td>31,112</td>
<td>27,375</td>
<td>27,359</td>
</tr>
<tr>
<td><strong>Kg infected medical waste/Patient Day</strong></td>
<td>1.0</td>
<td>1.1</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Electricity consumption Kw/bed</strong></td>
<td>2047.6</td>
<td>12128</td>
<td>9523</td>
<td>9033</td>
</tr>
<tr>
<td><strong>Diesel (L)/Bed</strong></td>
<td>-</td>
<td>1696</td>
<td>2562.5</td>
<td>2468.8</td>
</tr>
</tbody>
</table>

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consumption is lower than the benchmark (1729L/bed). The long term impact of led light use on electricity consumption is to be assessed.

8. CONCLUSIONS

Health systems everywhere have the potential to adapt to increasing needs associated with climate change. However, they can respond to these needs with lower impact on environment by playing a positive role in promoting sustainable energy and applying different waste solutions. Healthcare facilities have a major role in promoting health by being leaders in enhancing environmental friendly culture in their settings through investing in green buildings, waste segregation and recycling, adopting green purchase policies, and implementing sustainable operations. Hospitals and health systems can leverage their economic positions and moral standing in a community, to help achieve both the Millennium Development Goals related to health and sustainability, while also helping foster a green economy (CIBSE, 1999). Above all, hospitals and healthcare workers are key players in promoting environmental health, their attitude and practices can model the practices of the broader society and global community.

REFERENCES