

## Hospital Solid Waste Management in Lattakia City

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### □ ABSTRACT □

The problems of Hospital Waste Management in Lattakia City have been growing at an alarming rate, due to shortages of financial resources, lack of trained man power, lack of education and awareness about the environmental health problems associated with hospital waste disposal. The present study aims at studying the processes of collecting, storing and transporting hospital waste in Lattakia; it also investigates the rate of waste generation in the governmental, teaching, private hospitals. Four hospitals were chosen for this work. National Hospital (public), Al-Assad (teaching), Zahi-Azrak (military) and Al-Markazy (private). High values of Bed Occupancy Ratio and Average Length of Stay were recorded in Al- Assad Hospital 101% and 3.8 respectively, while small values were recorded in Al-Markazy Hospital (14.4%, 1.3). The research work took into account the amounts of medical waste accumulated from each section. The highest amount was established in genus – delivery section (2Kg/P/day in Al-Markazy Hospital) and the lowest amount was in internal section (0.22Kg/P/day in Military Hospital). The total generation rates were determined (kilogram per patient, per day) for the four hospitals as follows: 1.29; 1.01; 0.84; 0.67Kg/p/day for Al-Markazy, Al-Assad, National and Military Hospitals respectively. Moreover the study compares the different methods used in treating hospital wastes and makes recommendation for the most suitable method for the City of Lattakia.

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## إدارة نفايات المستشفيات الصلبة في مدينة اللاذقية

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### □ الملخص □

تعاني عملية إدارة نفايات المستشفيات في مدينة اللاذقية من نقص في رؤوس الأموال الموظفة لهذا الغرض، نقص في الطاقم البشري المدرب، نقص في الوعي البيئي وجهل في مخاطر تداول النفايات الطبية. ومن أهمها عدم وجود المعالجة السليمة لنفايات المستشفيات هذه. يهدف البحث إلى دراسة عملية جمع وتخزين ونقل النفايات الطبية المطبقة في مستشفيات اللاذقية؛ فضلا عن تحديد معدل تولد النفايات الطبية في المستشفيات الحكومية، التعليمية والخاصة. لقد تم اختيار أربعة مستشفيات لإنجاز البحث وهي: المستشفى الوطني (عام)، مستشفى الأسد (تعليمي)، زاهي أزرق (عسكري) والمركزي (خاص). وقد تم تحديد نسبة انشغال الأسرة ومدة البقاء في المستشفيات المدروسة فكانت أعلى قيمة لنسبة الانشغال (101%) في مستشفى الأسد، بينما بلغت فقط (14.4%) في المستشفى المركزي. ثم حددت كميات النفايات الطبية لكل قسم من أقسام المستشفيات الأربع المدروسة، وقد بلغت أعلى قيمة في قسم التوليد والنسائية (2Kg/p/day في المستشفى المركزي) ولم تزد عن (0.22 Kg/P/day في قسم الداخلية المستشفى العسكري). ومن خلال القيم المحسوبة للأقسام تم تحديد المعدل الوسطي لكل مستشفى فكانت 1.29؛ 1.01؛ 0.84؛ 0.67 كغ/مريض/يوم للمستشفى المركزي، مستشفى الأسد، المستشفى الوطني ثم العسكري على التوالي. كما جرت مقارنة بين طرق معالجة نفايات المستشفيات واقتراح الطريقة الملائمة لمعالجة نفايات المستشفيات في مدينة اللاذقية.

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## INTRODUCTION:

Medical wastes include all infectious waste, hazardous wastes (including low-level radioactive) wastes, and any other wastes that are generated from all types of health care institutions, including hospitals, clinics, doctor (including dental and veterinary) offices, and medical laboratories (U.S. Congress, Office of Technology Assessment 1988, p. 3).

The terminology confusion is worsened by the US EPA's definition of medical waste in 40 CFR 259.10 as any solid waste, which is generated in the diagnosis, treatment, or immunization of human beings or animals in related research, biological production, or testing.

Hospital wastes are heterogeneous mixtures of general refuse, laboratory and pharmaceutical chemicals as well as containers, and pathological wastes. All of these wastes may contain potentially infectious wastes. In some cases, the wastes fired to Hospital incinerators may also contain wastes classified as hazardous under the Resource Conservation and Recovery Act (RCRA) or low-level radioactive waste (US EPA, 1990).

General refuse from Hospitals is similar to generic wastes from residences and institutions and includes artificial linens, paper, flowers, food, cans, diapers, and plastic cups. Laboratory and pharmaceutical chemicals can include alcohol; disinfectants; antineoplastic agents; and heavy metals, such as mercury. Infectious wastes include isolation wastes (refuse associated with isolating patients); cultures and stocks of infectious agents and associated biologicals; human blood and blood products; pathological wastes; contaminated sharps; and contaminated animal carcasses, body parts and bedding (US EPA, 1986). In the U.S., infectious wastes are required to be discarded in organ or red plastic bags or containers. Often these "red bag" wastes may contain non-contaminated general refuse discarded along with the infectious waste.

In addition, the US EPA has identified an optional infectious waste category, which consists of miscellaneous contaminated wastes. The suggestion is that a qualified person or committee should decide whether or not to handle these wastes as "infectious" in specific situations.

The terminology problem is further complicated by the fact that the terms infectious, pathological, biomedical, biohazardous, toxic, and medically hazardous have all been used to describe infectious waste (Rhyner, 1995 et al., Blackman, 1996).

The problems of Hospital Waste Management in City of Lattakia have been growing at an alarming rate, because the local authorities are not able to tackle them due to shortages of financial resources, lack of trained man power, lack of education and awareness about the environmental health problems associated with Hospital waste (MED-URBS,1995; Chahin,et al., 1996; CEHA, 1997).

There is no law related to medical waste management (Lattakia City Council, 2001). Therefore, there are no regulations related to the following management of the medical waste:

- Definition.
- Separation.
- Transport.
- Collection.
- Treatment.
- Disposal.

Most of medical facilities have no storage places of medical waste. They are placed at the entrance of nurse station or wards and transported to the temporary collection points outside the facility.

Al-Assad Hospital has an incinerator with 100 kg/h capacity. The residue after incineration is transported to Al-Bassa dumping site. Some medical waste of the facilities in Lattakia are directly transported to the open dump site without transporting to the above mentioned incinerator.

The purposes of this research work are the following:

- 1-Studying the processes followed in collecting, storing and transporting Hospital waste in Lattakia.
- 2-Investigating the rate of generation in the Hospital classified by the type (government, teaching, private).
- 3-Comparing different methods used in treating Hospital wastes and making recommendation for suitable method for Lattakia.

## MATERIALS AND METHODS

After reviewing the reports and studies gathered in Directorate of Health in Lattakia for the last two years it was noticed that the number of patients, bed occupancy and time of stay in Lattakia Hospitals had taken maximum values during the summer especially in the month of July, while the recorded values of mentioned items were less than that in winter (Lattakia City Council,2001). Depending on this fact our measurements were established in the month of July only.

Weight measurements were established during July, 2000. The weight of wastes and the number of stay patients of each section were determined every day (24 hours). Samples were collected for five days (continuously). After that the average generation rate was calculated for all studied Hospitals in Lattakia.

The working team was divided into four groups due to the four types of Hospitals (public, teaching, military and private) in Lattakia City. Table 1 shows the type and total number of hospitals in Lattakia.

**Table 1. Type and Number of Hospitals in Lattakia City**

Type of Hospital	National Hospital	Total Number of Bed
Public Hospital*	5	840
Private Hospital	8	169
Health Center	27	-
Clinic	550	-

Source: Lattakia City Council (2001).

\* Teaching and military hospitals are included.

Depending on health ministry suggested relation (Lattakia City Council, 2001), Bed Occupancy Ratio (BOR) and Average Length of Stay (ALS) were determined for National, Al-Assad, Soufy, Al-Markazy Hospitals by using the formulas:

$$\text{BOR} = \frac{\text{Total days of in Patients}}{\text{Number of beds} \times \text{Number of days per month}} \times 100$$

$$\text{ALS} = \frac{\text{Days of Out Patients}}{\text{Number of out Patients}}$$

## RESULTS AND DISCUSSION

### Evaluation of Storage, Transport and Disposal Methods

Based on sanitary and safety factors, it is important to underline the fact that no separation of hazardous wastes is practiced at any of the hospitals, and no storage containers are available for on-site storage. Therefore all plastic bags are placed in an unsecured area causing odor problems. The plastic bags, which have to be loaded manually into the collection vehicle, expose the workers to various hazards from leakage, spilled liquid and needle pricks. The problem of manual loading of the plastic bags is the same at all hospitals in the City.

The total number of beds is 1009 in Hospitals of Lattakia City: 83% of them are in the public Hospitals and 17% of them are in private Hospitals.

The Bed Occupancy Ratio changes from one section to another in the same Hospital, it is (352.5)% in thorax and emergency sections (National Hospital) and (31.7)% in ophthalmology section for the same Hospital (Table 2).

Table (3) shows Bed Occupancy Ratio and Average Length of Stay during July 2000 in studied Hospitals (data about Military Hospital was not available). The (BOR) and (ALS) have high values in governmental Hospitals, Teaching and public, (101%, 3.8 in Al-Assad Hospital) and (75.4%, 2.3 in National Hospital), which serve a large number of patients from Lattakia governorate. While they have small values in private Hospitals (14.4%, 1.3 in the best circumstances). These refer to the poor life level in the city. People avoid private Hospitals, because of their expensive costs, and go to government Hospitals which is free of charge.

**Table 2. The Bed Occupancy Ratio and Average Length of Stay in National Hospital Sections (July, 2000)**

Category / Section	Number of Bed	Total Days of Enter Patients	Bed Occupancy Ratio	Total Days of Out Patients	Number of Out Patients	Average Length of Stay
General Surgery	28	1328	73.8	1259	312	4
Cardiac	18	426	76.3	389	140	2.7
General Intern	24	733	98.5	678	184	3.6
Nervous	22	493	72.2	401	108	3.7
Bony Disease	40	868	70	687	184	3.7
Urinary-Genital	30	321	35.5	250	45	5.5
Thorax Disease- Emergency	11	1202	352.5	1170	700	1.6
Plastic Surgery-	25	451	58	288	50	5.7

Diabetes						
Mouth-Delivery	10	654	70.3	586	320	1.7
Ophthalmology	18	177	31.7	107	68	1.5
Nose-Throat	18	251	44.9	199	107	1.8
Pediatric	33	873	85.3	802	281	2.8
Genus	17	264	50	203	88	2.3
Intensive Cardiac Care	10	212	68.3	190	53	3.5
Intensive Internal Care	6	165	88.7	167	55	3
Nervous Surgery	6	140	75.2	98	26	3.7
Total	366	8558	75.4	6345	2721	2.3

Table (4) gives the daily generation amount of medical waste in Sections of Hospitals in Lattakia City. It is clear that generation amounts are close to each other in public and educational Hospitals. The highest value was established in private Hospitals (2 kg/P/day; Genus-Delivery Section), but the lowest value was established in Military Hospital (0.22 kg/P/day; Internal Disease Section). There is an increasing of medical waste amount in genus and delivery sections, operation, pediatric and internal sections. Depending on generation amounts of medical wastes in sections of Hospitals the generation rates were determined for studied Hospitals as follows: 1.29;1.01;0.84;0.67 Kg/P/day for Al-Markazy, Al-Assad, National and Military Hospitals respectively.

Treatment is a method, technique or process designed to change the biological character or composition of waste. The most common methods of treatment in the medical establishments were the dry thermal treatment and autoclave. These were followed by incineration. Al-Assad University Hospital treats own medical waste and the waste from other establishments (military Hospital is one of them).

Some medical wastes of private Hospitals (Al-Markazy and Al-Soufy) in Lattakia city were collected and transported to National Hospital, which has an incinerator (since 2000) with capacity 100 Kg/h (Lattakia City Council, 2001).

**Table 3. The Bed Occupancy Ratio and Average Length of Stay in Lattakia Hospitals (July, 2000)**

Hospital	Bed Occupancy Ratio	Average Length of Stay
Governmental Hospitals		
National Hospital (Public)	75.4	2.3
Al-Assad (Teaching)	101	3.8
Private Hospital		
Al-Soufy (Private)	9.4	1.2
Al-Markazy (Private)	14.4	1.3

**Table 4. Daily Generation Rate of Medical Waste (Kg/P/day)  
in Lattakia Hospitals**

Section	Type of Hospital			
	Public (National)	Teaching (Al-Assad)	Military (Zahi Azrak)	Private (Al-Markazy)
Pediatric	0.6	0.65	0.43	1.5
Surgery and Internal Disease	0.35	0.4	0.22	0.88
Operation	0.94	1.46	0.8	1.3
Genus-Delivery	1.21	1.6	-	2
Emergency	0.10	0.10	0.10	0.17
Sanitary Isolation	1.83	1.86	1.80	1.91
Average generation rate	0.84	1.01	0.67	1.29

### **Recommended Methods for Hospital Waste Treatment**

Since landfill operations may cause loss of containment integrity and dispersal of infectious waste, the US EPA recommends that all infectious waste be treated prior to disposal (Calvin, 1994; Jackson, et al., 1999). The US EPA further recommends the followings:

- Establishing standard operating procedures for each process used for treating infectious waste.
- Monitoring of all treatment processes to assure efficient and effective treatment.
- Use of biological indicators to monitor treatment (other indicators may be used provided that their effectiveness has been successively demonstrated).
- Treatment for each of the six infectious waste categories in Table 5.
- The following treatment methods for miscellaneous contaminated wastes (When a decision is made to manage these wastes as infectious):
  - Wastes from surgery and autopsy – incineration or steam sterilization.
  - Miscellaneous laboratory wastes – incineration or steam sterilization.
  - Dialysis unit wastes – incineration or steam sterilization.
  - Contaminated equipment – incineration, steam sterilization, or gas/vapor sterilization.

**Table 5. Recommended Techniques for Treatment of Infectious  
Waste (Source: Blackman, 1996).**

Category of Infectious Waste	Recommended Treatment Technique
Isolation Wastes	Steam sterilization Incineration
Cultures and stocks of infectious Agents and associated biologicals	Steam sterilization Incineration Thermal inactivation Chemical disinfection

Human blood and blood products	Steam sterilization Incineration Chemical disinfection Discharge to sanitary sewer <sup>a</sup>
Pathological wastes	Steam sterilization <sup>b</sup> Incineration Handing by mortician
Contaminated animal carcasses, body Parts, and bedding	
Carcasses and body parts	Steam sterilization <sup>b</sup> Incineration
Bedding	Incineration

<sup>a</sup> Provided secondary treatment is online and operating authorities have been notified.

<sup>b</sup> For aesthetic reasons, steam sterilization should be followed by incineration or by grinding with subsequent flushing to sewer system in accord with state and local regulations.

Since Lattakia City has no sanitary and safety system to dispose of solid wastes, because all kinds of solid wastes (medical and municipal) are transported to the open dumping site of Al-Bassa area (20 km north of Lattakia). The open dumping site has no special area designed for the medical waste. Depending on that and taking into consideration US EPA recommendations, the incineration at high temperature ( $\geq 1000$  °C) is the recommended technology for treatment the hospital waste of Lattakia City.

## CONCLUSIONS & RECOMMENDATIONS

As a result of this research work the following can be concluded:

- 1- The separation is carried out based on personal definition of medical waste, since there is no regulated definition for medical waste and also there is no regulations related to collection, separation, transport, treatment and disposal of medical waste in Lattakia.
- 2- The Bed Occupancy Ratio is very high in governmental Hospitals (101 % in Al-Assad Hospital), compared to private Hospitals (14.4%, in the best circumstances).
- 3- Average Length of Stay is Low in private Hospitals (1.3 in Al-Markazy Hospital) comparing with governmental Hospitals (3.8 in Al-Assad Hospital).
- 4- The generation rate of medical waste for Military, Public, Teaching and Private in Lattakia ranged from 0.67 kg/p/day to 1.29 kg/p/day.
- 5- Non-hazardous wastes should be kept separate from hazardous wastes and each type of hazardous wastes should be kept in appropriate containers.
- 6- A proper hospital waste management program should be done to control the existing situation in Lattakia hospitals.
- 7- It is very necessary to improve the handling, storage, transport, treatment and disposal method of medical wastes practiced by the hospitals in Lattakia City.
- 8- It is essential to establish national laws, guidelines, and criteria related to medical waste management.



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