



## The Prevalence of Gram-Negative Bacilli in the Environment and the Equipments: A Case Study in Hospitals of the East of Golestan Province, Iran

Ali Asghar Ayatollahi <sup>1</sup>, Abolfazl Amini <sup>1\*</sup>, Reza Kazemi Darsanaki <sup>2</sup>,  
Somayeh Rahimi <sup>3</sup>

<sup>1</sup> Laboratory Sciences Research Center, Golestan University of Medical Sciences, Gorgan, Iran.

<sup>2</sup> Young Researchers and Elites Club, Lahijan Branch, Islamic Azad University, Lahijan, Iran.

<sup>3</sup> Health Center of Golestan Province, Golestan University of Medical Sciences, Gorgan, Iran.

### ARTICLE INFO

#### Article type:

Original Article

#### Article history:

Received: 30 Apr 2016

Revised: 12 Aug 2016

Accepted: 29 Sep 2016

Published: 15 Oct 2016

#### Keywords:

Gram-negative bacilli,  
Nosocomial infection,  
Hospital, Environment  
equipments.

### ABSTRACT

**Background:** Nosocomial infections are considered as health issues that affect developed and poor countries. These infections can be transmitted to patients through hospital environment and equipments. The aim of this study was to evaluate the prevalence of Gram-negative bacilli in the environment and the equipments of hospitals in the East of Golestan province in 2015.

**Methods:** In this study, 770 samples were collected using sterile swabs from the environment and equipments which were in use in different units of six teaching hospitals located in the East of Golestan province. The collected samples were then identified by standard biochemical tests.

**Results:** Of the total samples, 249 samples (32.33%) were contaminated with Gram-negative bacilli with the most number of contaminations were *Enterobacter aerogenes* (37.75%) at the Department of Surgery (18.07%). Among the medical equipments and surfaces, the highest level of contamination was observed in laryngoscope and its blades (10.44%), suction (7.23%), and EKG sensors and monitoring connectors (7.23%). Telephone handset (5.22%) and patients' bed (5.22%) had the highest rate of contamination with Gram-negative bacilli in the non-medical equipments.

**Conclusion:** The results of the present study shows that Gram-negative bacilli contamination rates are considerable in hospitals in East of the Golestan province. Thus, hand washing, disinfecting, sterilizing medical equipment and generally compliance with the standards in this field are of great importance.

- **Please cite this paper as:** Ayatollahi AA, Amini A, Kazemi Darsanaki R, Rahimi S. The Prevalence of Gram-Negative Bacilli in Environment and Equipments of Hospitals in the East of Golestan Province. *J Med Bacteriol.* 2016; **5** (4): pp.15-21.

## Introduction

Nosocomial infections are one of the most important causes of mortality in hospitals. In the past decades, whenever the issue of diversity and quality of patient care was noted, the use of hospital infection rate in reflecting the quality of care has become the first priority. Almost a third of these infections are classified in the range of preventable. Seven to 10% of patients hospitalized in the medical centers are affected by nosocomial infections (1). Bacterial contamination of medical equipment is a main cause of nosocomial infections (2), and sampling of supplies and equipments and their microbial culture are the most important measures to control infections in hospitals (3).

Gram-negative bacilli such as *Acinetobacter* species, *Escherichia coli*, *Klebsiella*, *Pseudomonas aeruginosa*, *Serratia marcescens* and *Shigella* can remain stable for months on dry surfaces, humid environments and adverse conditions that other bacteria are unable to tolerate (6). Several studies have been done on bacterial contamination of medical equipment in Iran and other countries. In the study of Bernard et al., 85% of physicians' otoscopes were detected as contaminated with *E. coli*, *K. pneumoniae* and *P. aeruginosa* (4). Umar et al. also reported 23% contamination with Gram-negative bacilli in equipment of dental clinics (5). In Iran, Amanlo study in Zabol, Tohidnia in Kermanshah and Moniri in Kashan reported 30%, 31.6% and 65.7% Gram-negative bacilli contamination, respectively (1, 6, 7). Most pathogens can live and remain viable for month on surfaces and equipments, and act as a continuous source of microorganisms' transmission in hospitals (6, 8). Sampling and cultivation of equipment and supplies used in hospitals is one of the most important measures for identification and control of nosocomial infections. The aim of this study was to determine the prevalence of Gram-negative bacilli in the

environment and equipment of hospitals in East of the Golestan province, in 2015.

## Material and method

In this descriptive-analytical study, 770 samples were collected by sterile swab dipped in Tryptic Soy broth (TSB) from the surface of medical and non-medical equipments used in seven different units (operating room, intensive care unit (ICU), coronary care unit (CCU), surgery, pediatrics, emergency and internal medicine) from six hospitals in East of the Golestan province (Gonbad, Minoodasht, Kalaleh, Aliabad). The criteria for Gram-negative bacilli contamination rate was 1-2 hours after the sterilization of supplies and equipment. Immediately after collection were incubated in Eosin Methylene Blue agar (EMB) and Blood agar for 24 to 48 hours at 37 °C and the cultures were later assessed for bacterial growth. Causative agents of infection were determined by Gram staining and standard biochemical tests. The obtained results were analyzed using SPSS-22 software, descriptive statistical techniques and chi-square test.

## Result

Collected data form all of the 770 samples showed that 249 samples (32.33%) were contaminated with Gram-negative bacilli with the greatest number of infections related to *Enterobacter aerogenes* (37.75%). The highest and lowest rate of contamination was observed in the surgical ward (18.07%) and the CCU (8.43%), respectively (Table 1). No significant difference was observed between the contamination rate and wards ( $P > 0.05$ ). Among the studied medical equipment and surfaces, laryngoscope and its blade (10.44%), suction (7.23%) and ECG sensor and its monitoring connector (7.23%) had the highest rate of contamination with Gram-negative

bacilli. Among the non-medical equipment, telephone handset (5.22 %) and patients' bed (5.22%) had the highest contamination rate with these bacteria. No contamination was reported from the dining table, flexible duct, colonoscopes and oxygen flowmeters (Table 2). There was no significant difference between the equipments and contamination rate ( $P < 0.05$ ). The contamination rate ranged from 10.8% to 22.9% in the six investigated hospitals in East of the province (Table 3). No significant difference was observed between the hospital type and contamination rate ( $P > 0.05$ ).

## Discussion

In spite of the advancements in medical sciences and equipments, microbial contamination in different hospital wards and its complications still cause problems, irreparable damage and losses throughout the world (9). The contamination rate in the 6 investigated hospitals of the present study ranged from 10.8% to 22.9%. Several studies have been performed on the level of bacterial contamination of medical equipment in Iran and other countries. Studies of Amanlo in Zabol, Tohidnia in Kermanshah, Moniri in Kashan, Jalalvandi in Kermanshah, and Afshar Yavari in Urmia reported 30%, 31.6% , 65.7%, 5%, 8.8% and 15.15% contamination with Gram-negative bacilli, respectively (1,6,7,10, 11). In this study, the highest and lowest rates of contamination were observed in the surgical ward (18.07%) and the CCU (8.43%), respectively. Aslani et al. study in Shahrekord on 137 samples collected in 2009, reported the highest contamination rate in the neonatal unit (27.7%) (12). Ghenaat et al. in Mashhad, reported 44.5% contamination in the internal medicine unit during a decade (13). The inconsistencies in the findings of these studies could be due to several factors including the status of the wards and performance of the staff. However, the results of the present study indicated higher prevalence of contamination in the surgical wards and operating rooms compared with the internal medicine unit, which further

highlights the need to develop programs for prevention of infections in these wards. In the present study, the highest contamination among the Gram-negative bacilli was related to *Enterobacter aerogenes* (37.75%) and *Serratia marcescens* (18.47%), which is in agreement with the findings of Jalalvandi and Moniri (10, 6). Garcia-Cruz et al. reported *Klebsiella* (50.4%), *Pseudomonas* (32.1%), *E. coli* (9.17%) and *Enterobacter* (8.2%) as the most common Gram-negative bacilli in internal surfaces of hospitals in Mexico (14). Umar et al. also reported 23% contamination with Gram-negative bacilli in equipment of dental clinics (5). Amanlo et al. reported *Klebsiella* (47%.2), *Pseudomonas* (27.7%), *E. coli* (19.4%) and *Serratia* (5.5%) as the most common Gram-negative bacilli on the surface of supplies and equipment of operating rooms (1). In Afshar Yavari et al. study on operating room departments of Urmia's teaching hospitals, the highest incidence was related to *Pseudomonas* (60%), *Klebsiella* (20%) and *E. coli* (8%), respectively (11). Tohidnia also reported *Klebsiella* (60.8%) as the most important Gram-negative bacilli contaminant of equipment used in the Radiology departments (7). In the study of Haghbin et al., *Pseudomonas* was responsible for most bacterial contaminations in telephone handset and stationery of hospitals (15). In the present study, the highest level of contamination was observed in laryngoscope and its blade (10.44%), suction (7.23%) and EKG sensor and its monitoring connector (7.23%) among the medical equipment and surfaces. Telephone handset (5.22%) and patient's bed (5.22%) had the highest rate of contamination with Gram-negative bacilli in the non-medical equipment. In Jalalvandi study, suction unit (28.8%) and trolley (23.3%) and in the study of Aslani, telephone handset (18.2%), manometer (17.5%) and refrigerator door handle (8%) had the highest rate

**Table 1.** Prevalence of Gram-negative bacilli in different wards of hospitals.

ward	The type and the rate of contamination							Number of contamination (%)
	<i>E. aerogenes</i>	<i>S. marcescens</i>	<i>Klebsiella</i> spp.	<i>Citrobacter</i> spp.	<i>P. aeruginosa</i>	<i>P. mirabilis</i>	<i>E. coli</i>	
Surgical ward	16	12	6	6	4	1	0	45 (18.1)
operating room	17	8	3	7	4	2	1	42 (16.8)
ICU	13	4	6	5	1	0	1	30 (12.1)
CCU	8	2	8	3	0	0	0	21 (8.4)
Emergency	13	7	6	5	4	4	1	40 (16.1)
Neonatal and pediatric ward	16	8	2	3	2	3	1	35 (14.1)
Internal medicine unit	11	5	4	3	6	4	3	36 (14.4)
Total	94 (37.7)	46 (18.5)	35 (14.1)	32 (12.8)	21 (8.4)	14 (5.6)	7 (2.8)	249 (100)

**Table 2.** Frequency of Gram-negative bacilli in hospital equipment.

Equipment / Supplies	The type and rate of contamination							Total
	<i>E. aerogenes</i>	<i>S. marcescens</i>	<i>Klebsiella</i> spp.	<i>Citrobacter</i> spp.	<i>P. aeruginosa</i>	<i>P. mirabilis</i>	<i>E. coli</i>	
Laryngoscope and blade	10	5	6	3	0	2	0	26 (10.4)
ECG Sensors and its monitoring connector	6	3	4	1	3	0	1	18 (7.2)
Suction	3	9	0	2	3	1	0	18 (7.2)
Telephone handset	7	1	2	0	0	2	1	13 (5.2)
Drugs' trolley	4	5	2	2	1	0	0	14 (5.6)
Patients' beds	3	0	5	0	3	0	2	13 (5.2)
Bedsheet	3	0	3	3	0	0	1	10 (4.0)
Dressing trolley	5	5	0	1	0	0	0	11 (4.4)

Oxygen mask	4	3	2	0	0	4	0	13 (5.2)
Gan	10	0	0	1	1	0	0	12 (4.8)
Infusion Set	5	2	0	2	1	0	0	10 (4.0)
Patient clothing	1	2	0	4	2	0	0	9 (3.6)
Bagging	7	0	1	3	0	0	0	11 (4.4)
anesthetic machine	0	1	0	1	0	0	0	2 (0.8)
Endotracheal tube	5	2	0	0	0	0	0	7 (2.8)
Ventilator	1	2	2	0	0	0	2	7 (2.8)
Bronchoscope	0	0	0	1	0	0	0	1 (0.4)
Surgical instruments	0	1	2	2	0	2	0	7 (2.8)
IV	1	1	0	0	3	0	0	5 (2.0)
Endoscope	1	0	0	1	0	0	0	2 (0.8)
neonatal incubator	1	2	0	0	0	1	0	4 (1.6)
Electroconvulsive	4	0	1	0	0	1	0	6 (2.4)
Sialic lights	1	1	1	2	0	1	0	6 (2.4)
Negatoscope	2	0	0	0	0	0	0	2 (0.8)
CPR trolley	2	0	0	0	1	0	0	3 (1.2)
Gurney	2	0	0	0	1	0	0	3 (1.2)
Colonoscope	0	0	0	0	0	0	0	0 (0)
Nebulizers	0	0	0	2	0	0	0	2 (0.8)
Cystoscope	0	0	0	0	1	0	0	1 (0.4)
Cautery	1	0	2	1	0	0	0	4 (1.6)
Otoscope	2	0	1	0	1	0	0	4 (1.6)
Oxygen flow meter	0	0	0	0	0	0	0	0 (0)
Refrigerator door handle	1	0	0	0	0	0	0	1 (0.4)
Flexible pipe	0	0	0	0	0	0	0	0 (0)
Manometer	1	0	0	0	0	0	0	1 (0.4)
Baby scales	1	0	0	0	0	0	0	1 (0.4)
IV stand	0	1	0	0	0	0	0	1 (0.4)
Echo	0	0	1	0	0	0	0	1 (0.4)
Dining table	0	0	0	0	0	0	0	0 (0)
Numbers (Percentage)	94 (37.7)	46 (18.4)	35 (14.0)	32 (12.8)	21 (8.4)	14 (5.6)	7 (2.8)	249 (100)

**Table 3.** Prevalence of Gram-negative bacilli contamination in 6 hospitals in the East of Golestan province.

Hospital	Sample	Prevalence	%
A	198	57	22.9
B	110	37	14.9
C	110	39	15.7
D	88	27	10.8
E	132	43	17.3
F	132	46	18.5
<b>Total</b>	<b>770</b>	<b>249</b>	<b>100</b>

of contamination (12, 10). Hands have an important role in spread of contaminations in non-medical equipment such as phone, refrigerator and beds. Therefore, thoroughly washing of hands should be instructed and well-monitored. The contamination rate of Gram-negative bacilli is different in various studies. In the study of Bernard et al., 85% of physicians' otoscopes were contaminated with Gram-positive (*S. aureus*, *S. epidermis* and *E. faecalis*) and Gram-negative (*E. coli*, *K. pneumoniae* and *P. aeruginosa*) pathogens (4).

### Conclusion

The results of the present study show that the Gram-negative bacilli contamination rates are considerable in hospitals located in East of the Golestan province. Thus, specific and concrete policies should be developed for cleaning and decontamination of these hospitals for avoiding additional costs as well as achieving better efficiency. Periodic cultivation from the equipment and high risk units of hospitals, Biogram tests to determine the most effective antibiotic and careful hand washing are considered as the most important actions for decontamination and sterilizing the medical and non-medical equipment to prevent nosocomial infections.

### Acknowledgements

The authors would like to thank the Deputy of Research and Technology of Golestan University of Medical Sciences for approval and financial support of this study (Code: 910510136) and all laboratory staff who have cooperated in conducting this project.

### Conflict of interest

None declared.

### Financial disclosure

This research was financially supported by the Deputy of Research and Technology of Golestan University of Medical Sciences, Iran.

### References

1. Amanlo S, Farjah G, Taghavi M, et al. Microbial contamination of operation rooms in Amir-al Mominin hospital of Zabol, Iran. *JNKUMS* 2011; **3**(3): 7-14.
2. Yusha'u M, Bukar A, Aliyu BS, et al. Bacterial Contamination of Some Hospital Equipments in Kano, Nigeria. *Hamdard Medicus* 2012; **55**(3): 39-42.
3. Nobahar M, Vafaei AA. Survey of Contamination Stethoscopes as One of the Factor for Nosocomial Infections: Transmission in Educational Hospitals in Semnan City. *Iran J Infect Dis Trop Med* 2004; **8**(23): 28-25.
4. Bernard L, Kereveur A, Durand D, et al. Bacterial contamination of hospital stethoscope. *Inf Control Hosp Epidemiol* 1999; **20**(9): 274-276.
5. Umar D, Basheer B, Husain A, et al. Evaluation of Bacterial Contamination in a Clinical Environment. *J Int oral Health* 2015; **7**(1): 53-55.
6. Moniri R, Momen Heravi M. Evaluation of Bacterial Contamination in Medical Devices and Anti-Bacterial Resistance of Isolated Gram Negative Bacilli in Shahid Beheshti Hospital in Kashan, Iran, 2004. *Feyz* 2006; **9**(36): 55-50.
7. Tohidnia MR, Dezfolimanesh J, Almasi A.



- Bacterial contamination of radiography equipment in radiology departments of Kermanshah University of Medical Sciences (2010). *J Kermanshah Univ Med Sci* 2013; **16**(3): 273-276.
8. Amirmozafari N, Forouhesh Tehrani H, et al. Survey Genus and Species of Non-Fermentative Gram Negative Bacilli Isolated from Hospitalized Patients. *J Guilan Univ Med Sci* 2008; **16**(64): 67-75.
  9. Khosravi A, Parhizgari N, Abbasi Montazeri E, et al. The Prevalence of Bacteria Isolated From Endotracheal Tubes of Patients in Golestan Hospital, Ahvaz, Iran, and Determination of Their Antibiotic Susceptibility Patterns. *Jundishapur J Microbiol* 2013; **6**(1): 67-71.
  10. Jalalvandi F, Teimouri B, Sohrabi N, et al. Microbial Contamination of Operating Rooms Equipments in Selected Hospitals in Kermanshah. *Iran J Infect Dis Trop Med* 2013; **17**(59): 49-52.
  11. Afshar Yavari Sh, Diba K. The assessment of bacterial and fungal flora of operating rooms in Urmia Medical University hospitals. *Urmia Med J* 2004; **15**(1): 38-33.
  12. Aslani Y, Saadat M, Etemadifar SH, et al. The Evaluation of Different Hospital Equipment Microbial Contamination in Medical Training Center Hajar of Shahrekord. *Hamadan Nurs & Midwifery Fac* 2009; **17**(12): 19-23.
  13. Ghenaat J, Sadeghian A, Ghazvini K. Surveillance of Bacterial Contamination in Ghaem Hospital during 10 Years (1370 to 1380). *Iran J Otorhinolaryngol* 2004; **16**(3): 35-28.
  14. Garcia-Cruz CP, Najera Aguilar MJ, Arroyo-Helguera OE. Fungal and Bacterial Contamination on Indoor Surfaces of a Hospital in Mexico. *Jundishapur J Microbiol* 2012; **5**(3):460-464.
  15. Haghbin S, Pourabbas B, Serati Z, et al. Bacterial Contamination of Mobile Phones and Pens in Pediatric and Neonatal Intensive Care Units. *Int J Curr Microbiol App Sci* 2015; **4**(2): 75-81.