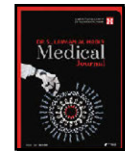
DR SULAIMAN AL HABIB

Dr. Sulaiman Al Habib Medical Journal
Vol. 3(3); September (2021), *pp.* 113–119
DOI: https://doi.org/10.2991/dsahmj.k.210719.001; ISSN 2666-819X; eISSN 2590-3349
https://www.atlantis-press.com/journals/dsahmj



Research Article

Hospital-acquired Respiratory-Tract Infections in the Teaching Hospitals of Sfax

Maissa Ben Jmaa[1,*], Sourour Yaich[2], Houda Ben Ayed[1], Maroua Trigui[2], Mariem Ben Hmida[2], Habib Feki[1], Jamel Damak[2]

[1]*Preventive Medicine and Hygiene Department, Hedi Chaker University Hospital, University of Sfax, Tunisia*
[2]*Community Health and Epidemiology Department, Hedi Chaker University Hospital, University of Sfax, Tunisia*

ARTICLE INFO

Article History

Received 03 March 2021
Accepted 08 July 2021

Keywords

Infection
intensive care
microorganisms
prevalence
respiratory tract
risk factors

ABSTRACT

Hospital-acquired Respiratory-Tract Infections (HARTIs) are identified as the most frequent type of hospital-acquired infections. They can engender significant morbidity and mortality rates, generating a heavy economic burden, especially in the limited resources countries. In this perspective, this study aimed to determine the prevalence of HARTIs in the University Hospitals (UHs) of Southern Tunisia and to identify their main associated factors. It was a cross-sectional study conducted in the two UHs of Sfax governorate, Tunisia, from July 10 to 24th, 2017, including all hospitalized patients for at least 48 hours. It was a 1-day pass per department and a 1-week survey per UH. In total, 34 cases of HARTIs were notified among 752 surveyed patients, accounting for an overall prevalence of 4.5%. The prevalence of HARTIs in the Intensive Care Units (ICU) was 20.6%. Multivariate logistic regression analysis showed that developing a HARTI in non-ICU was independently associated with tobacco use [Adjusted Odds Ratio (AOR) = 2.83; 95% Confidence Interval (95% CI) = [1.10–7.27]; $p = 0.03$], central vascular catheter (AOR = 5.70; 95% CI = [1.29–25.15]; $p = 0.022$) and McCabe Index ≥1 (AOR = 7.38; 95% CI = [2.73–19.97]; $p < 0.001$). In ICU, only endotracheal tube was independently associated with HARTIs (AOR = 42.5; 95% CI = [4.97–64.13]; $p = 0.001$). This study illustrated the extent of HARTIs problem threatening the quality of care in Southern Tunisia. Identifying the risk factors of HARTIs in both ICUs and non-ICUs may help healthcare workers to ascertain the avoidability of these infections.

1. INTRODUCTION

Hospital-acquired Infections (HAIs) represent a major public health problem. According to the latest estimates from the World Health Organization, 7% of hospitalized patients in developed countries would acquire at least one HAI, whereas in developing countries, 10% of these patients would develop a HAI [1]. Hospital-acquired Respiratory Tract Infections (HARTIs) have been identified as the most frequent type of HAIs [2,3]. They include upper respiratory tract infections, pneumonia, and other lower respiratory tract infections such as bronchitis and tracheobronchitis [4]. Hospital-acquired Pneumonia (HAP) may be managed both in a medical ward and in an Intensive Care Unit (ICU), when the prognosis is more severe. As a subset of HAP, Ventilator-associated Pneumonia (VAP) is considered one of the most frequent infections in ICU patients [5]. HAP and VAP may engender significant morbidity and mortality rates, prolong the hospital Length of Stay (LOS), and necessitate additional diagnostic and therapeutic interventions, generating a heavy economic burden, especially in countries with limited resources [6]. The presence of specific hosts such as male sex, pre-existing pulmonary disease, and multiple organ system failure added to several invasive devices could enhance patients' susceptibility to develop HARTIs [7,8]. Thorough knowledge and identification of the factors associated with these infections are recognized as a key step to develop infection control programs and design treatment protocols. However, in developing countries, the awareness gap of these risk factors and the lack of reliable data make it difficult to estimate the extent of this public health problem [9]. In Tunisia, according to the first national survey conducted in 2005, HARTIs were the second most frequent type of HAIs, with a prevalence of 2.6% [10]. The two University Hospitals (UHs) of Sfax governorate, which are the most qualified hospitals for healthcare management in Southern Tunisia, received numerous patients from neighboring governorates. With this perspective, this study aimed to determine the prevalence of HARTIs in the UHs of Sfax and to identify the main associated factors.

2. MATERIALS AND METHODS

2.1. Study Design and Settings

This investigation, which was designed as a cross-sectional study, was conducted in the two UHs of Sfax, Southern Tunisia, from July 10th to 24th, 2017. There are two tertiary-level UHs in the governorate of Sfax: Habib Bourguiba UH (HBUH) and Hedi Chaker

*Corresponding author. Email: *maissabenjmaa@live.fr*
Peer review under responsibility of the Dr. Sulaiman Al Habib Medical Group
Data availability statement: The data that support the findings of this study are available from the corresponding author [MBJ], upon reasonable request.

UH. The latter is divided into adult and pediatric departments, whereas HBUH has surgery and general medicine departments (neurology, oncology, and radiotherapy) as well as ICUs.

2.2. Study Population and Case Definition

The same protocol of the national Tunisian survey of HAI conducted in 2005 and 2012 was applied in this survey [4]. Eligible patients were all inpatients admitted on the survey day for at least 48 hours. We excluded all patients hospitalized less than 48 hours or undergoing a same-day treatment or surgery, as well as departments of emergencies, hemodialysis, radiology and outpatient departments.

2.3. HARTI Definitions

All types of HARTIs were defined according to United States Centers of Disease Control and Prevention (CDC) criteria [11]. HARTIs were classified as upper respiratory tract infections (HAURTIs), including angina, pharyngitis, laryngitis, sinusitis, otitis media and flu, and lower respiratory tract infections (HALRTIs) which include bronchitis, tracheobronchitis, bronchiolitis, tracheitis, lung abscess, and empyema [4]. An infection was considered hospital-acquired unless it was present or incubating at the time of admission. We recorded only active HARTIs including those which were symptomatic or under anti-infective treatment on the day of the survey. HAP was defined as new or increased production of purulent sputum and/or fever >38°C with appropriate chest signs and/or new or progressive radiographic evidence of chest infiltrates not attributed to embolus or heart failure [12]. The remaining cases were classified as bronchitis. All HALRTIs in patients who were mechanically ventilated were considered to be VAP [12].

2.4. Data Collection

A pilot study was undertaken prior to the survey, in June 2017, to examine the feasibility of the approach. Standard information was collected by epidemiologists and hygiene practitioners trained for this purpose using anonymous questionnaires. They collected data at bedside by interrogating and examining patients as well as consulting medical and nursing chart, microbiology reports, X-ray and temperature charts. Infections were also identified by consultation with the clinical team in charge of patient care. In fact, the diagnosis of HARTI was first suspected by the investigators and then confirmed by medical staff including expert doctors and hygiene referents in each department, who verified the diagnosis criteria for each patient. In a few cases, a follow-up of 2 or 3 days was required to have the results of complementary examinations done during the survey day and then to probably confirm (or disprove) the HARTI. For each patient, variables related to sociodemographic and clinical profile, exposure to indwelling invasive devices or a surgical procedure and anti-infective treatment prescribed on the day of the survey were recorded. Patients were classified according to the severity of their underlying condition as proposed by McCabe and Jackson (0 = non-fatal disease; 1 = ultimately fatal disease; 2 = rapidly fatal disease) [13]. Other details dealing with organisms isolated in respiratory sputum were also collected.

2.5. Statistical Analysis

Statistical analyses were performed using SPSS version 20 (SPSS Inc., Chicago, IL, USA). Categorical variables were presented as percentages. The Kolmogorov–Smirnov test was used to assess the distribution of continuous variables. The results of continuous variables were presented as medians and Interquartile Ranges (IQR) when they were not normally distributed. Factors statistically associated with HARTIs were determined using univariate logistic regression analysis [Crude Odds Ratio (COR); 95% confidence interval (95% CI)]. To define the independent risk factors predictive of HARTIs in both ICU and non-ICU, two multivariate analysis models were carried out using logistic regression [Adjusted Odds Ratio (AOR); 95% CI; p]. All variables that had p value ≤0.2 at the logistic univariate analysis were included in the logistic regression model, and a backward stepwise approach was used. Any variable with a $p < 0.05$ was retained in the final model.

3. RESULTS

3.1. Description of Patients with HARTIs

In total, 34 cases of HARTIs were observed among 752 surveyed patients, accounting for an overall prevalence of 4.5%. The sex ratio was 1.26. The median age of infected patients was 43.2 years (IQR = 17–65 years). Twenty-one cases (61.8%) were with extreme age. The median LOS was 15 days (IQR = 10.5–21.5 days) and 27 cases (79.4%) had LOS >7 days. The main diagnostic categories of infected patients were malignant neoplasm (10 cases; 29.4%), followed by diseases of the respiratory system (six cases; 17.7%) and polytrauma (three cases; 8.8%). Twenty-five patients (73.5%) had at least one associated comorbidity. The distribution according to the McCabe index showed that 23 patients had McCabe index ≥1 (n = 23; 67.7%). On the survey day, 33 patients (97%) were receiving anti-infective treatment. Twenty patients received double or more anti-infective treatment (58.9%) Table 1. The most frequently administered curative antibiotics were imipenem (13 cases; 39.4%), colistin (seven cases; 21.2%), and amoxicillin clavulanic acid (seven cases; 21.2%). Seven patients (21.2%) received antifungal treatment. Voriconazole was the most prescribed antifungal agent (n = 4; 57.1%).

3.2. HARTIs Types and Their Distribution According to Specialties

HALRTIs represented 85.3% (29 cases) of all HARTIs, among which 86.2% had HAP (25 cases). The prevalence of HAP was 3.3%. Thirteen of the 25 patients with HAP (52%) had VAP. All cases with VAP were observed in the ICU. The highest prevalence of HARTIs was in ICUs (20.6%) Table 2.

3.3. Microbiological Results

The causative microorganisms were isolated in 19 cases (55.9%). In total, 21 pathogens were identified among which 10 (47.6%) were Gram-negative bacilli and eight (38%) were parasites. The most frequently isolated Gram-negative bacilli were

Table 1 | Sociodemographic and clinical characteristics of patients with hospital-acquired respiratory tract infections

	HARTIs, *n* (%)
Overall	34 (100)
Sex	
Male	19 (55.9)
Female	15 (44.1)
Extreme age (≤15 and ≥60 years)	21 (61.8)
LOS >7 days	27 (79.4)
Main diagnosis categories	
Malignant neoplasm	10 (29.4)
Diseases of the respiratory system	6 (17.7)
Polytrauma	3 (8.8)
Mental and behavioral disorders	3 (8.8)
Postoperative reanimation	2 (5.9)
Diseases of the digestive system	2 (5.9)
Acute renal failure	2 (5.9)
Myocardial infarction	2 (5.9)
Contact with scorpions	1 (2.9)
Diabetes mellitus	1 (2.9)
Other diagnoses	2 (5.9)
Associated comorbidities	
None	9 (26.5)
One or more	25 (73.5)
Surgery 30 days prior to the survey day	10 (29.4)
McCabe index	
0	11(32.4)
≥1	23 (67.6)
Invasive medical devices	
Urinary catheter	11 (32.4)
Peripheral vascular catheter	22 (64.7)
Central vascular catheter	12 (35.3)
Endotracheal tube	12 (35.3)
Parenteral nutrition	7 (20.6)
Number of anti-infective treatment	
0	1 (2.9)
1	13 (38.2)
≥2	20 (58.9)

LOS, length of hospital stay.

Table 2 | Prevalence of hospital-acquired respiratory tract infections overall and according to the ward specialty

Specialties	Number of surveyed patients	All HARTIs	Types of HARTIs			
			HALRTIs			HAURTIs
			HAP		HAAB	
			VAP	NVAP		
		n (Pr)	*n* (Pr)	*n* (Pr)	*n* (Pr)	
Overall	752	34 (4.5)	25 (3.3)		4 (0.1)	5 (0.7)
Non-ICU						
General medicine	427	15 (3.5)	0 (0)	11 (2.6)	1 (0.2)	3 (0.7)
Surgery	262	6 (2.3)	0 (0)	1 (0.4)	3 (1.1)	2 (0.8)
ICU	63	13 (20.6)	13 (20.6)	0 (0)	0 (0)	0 (0)

HAAB, hospital-acquired acute bronchitis; HALRTIs, hospital acquired lower respiratory tract infections; HAP, hospital acquired pneumonia; HARTIs, hospital acquired respiratory tract infections; HAURTIs, hospital-acquired upper respiratory tract infections; ICU, intensive care units; NVAP, non-ventilator-associated pneumonia; Pr, prevalence; VAP, ventilator associated pneumonia.

Table 3 | Number and relative share of isolated microorganisms in patients with hospital-acquired respiratory tract infections

	N	Percentage (%)
Gram-positive cocci	2	9.5
Streptococcus pneumoniae	1	4.8
Enterococcus (others)	1	4.8
Gram-negative bacilli	10	47.6
Acinetobacter baumannii	4	19
Klebsiella pneumoniae	1	4.8
Pseudomonas aeruginosa	3	14
Enterobacter cloacae	1	4.8
Enterobacter (others)	1	4.8
Fungi	8	38.1
Aspergillus spp.	6	28.6
Candida albicans	2	9.5
Virus	1	4.8
Respiratory syncytial virus	1	4.8
Total	21	100

Acinetobacter baumannii (four cases; 19%) and *Pseudomonas aeruginosa* (three cases; 14%) (Table 3).

3.4. Factors Associated with HARTIs in Non-ICUs

Using univariate analysis, factors associated with HARTIs in non-ICU were extremes of age (p = 0.04), tobacco use (p = 0.024), associated comorbidities (p = 0.007), central vascular catheter (p = 0.007), McCabe index ≥1 ($p < 0.001$), and a LOS >7 days (p = 0.006) (Table 4).

Multivariate logistic regression analysis showed that developing a HARTI in non-ICU was independently associated with tobacco use (AOR = 2.83; 95% CI = [1.10–7.27]; p = 0.03), central vascular catheter (AOR = 5.70; 95% CI = [1.29–25.15]; p = 0.022), and McCabe index ≥1 (AOR = 7.38; 95% CI = [2.73–19.97]; $p < 0.001$) (Table 4).

3.5. Factors Associated with HARTIs in ICUs

Using univariate analysis, factors associated with HARTIs in ICU were extremes of age (p = 0.04), intrahospital transfer (p = 0.007), tobacco use ($p < 0.001$), surgery 30 days prior to the survey day (p = 0.038), urinary catheter (p = 0.001), central vascular catheter (p = 0.022), parenteral nutrition (p = 0.007), and endotracheal tube ($p < 0.001$). Patients with McCabe index ≥1 had significantly higher prevalence of HARTIs than those with McCabe Index equal to zero (p = 0.017). Logistic regression analysis showed that only endotracheal tube was independently associated with HARTIs (AOR = 42.5; 95% CI = [4.97–64.13]; p = 0.001) (Table 5).

4. DISCUSSION

Hospital-acquired respiratory tract infections are a serious patient safety issue in UHs worldwide. Thus, the prevention of these

Table 4 Factors associated with hospital-acquired respiratory tract infections in non-intensive care units: results of univariate and relevant multivariate analysis

	HARTIs	Univariate analysis		Multivariate analysis	
	n (%)	COR (95% CI)	*p*	AOR (95% CI)	*p*
Extremes of age (≤15 and ≥60 years)					
No	8 (1.9)	1	0.04*	–	–
Yes	13 (4.7)	2.52 (1.03–6.16)		–	–
Sex					
Male	10 (2.9)	1	0.83	–	–
Female	11 (3.2)	1.1 (0.4–2.2)		–	–
Intrahospital transfer					
No	20 (3)	1	0.31	–	–
Yes	1 (8.3)	3 (0.37–24.26)		–	–
Interhospital transfer					
No	20 (3)	1	0.587	–	–
Yes	1 (3.6)	1.19 (0.15–9.17)		–	–
Surgery 30 days prior to the survey day					
No	18 (3.2)	1	0.66	–	–
Yes	3 (2.4)	0.8 (0.22–2.6)		–	–
Tobacco use					
No	12 (2.2)	1	0.024*	1	0.03*
Yes	9 (6.3)	2.96 (1.22–7.17)		2.83 (1.10–7.27)	
Associated comorbidities					
0	3 (1)	1	0.007*	–	–
≥1	18 (4.6)	4.74 (1.38–16.26)		–	–
Urinary catheter					
No	20 (3.2)	1	0.711	–	–
Yes	1 (1.5)	0.47 (0.06–3.57)		–	–
Peripheral vascular catheter					
No	7 (2.1)	1	0.14	–	–
Yes	14 (4)	1.98 (0.78–4.96)		–	–
Central vascular catheter					
No	18 (2.7)	1	0.007*	1	0.022*
Yes	3 (21.4)	9.95 (2.55–38.77)		5.70 (1.29–25.15)	
Parenteral nutrition					
No	19 (2.8)	1	0.08	–	–
Yes	2 (12.5)	4.61 (0.98–21.60)		–	–
McCabe index					
0	6 (1.1)	1	<0.001*	1	<0.001*
≥1	15 (9.6)	9.34 (3.56–24.52)		7.38 (2.73–19.97)	
LOS					
≤7 days	4 (1.2)	1	0.006*	–	–
>7 days	17 (4.8)	4.15 (1.38–12.46)		–	–

*Statistically significant difference. AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio; HARTIs, hospital acquired respiratory tract infections; LOS, length of hospital stay.

infections has become a priority, whose essential component is establishing epidemiological surveillance systems of HARTIs in these hospitals. Otherwise, reliability of data is a challenge in developing countries. Prevalence surveys have proved their usefulness thanks to their lower cost and rapidity of execution. This survey is the first study to assess the burden of HARTIs in the local area. The overall prevalence of HARTIs in our UHs was relatively high (4.5%). Although prevalence studies have limitations in comparison, our result was similar to that of the UH of Center-East of Tunisia [14] and higher than the prevalence of HARTIs reported at the Tunisian national level in 2005 (2.05%) [4]. Prevalence rates were even lower in France (1.4%) [15] and China (1.8%) [3]. The reasons for differences observed in prevalence rates could be attributed to the differences in the diagnostic techniques used and the lack of standardized prevention methodology worldwide. Furthermore, the low sensitivity of radiological and clinical findings could result in a low degree of certainty in the diagnosis of HALRTIs and then the estimation of their real prevalence rate.

The study results demonstrated that HARTIs mainly occurred in the lower respiratory tract and the prevalence of HALRTIs was 3.8%. This rate was higher than that reported in a point prevalence survey conducted in France (1.2%) [15], Europe (2%) [16], and Greece (2.5%) [12]. The majority of HALRTIs were HAP, with a prevalence of 3.3%. Previous studies conducted in both developed (1.3%) [2,15] and developing countries (1.1%) [17,18] showed lower prevalence rates. Possible explanations for these disparities may be differences in criteria used for HAP diagnosis, data collection procedures, as well as the vocation and the size of the studied UHs. In fact, rates comparison could only be worthwhile if similar methodologies have been adopted [19].

Table 5 | Factors associated with hospital-acquired respiratory tract infections in intensive care units: results of univariate and relevant multivariate analysis

	HARTIs *n* (%)	Univariate analysis		Multivariate analysis	
		COR (95% CI)	*p*	AOR (95% CI)	*p*
Extremes of age (≤15 and ≥60 years)					
Yes	8 (15.4)	1	0.04*	–	–
No	5 (45.5)	4.5 (1.12–20)		–	–
Sex					
Female	4 (13.3)	1	0.17	–	–
Male	9 (27.3)	2.45 (0.7–9.1)		–	–
Intrahospital transfer					
No	8 (14.5)	1	0.007*	–	–
Yes	5 (62.5)	9.79 (1.94–49.27)		–	–
Interhospital transfer					
No	11 (19.6)	1	0.63	–	–
Yes	2 (28.6)	1.63 (0.28–9.58)		–	–
Tobacco use					
No	6 (11.3)	1	<0.001*	–	–
Yes	7 (70)	18.28 (3.7–90.28)		–	–
Surgery 30 days prior to the survey day					
No	6 (13.3)	1	0.038*	–	–
Yes	7 (38.9)	4.1 (1.15–14.87)		–	–
Associated comorbidities					
None	7 (17.1)	1	0.35	–	–
≥ 1	6 (27.3)	1.4 (0.53–6.25)		–	–
Urinary catheter					
No	3 (7.3)	1	0.001*	–	–
Yes	10 (45.5)	10.56 (2.5–44.74)		–	–
Peripheral vascular catheter					
No	5 (14.3)	1	0.16	–	–
Yes	8 (28.6)	2.4 (0.69–8.40)		–	–
Central vascular catheter					
No	4 (10.8)	1	0.022*	–	–
Yes	9 (34.6)	4.37 (1.17–16.27)		–	–
Parenteral nutrition					
No	8 (14.5)	1	0.007*	–	–
Yes	5 (62.5)	9.79 (1.95–49.27)		–	–
Endotracheal tube					
No	1 (2.5)	1	<0.001*	1	0.001*
Yes	12 (52.2)	42.5 (4.97–64.13)		42.5 (4.97–64.13)	
McCabe index					
0	5 (11.6)	1	0.017*	–	–
≥1	8 (40)	5.07 (1.39–18.45)		–	–
LOS					
≤7 days	3 (15)	1	0.52	–	–
>7 days	10 (23.3)	1.72 (0.42–7.08)		–	–

*Statistically significant difference. HARTIs, hospital acquired respiratory tract infections; COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval; LOS, length of hospital stay.

Moreover, the increased susceptibility of our population to HALRTIs and precisely to HAP might be explained by the absence of an effective strategy of infection control in Southern Tunisia. Consequently, there is a lack of unified hygiene policies and awareness of healthcare workers toward preventive measures for HAP. Thus, healthcare providers would have poor compliance with HALRTI control practices including regular oral care, preventing cross-contamination or colonization via hands of personnel, appropriate disinfection or sterilization of respiratory-therapy devices and use of available vaccines to protect against particular infections. Other new measures are being investigated and involve reducing oropharyngeal and gastric colonization by pathogenic microorganisms [20].

The greatest prevalence of HARTIs was recorded in ICUs and all patients with HARTIs in ICUs had VAP. The reasons for this could be attributed to the alteration of the patients' natural barriers owing to the underlying illness severity, the virulence of infectious agents in ICUs and their antimicrobial resistance, as well as the use of advanced invasive medical procedures such as endotracheal tube. In fact, creating an artificial respiratory tract deprives a patient of the possibility to heat, humidify, and purify inhaled air [7]. This, in turn, generates a series of nursing and medical interventions that may be conducive to developing HAP, a particular type of which is VAP [7].

Gram-negative bacilli represented the majority of all recovered microorganisms, among which *Acinetobacter baumannii* was the most frequently isolated. These results were consistent with other studies conducted in Greece [12] and Cuba [21]. In fact, *Acinetobacter baumannii* is mainly encountered in hospital environments where it can survive for long periods owing mainly to its capacity to withstand desiccation. All these characteristics could increase the spread of epidemic strains especially through breathing machines or others equipment if they were not properly cleaned, and also through the hands of healthcare workers when appropriate control measures were not taken [21]. Thus, inadequate cleaning and hygiene, environmental disinfection, poor adherence to hand hygiene or a general breakdown of hospital infection control protocols would lead to increasing rates of *Acinetobacter baumannii* infection. These results suggest the need for thorough investigation of quality control systems to assess compliance with infection control norms in these UHs.

Tobacco use increased the risk of HARTIs in non-ICUs. In fact, it was well documented that there is an increased susceptibility to respiratory tract infections in smokers compared with non-smokers [22].

The mechanisms causing the enhanced vulnerability to respiratory infections in smokers include disruptive effects on the immune system such us alterations in the innate and adaptive immune responses, and modifications in the respiratory microbiota with fewer normal bacteria and more potential pathogens [22]. Moreover, the McCabe index as well as the presence of central vascular catheter were significantly associated with the occurrence of HARTIs in the study population. Thus, the prevalence of HARTIs might be decreased by the judicious use of indwelling catheters and the strict adherence to CDC recommendations. Actually, the rational use of catheter and the reduction of its duration have been reported as a major factor in preventing HAIs. However, for most intensivists, it would be quite difficult to reduce it. Thus, respecting hygiene precautions and using aseptic techniques while handling these devices for fragile patients are highly recommended.

In the ICUs, endotracheal tube was an independent risk factor of HAP, as described in several studies [23–25]. In fact, owing to differences in inspired gas and ambient air temperatures, a condensate will be formed in the tubing used in mechanical ventilation, which could lead to several problems [23]. Indeed, this condensate could easily become contaminated. Furthermore, using an artificial airway could foster micro-aspirations by impairing effective removal of secretions from the respiratory tract to the outside. To mitigate the risk of inhalation of contaminated condensate, it is recommended to use in-line devices with one-way valves and to reduce the number of ventilation days or to resort to non-invasive ventilation [26].

5. LIMITATIONS

Although a standardized measurement approach was adopted and investigators were trained on collecting data, random measurement errors could arise from human investigators and the variance of clinical opinion among experts when diagnosing HARTIs. Furthermore, in the UHs of Sfax there was a lack of knowledge in some clinicians regarding infection control policies, especially for those who have a heavy workload, which can affect the care quality.

6. CONCLUSION

In conclusion, this study illustrated the extent of HARTIs problem threatening the quality of care in our region. The highest prevalence of these infections was noted in ICUs. Invasive respiratory devices were found to be the main risk factors. Thus, to reduce the burden of VAP, it is recommended to promote procedures that safely reduce duration of intubation whenever possible, to consider non-invasive ventilation, and to start an early and appropriate weaning protocol. Moreover, knowledge of the prevalent organisms helps to rationalize the use of antimicrobial agents. These findings pointed to an urgent need to manage the spread of these infections by implementing meticulous preventive measures in high-risk groups with adequate staffing and strict hospital infection control policy.

CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

AUTHORS' CONTRIBUTION

MBJ, HBA, SY, MBH, MT: Substantial contribution to conception and design of the study, to data acquisition, data analysis and interpretation. MBJ and HBA wrote the article and/or revised the article for important intellectual content. SY, JD and HF approved the final version of the submitted manuscript. All Authors revised the manuscript and gave their contribution to improve the paper. All authors read and approved the final manuscript.

REFERENCES

[1] World Health Organization (WHO). Health care-associated infections. Fact Sheet. Geneva: WHO; 2016.

[2] European Centre for Disease Prevention and Control. Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals. ECDC; 2013. Available from: https://www.ecdc.europa.eu/en/healthcare-associated-infections-acute-care-hospitals/surveillance-disease-data/report (accessed January 15, 2020).

[3] Tao XB, Qian LH, Li Y, Wu Q, Ruan JJ, Cai DZ, et al. Hospital-acquired infection rate in a tertiary care teaching hospital in China: a cross-sectional survey involving 2434 inpatients. Int J Infect Dis 2014;27;7–9.

[4] Annabi Attia T, Dhidah L, Hamza R, Kibech M, Lepoutre-Toulemon A. The first Tunisian national prevalence survey of nosocomial infections: main results. Hygiènes 2007;15;144–9.

[5] Chinsky KD. Ventilator-associated pneumonia: is there any gold in these standards?. Chest 2002;122;1883–5.

[6] Bhadade R, Harde M, deSouza R, More A, Bharmal R. Emerging trends of nosocomial pneumonia in intensive care unit of a tertiary care public teaching hospital in Western India. Ann Afr Med 2017;16;107–13.

[7] Wałaszek M, Kosiarska A, Gniadek A, Kołpa M, Wolak Z, Dobroś W, et al. The risk factors for hospital-acquired pneumonia in the Intensive Care Unit. Przegl Epidemiol 2016;70;15–20, 107–10.
[8] McEachern R, Campbell GD. Hospital-acquired pneumonia: epidemiology, etiology, and treatment. Infect Dis Clin North Am 1998;12;761–79.
[9] Ige OK, Adesanmi AA, Asuzu MC. Hospital-acquired infections in a Nigerian tertiary health facility: an audit of surveillance reports. Niger Med J 2011;52;239–43.
[10] Amazian K, Rossello J, Castella A, Sekkat S, Terzaki S, Dhidah L, et al. Prévalence des infections nosocomiales dans 27 hôpitaux de la région méditerranéenne. East Mediterr Health J 2010;16; 1070–8.
[11] Garner JS, Jarvis WR, Emori TG, Horan TC, Hughes JM. CDC definitions for nosocomial infections, 1988. Am J Infect Control 1988;16;128–40.
[12] Kofteridis DP, Papadakis JA, Bouros D, Nikolaides P, Kioumis G, Levidiotou S, et al. Nosocomial lower respiratory tract infections: prevalence and risk factors in 14 Greek hospitals. Eur J Clin Microbiol Infect Dis 2004;23;888–91.
[13] McCabe WR, Jackson GG. Gram-negative bacteremia: I. Etiology and ecology. Arch Intern Med 1962;110;847–55.
[14] Ben Cheikh A, Ben Rejeb M, Ghali H, Chelly S, Khefacha S, Said Latiri H. Healthcare-associated infections in a Tunisian University Hospital in 2017: prevalence and risk factors. Rev Epidemiol Sante Publ 2018;66;S395.
[15] Thiolet JM, Vaux S, Lamy M, Gauthier A, Barret AS, Leon L. National point prevalence survey of healthcare-associated infections and antimicrobial use in French care settings, May to June 2012. Santé Publique France; 2018. Available from: https://www.santepubliquefrance.fr/maladies-et-traumatismes/infections-associees-aux-soins-et-resistance-aux-antibiotiques/infections-associees-aux-soins/documents/rapport-synthese/enquete-nationale-de-prevalence-des-infections-nosocomiales-et-des-traitements-anti-infectieux-en-etablissements-de-sante-france-mai-juin-2012.-r (accessed February 15, 2020).
[16] Zarb P, Coignard B, Griskeviciene J, Muller A, Vankerckhoven V, Weist K, et al. The European Centre for Disease Prevention and Control (ECDC) pilot point prevalence survey of healthcare-associated infections and antimicrobial use. Euro Surveill 2012;17;20316.
[17] Razine R, Azzouzi A, Barkat A, Khoudri I, Hassouni F, Chefchaouni AC, et al. Prevalence of hospital-acquired infections in the university medical center of Rabat, Morocco. Int Arch Med 2012;5;26.
[18] Yallew WW, Kumie AK, Yehuala FM. Point prevalence of hospital-acquired infections in two teaching hospitals of Amhara region in Ethiopia. Drug Healthc Patient Saf 2016;8;71–6.
[19] Kakupa DK, Muenze PK, Byl B, Wilmet MD. [Study of the prevalence of nosocomial infections and associated factors in the two university hospitals of Lubumbashi, Democratic Republic of Congo: case of the University Clinics of Lubumbashi and the Janson Sendwe Hospital]. Pan Afr Med J 2016;24;275.
[20] Centers for Disease Control and Prevention. Guidelines for prevention of nosocomial pneumonia. MMWR Recomm Rep 1997;46;1–79.
[21] Medell M, Hart M, Duquesne A, Espinosa F, Valdés R. Nosocomial ventilator-associated pneumonia in Cuban intensive care units: bacterial species and antibiotic resistance. MEDICC Rev 2013;15;26–9.
[22] Bagaitkar J, Demuth DR, Scott DA. Tobacco use increases susceptibility to bacterial infection. Tob Induc Dis 2008;4;12.
[23] Rotstein C, Evans G, Born A, Grossman R, Light RB, Magder S, et al. Clinical practice guidelines for hospital-acquired pneumonia and ventilator-associated pneumonia in adults. Can J Infect Dis Med Microbiol 2008;19;19–53.
[24] Guzmán-Herrador B, Molina CD, Allam MF, Navajas RFC. Independent risk factors associated with hospital-acquired pneumonia in an adult ICU: 4-year prospective cohort study in a university reference hospital. J Public Health 2016;38;378–83.
[25] Tablan OC, Anderson LJ, Besser R, Bridges C, Hajjeh R, CDC, et al. Guidelines for preventing health-care—associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. MMWR Recomm Rep 2004;53;1–36.
[26] Keyt H, Faverio P, Restrepo MI. Prevention of ventilator-associated pneumonia in the intensive care unit: a review of the clinically relevant recent advancements. Indian J Med Res 2014;139;814–21.