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Healthcare-Associated Infection Specificities' in a Tunisian University Hospital: Overview of the Results

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Authors' contributions

This work was carried out in collaboration between all authors. Authors MM, AA and NB designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors SBF and MN managed the analyses of the study. Author ABA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Our study was conducted, in university hospital center Farhat Hached of Sousse (city in Tunisian center-east), within healthcare-associated infections (HAI) epidemiological surveillance program.
Aim: The aim of this study was to determine the healthcare-associated infection (HAI) prevalence in order to develop appropriate strategies for prevention and control in our hospital.
Methods: Point-prevalence survey, including all patients who had been hospitalized for at least 48 hours, measuring prevalence of HAI a "given day", with only one passage by service. Criteria of Centers for Disease Control Atlanta USA, Prevention National Nosocomial Infection Surveillance and National Healthcare Safety Network system, were used and adapted to our context to define

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HAI. Study was performed using a questionnaire completed by the investigator in its passage by each service.
Results: 312 patients were involved. The prevalence of infected patients was 12.5% and that of HAI was 14.5%. Infections on peripheral venous catheter dominated (42.2%) among all identified HAI. The prevalence of respiratory infections is the highest. Microbiological documentation was available only in 28.8% of HAI. *Negative Gram Bacilli* were the causative germs most commonly isolated (66%). Indeed, 38.4% of study's population has received antibiotherapy in the last 3 months.
Conclusion: predominance of infections on peripheral venous catheter needs to be subject of specific prevention actions. Elsewhere, we should urge rational use of antibiotics.

Keywords: Healthcare associated infections; prevalence study; Tunisia.

1. BACKGROUND

Healthcare-associated infections (HAI) are defined by the CDC (Centers for Disease Control) Atlanta USA as a localized or systemic condition resulting from an adverse reaction to the presence of an infectious agent(s) or its toxin(s). There must be no evidence that the infection was present or incubating at the time of admission to the acute care setting [1]. HAI remain a worldwide major health problem particularly in developing countries which suffer from lack of legislation and low socio-economic level. Due to their frequency, seriousness and additional cost the struggle against HAI is considered a public health priority. Prevalence studies can be a useful part of an effective surveillance system, provide up-to-date information about HAI trend and help to identify areas for further investigations. Furthermore, they can be particularly useful where financial resources are in short supply, because prevalence surveys can be conducted quickly and unsophisticatedly [2]. Thus, we have carried out our study, in 2012, at university hospital center (UHC) Farhat Hached of Sousse, according to HAI epidemiological surveillance (ES) program based on regular prevalence surveys that have started since 2000 in order to better direct prevention axes. Last investigation is dating back to 2007.

The aim of our study is to determine and assess HAI prevalence rate at our hospital and to describe HAI distribution according to anatomical sites, services at risk and most involved germs.

2. METHODS

We carried out our study at UHC Farhat Hached of Sousse –Tunisia. It is a public health institution with a medical vocation composed of 26 medical services, 4 surgical services and 9 laboratories. Hospitalization capacity reached up to 698 beds in 2012, in which 1661 employees are practicing. Among them, 1354 health professionals: 1134 paramedics and 220 doctors.

An operational hygiene department is implemented for investigation and in order to define hygiene policy and formalize programs that will be adopted then achieved, at hospital. This team collaborates with hospital HAI control committee (HAICC). HAI's control and prevention include training, awareness raising, monitoring and assessment of professional practices; and contribute to improvement of quality and safety care. It is a descriptive transverse survey, including all patients who had been hospitalized for at least 48 hours, in 16 clinical services of our UHC which are: general surgery, ENT (Ear-nose-throat), ophthalmology, dermatology, hematology, rheumatology, pediatrics, cardiology, medical intensive care, anesthesia-reanimation, pneumology, gynecology (with high-risk and post-operative pregnancies), oncology, psychiatry, internal medicine and infectious diseases and endocrinology. A single passage was carried out by service. Criteria of CDC Atlanta USA, Prevention National Nosocomial Infection Surveillance (NNIS) and National Healthcare Safety Network (NHSN) system, were used and adapted to our context to define HAI [2]. Study was performed using a questionnaire completed by the investigators in its passage by each service. Questionnaires have been daily validated to ensure data completeness. Main sources of data were patients' medical records, treating physicians and hygiene referents of each service. Variables measured were related to patients' general characteristics, clinical profiles, exposure to invasive devices or a surgical procedure and possible presence of one

or several active HAI the day of survey. For each estimate, a confidence interval was calculated according to the conventional formula. When the application conditions of the conventional formula were not met (np<5 or n (1-p) <5), the Wilson procedure with continuity correction was used [3].

3. RESULTS

3.1 Population Characteristics

The prevalence survey included 312 patients in our UHC, predominantly female (56.7%). Sex ratio was 0.76. Mean age was 47 (SD: 21.1) years. Almost, 72.7% of patients were hospitalized in medical services. Furthermore, 2.5% were allocated to intensive care unit. Admission to hospital within emergency department represented 43.3% among all cases. Patients were transferred between services and establishments in 2.6 % and 1.9% of all cases, respectively.

Diabetes (20.5%) and immunosuppression (20.5%) were main intrinsic risk factors, followed by obesity (16.7%) and neutropenia (3.8%). In addition, the history of hospitalization during the last 12 months preceding the survey and the use of antibiotics during the last 3 months was observed, respectively, in 32.4% and 24.4% among the study population.

Thus, among patients who received antibiotic therapy in the last 3 months, 69.7% received monotherapy, 15.8% received dual therapy and 14.5% received triple therapy. The most common prescribed antibiotics were association of Amoxicillin and Clavulanic Acid (35.5%) followed by Penicillin G (23.6%) and Cephalosporin-Third Generations (17.1%).

Peripheral venous catheter (PVC) was the most frequently encountered medical device (65.7%) followed by exposure to surgical procedure (15. 7%) and urinary probe (9.6%). Among the 49 operated patients, 17 received a prophylactic antibiotic treatment, which corresponds to 34.7%. Thus, 10 patients (10/17) received a single antibiotic and 7 (7/17) have received a double antibiotherapy. Predominant prescribed prophylactic antibiotics were association of Amoxicillin with Clavulanic Acid (64.7%) and Nitroimidazoles (41.1%).

Concerning health status of patients undergoing surgery, 85.7% had an ASA (American Society of Anesthesiologists) grade of 1 or 2; and 81.6% were operated for a clean or clean-contaminated surgery and intervention duration was less than 2 hours in approximately 83.7% of cases. Among 83.7% of patients, NNIS grade was equal to 0 or 1. Lastly, only 77.66% of interventions were scheduled (Table 1).

3.2 Characteristics of Health-Care Associated Infections

Among total of 312 patients included in this study, 39 submitted at least one HAI which corresponds to a prevalence rate of 12.5% (CI 95% (0.08 -0.16)). HAI number identified in these patients was 45, meaning a prevalence rate of 14.4% (CI 95% (0.10 - 0.18)). Of the 39 patients 17 (43.66%) undergone surgical procedure and 22 were hospitalized in medical services (56.4%). Thus, prevalence survey allowed us to identify high risk services where HAI prevalence rate varied between 12% and 45% .In fact, the majority of infected patients were allocated to these wards: haematology-oncology ward, surgical department, gynecology ward, ENT and pneumology ward.

According to infection site, 44.5% were recorded as catheter-related infections. The absolute majority were related to peripheral intravenous line (42.2%) versus 2.3% infections related to central venous catheter. Overall, 6 cases were systemic infections and 1 case of primary blood stream. It should be noted that the prevalence of respiratory infections is the highest of all system infections (15.6%). Three patients had healthcare associated pneumonia (6.7%) which was clinically defined. Otherwise, the most common HAI system infections were ENT (13.4% of all HAI), urinary tract (for 44% of all cases and accounted for patients with urinary catheter), similar percentage was recorded for surgical site and skin/soft tissues (4.4%). Regarding causative organisms, 13 microbiological samples were done representing only 28.8% of identified HAI. Overall, 6 samples were positive (HAI bacteriologically documented); 4 of them to *Negative Gram Bacilli* (NGB), 1 patient identified with *Coagulase negative staphylococci* and 1 case of infection by *Candida albicans (C. albicans)* (Table 2).

4. DISCUSSION

According to the World Health Organization (WHO), HAI is a hospital-acquired infection which was not present or incubating at the time of patient admission. A growing awareness of the problem of HAI prompted the WHO to promote the creation of the World Alliance for Patient Safety. Prevention of HAI is the target of the Alliance First Global Patient Safety Challenge, "Clean Care is Safer Care". A substantiated goal since it was reported that at any time, more than 1.4 million patients worldwide in developed and developing countries are afflicted by HAI. In fact; it complicates between 5 and 10% of admissions in acute care hospitals in industrialized countries. In developing countries, the risk is two to twenty times higher and the proportion of infected patients frequently exceeds 25%. The occurrence of HAI in developing countries implies higher mortality rates, prolonged hospital stays, excess costs, increased microorganism resistance to antimicrobials, and other adverse consequences [1,4-11].

Although, HAI is the most frequent result of unsafe patient care worldwide, few data are available and out there and scarcely reported international studies about it especially in resource-limited countries, such as Tunisia. Face to this serious issue, the lack of sufficient data enhances conducting studies to assess current situation. Hence, we believe that results from prevalence surveys are useful to gain an overview of the distribution and magnitude of

Table 1. Main features of study's population

Concepts	Number of patients (%)	95% CI
Admitting department (N=312)		
Medical services	227 (72.7)	[67.8% - 77.6%]
Surgical services	85 (27.2)	[22.3% - 32.1%]
Entry ways for hospitalization (N=312)		
By appointment	163 (52.2)	[46.7% - 57.7%]
Emergency	135 (43.3)	[37.8% - 48.8%]
Transfer	14 (4.5)	[2.2% - 6.8%]
Admission clinical profile (N=312)		
History of hospitalization in the last 12 months	101 (32.3)	[27.1% - 37.5%]
Antibiotic therapy in the last 3 months	76 (24.1)	[19.4% - 28.8%]
Diabetes	64 (20.5)	[16% - 25%]
Immunosuppression	52 (16.6)	[12.5% - 20.7%]
Neutropenia	12 (3.8)	[1.7% - 5.9%]
Antibiotics most commonly used (N=103)		
amoxicillin and clavulanic acid	27 (35.5)	[26.3% - 44.7%]
Penicillin G	18 (23.6)	[15.4% - 31.8%]
Cephalosporin-third generations	13(17.1)	[9.8% - 24.4%]
Aminoside	10 (13.1)	[6.6% - 19.6%]
Fluoroquinolone	7 (9.20)	[3.6% - 14.8%]
other	28 (1.5)	[0% - 3.8%]
Invasive Care (N=312)		
PVC	205 (65.7)	[60.4% - 71%]
Surgical Intervention	49 (15.7)	[11.7% - 19.7%]
Urinary Probe	30 (9.6)	[6.3% -12.9%]
Intubation/Artificial ventilation	15 (4.8)	[2.4% - 7.2%]
Gastric Tube	8 (2.5)	[0.8% - 4.2%]
Operated patients profile (N=49)		
ASA Score 1-2	42 (85.7)	[75.9% - 95.5%]
Intervention duration <2H	41 (83.7)	[73.4% - 94%]
NNIS Code 0-1	41 (83.7)	[73.4% - 94%]
Contaminating class 1-2	40 (81.6)	[70.8% -92.4%]
Scheduled surgery	38 (77.6)	[65.9% - 89.3%]

CI: confidence interval; PVC: Peripheral venous catheter; ASA: American Society of Anesthesiologists; NNIS: National Nosocomial Infection Surveillance

Table 2. Characteristics of health-care associated infections

Characteristics	Number of patients (%)	95% CI
Prevalence	39 (12.5)	[8.8% -16.2%]
Prevalence according risk level of services		
High risk services	32(24.2)	[19.4% - 29%]
Low risk services	7(3.9)	[1.8% - 6%]
Most common HAI system infections (N=45)		
Venous catheter		
peripheral	19(42.2)	[27.8% - 56.6%]
central	1(2.3)	[0% - 6.7%]
ENT	6(13.4)	[3.4% - 23.4%]
Respiratory tract	4(8.9)	[0.6% - 17.2%]
Pneumonia	3(6.7)	[0% - 14%]
Urinary tract	2(4.4)	[0% -10.4%]
Surgical site(superficial infections)	2(4.4)	[0% - 10.4%]
Skin/soft tissues	2(4.4)	[0% - 10.4%]
Others	6(13.3)	[3.4% - 23.2%]
Isolated germs(N=6)		
Negative Gram Bacilli (NGB)	4(66.6)	[28.9% -
Coagulase Negative Staphylococci	1(16.7)	104.3%]
Candida albicans	1(16.7)	[0% - 46.5%]
		[0% - 46.5%]

HAI: Healthcare-associated infection; CI: confidence interval; ENT: Ear, Nose and Throat

HAI and lead to major cost savings through the improvement of basic infection control measures in any healthcare setting, regardless of resources available or level of development. Our survey highlighted an infected patients' prevalence of 12.5% and a HAI prevalence of 14.5%, higher than those reported by literature in developed countries higher than what was found in several countries since 2000: 4.9% in Italy [12], 7.2% in Switzerland [13], 7.2% in Netherland [14] and 5.4% in France [15]. In Norway studies showed an overall rate of 6.5% of HAI. The prevalence of HAI ranged from 6.6% in 1997 to 7.2% in 1999. Urinary tract infections predominated (2.9%), lower respiratory tract infections represented 1.0% and skin and soft tissue infections were present in 1.6% of all cases. Postoperative wound infections were registered in 0.3% among operated patients [16]. In addition, the calculated prevalence rate in UK was 9% which mainly affected four sites: the urinary tract (23.0%), surgical-wound infections (10.7%), lower-respiratory tract (22.9%) and skin infections (9.6%) [17]. Other survey conducted by Smyth et al in acute hospitals across England, Wales, Northern Ireland and the Republic of Ireland estimated an overall prevalence of 7.59%. HAI prevalence in England was 8.19%, in Wales 6.35%, in Northern Ireland 5.43% and in the Republic of Ireland 4.89%. They noted also that the most common HAI system infections were gastrointestinal (20.6% of all HAI), urinary tract (19.9%), surgical site (14.5%), pneumonia (14.1%), skin and soft tissue (10.4%) and primary bloodstream (7.0%) [18].

Likewise in France, a conducted study, by Floret and al, reported a prevalence of 6.1% and varied according to the category of patient from 1.93% (no risk factors) to 15.2% (three risk factors). The prevalence of SSI (surgical site infection) was 2.2% in 2004. The prevalence of urinary catheter infections on the day of the survey or in the seven days preceding the survey was 17.6% in 2004. The prevalence of intravascular catheter infections in exposed subjects was 0.8% in 2004 [19]. As well as Greece, where the calculated prevalence of HA1 was 6.8%, 5.5% and 5.9% for the three years, respectively. Among these, urinary tract infections ranged from 22.4 to 38.2%, lower respiratory tract infections ranged from 21.1 to 32.6%, SSI ranged from 14.6 to 22.7% and bloodstream infections ranged from 9.0 to 13.2% [20]. Indeed, the prevalence of patients with at least one HAI was 4.6% in Slovenia. The prevalence of urinary tract infections was highest (1.2%), followed by pneumonia (1.0%), surgical wound infection (0.7%) and bloodstream infection (0.3%) in intensive care units (ICUs) [21].

Meanwhile, our rate was comparable to that reported in some developing countries such as Senegal (10.9%) [22] and Morocco where the prevalence of infected patients was 9.7% with a highest HAI in ICUs (34.5%) and lowest in pediatric surgery (1.5%) [23]. The frequency of urinary tract infections was the highest (35%) followed by surgical wound infection (29.3%), lower respiratory tract infection (10.6%), bloodstream infection (8.1%), skin and soft tissue infection (5.7%) and catheter related infection (4.9) [23]. Furthermore, other developing countries reported higher rates such as Congo where the overall prevalence was 34.5%. Among HAI, the most common were SSI (27.1%), followed by lung infections (22.0%) and urinary tract infections (17.0%) [24]. In Lithuania, 37% of patients developed at least one ICU-acquired infection. Respiratory, bloodstream and urinary tract infections were the most common [25].

Thus, in Tanzania, study showed that 19.4% of the patients developed SSI [26] and in Indonesian hospitals 1.7% had SSI, 0.9% had urinary tract infection and 0.8% had septicemia [27]. In addition, Prevalence studies conducted in some developing countries (Albania, Brazil, Tanzania, Thailand and Tunisia) have reported hospital-wide nosocomial infection rates mostly higher than 15% with a range from 6% to 27% [27-29]. The problem affects critically ill patients even more dramatically with infection rates ranging from 11 to 90 episodes per 1000 intensive care unit (ICU)-days among adults, and from 40 to 60 per 1000 ICU-days among neonates (4,7,11). A multicenter study conducted in 27 hospitals in Algeria, Egypt, Italy, Morocco and Tunisia estimated that the prevalence of HAI was 10.5%; this was higher in non-teaching centers and moderate-sized hospitals. Overall, urinary tract infections were the most common (25.9%). Pediatric departments rated particularly high (11.3%). However, urinary tract infections were almost half of HAI in Italy; they were also in the lead in Tunisia [30]. In Egypt, infections of the operating site were predominant infections, while skin and soft tissue infections were most frequent in Algeria and respiratory infections frequent in Morocco [11,30]. The ICU had the higher prevalence rate (24.8%), followed by services of pediatrics (11.3%). Surgery ward, gynecological obstetrics and medical services which had prevalence rate of 8.0%, 7.7% and 7.6% respectively. In Italy and Egypt, HAI were more frequent in the Medical services (respectively 11.5% and 11.6%) than in those of Surgery (8.6% and 8.4% respectively) [30]. We should note, also, that systematic review and meta-analysis conducted by Allegranzi and all precise that prevalence of HAI in developing countries was 15.5% [2].

Regarding causative organisms, overall, 6 samples were positive (HAI bacteriologically documented); 4 of them to Negative Gram Bacilli (NGB), 1 patient identified with *Coagulase negative staphylococci* and 1 case of *yeast C.albicans* ; all of them sensitive to antibiotics. Our results are not similar with those found by Razine and al, the predominant micro-organisms were *Staphylococcus* (18.7%) followed by *Escherichia coli* (14.7%) and *Klebsiella pneumoiae* (14.7%) [23]. Site of infection most frequently affected by *Staphylococcus* was urinary tract (42.9%). Methicillin-resistant strains accounted for 50% of isolated *Staphylococcus*. *Escherichia coli* was resistant to Fluoroquinolones in 27% of cases and to Amoxicillin-Clavulanic Acid in 36% of cases [23]. Almost 65.5% were *Gram-Negative* in Greece [20]. Thus, most frequently single isolated micro-organism was *Staphylococcus aureus* (18.2%) and *Escherichia coli* (10.2%) in Slovenia [21].

In Norway, The predominant bacterial types were *Staphylococcus aureus* and *Escherichia coli*. Only one Methicillin-Resistant *S. Aureus* was isolated [16]. Nevertheless, in Senegal, the germs were multi resistant: *Enterobacter cloacae* secreting broad-spectrum beta lactamase, methicillin resistant *Staphylococcus aureus*, and *Pseudomonas aeruginosa* [22]. *Staphylococcus aureus* was the most frequently isolated micro-organism followed by *Escherichia coli* and *Klebsiella spp.,* most of which were multi-resistant in Tanzania [25]. Indeed, microbiological examination highlighted five germs responsible for HAI in infected patients: *Escherichia Coli* (11.9%), *Staphylococcus aureus* (6.8%), *Pseudomonas aeruginosa* (5.1%), *Shigella spp* (5.1%) and *Salmonella typhimurium* (1.7%) in Congo [24]. *Coagulase-negative staphylococcus, S. aureus* and *Acinetobacter* were isolated in Lithuania [25]. In addition, Amazian and al, in a multicenter study, showed that four germs accounted for almost half of all germs isolated: *Escherichia coli* (17.2%), *Staphylococcus aureus* (12.5%), *Pseudomonas aeruginosa* (9.2%) and *Klebsiella aneumoniae* (9.2%); this study precise that 31.6% isolated *S. aureus* were resistant to Methicillin. Though, 13.5% of the isolated

Enterobacteriaceae were sensitive to all antibiotics, 39.6% were resistant to Aminopenicillins, 14.6% to Third Generation Cephalosporins, 5.2% to Cephalosporins Third Generation, Quinolones and Carbapenems [30].

Concerning prescribing habits of antibiotics, our study highlighted that 69.7% of patients received monotherapy in the last 3 months, 15.8% received dual therapy and 14.5% received triple therapy. Most common prescribed antibiotics were association of Amoxicillin and Clavulanic Acid (35.5%) followed by Penicillin G (23.6%) and Cephalosporin- Third Generations (17.1%). Indeed, 34.7% of patients who have undergone surgery received a prophylactic antibiotherapy which is mainly association of Amoxicillin and Clavulanic Acid and Nitroimidazoles. The appropriate use of antibiotics was brought up for debate in many studies and researches. This issue is largely discussed and still a controversial subject as antibiotics are still widely prescribed. Approximately, same condition reported by Razine in Morocco where 32.8% of patients were receiving antimicrobial drugs. They were curative in 76% and prophylactic in 24% of cases: Amoxicillin-Clavulanic Acid (32%) and Third-Generation Cephalosporin (13%) [23]. In Norway, only 7% of patients with wound infections received Antibacterial prophylaxis or treatment [16]. In Congo, Cefotaxime, Third-Generation Cephalosporin was the most prescribed antibiotic (37.9%), followed by Amoxicillin (19.6%) and Ampicillin (16.3%) for monotherapy. Dual and triple therapy was also prescribed [24]. Even in Greece, the prevalence of antibiotic usage among the hospitalized patients was found to be 49.3% in 1994 and 52.7% in 1996 [20].

4.1 Limitations

The main limitation of our study is the identification of only cases in a public UHC which could under-link records. This would have led to selection bias and a corresponding underestimation in prevalence of HAI.

4.2 Recommendations

In order to have a better approach to the reality of HAI and to be able to evaluate the trend over time, it would be interesting to carry out periodic and successive prevalence surveys. This method also leads to evaluate the impact of the preventive measures put in place between the successive surveys. Moreover, it is necessary to carry out multicenter prevalence surveys with a much larger number of establishments with a randomized sample which allows a more accurate approach to the national situation with the aim of proposing standard national surveillance measures.

5. CONCLUSION

Henceforth HAI are preventable, we believe that it is yet largely underestimated and even unknown by some healthcare professionals and policy makers. More emphasis should be placed in order to interrupt the ongoing high rates especially in our country where we suffer from lack of equipment, awareness and resources. Indeed, information reported by this survey may help to give an overview of status. Elsewhere, government involvement and pledge to action is crucial to make preventive interventions a successful reality.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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