MedPharmRes

journal of University of Medicine and Pharmacy at Ho Chi Minh City
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Review

Hospital-acquired infections in ageing Vietnamese population: current situation and solution

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Received May 23, 2019: Revised May 01, 2020: Accepted May 12, 2020

Abstract: Hospital-acquired infection (HAI) is a growing problem all around the world particularly for countries with aging and high-density population such as Vietnam. In this review, we summarized the current status of HAIs in Vietnam regarding types of infection, rates of infection, hospital-stay duration and cost of treatment, and provided an overview with suggestions on strategies in combating these infections especially in Vietnamese settings. From quite dispersed and varied data reported in English and Vietnamese, we have seen HAI rates of less than 10%. Over the years, the HAIs in Vietnam remained quite stable and even slightly decreased in recent years. Among all HAIs, respiratory tract infections are the most common, occurring in up to 80% of cases. Most Vietnamese statistical data on the etiology of HAIs focused on bacterial HAIs, mostly Candidiasis, whereas limited information was found on fungal infections, nosocomial viral and other parasitic infections. The most important HAI causative pathogens in Vietnamese hospitals include *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, *Klebsiella pneumoniae*, *Staphylococcus aureus* and *Candida* species. There is absolutely few scientific data, but web-based information on HAIs treatment cost and measures to control the infections were found. Works are reported to be implemented to control HAIs in Vietnam at both national and hospital level. However, further improvement in controlling HAIs in Vietnam should be considered.

Keywords: Ageing population; control; hospital- acquired infections; Vietnam.

1. INTRODUCTION

Hospital-acquired or healthcare-associated infections (HAIs) are infections which did not present or incubate at admission yet acquired during hospitalization. Infections occurring later than 48 hours after admission are usually considered as HAIs [1]. HAIs are also known under other ancient Greek-derived names as nosocomial (*nosus*- disease and *komeion*- take care of) or iatrogenic (*iatros*- doctor) infections.

HAIs are frequently associated with an open wound and the medical devices used in treatments, such as catheters or ventilators. US Center for Disease Control and Prevention (CDC) has classified HAIs into 4 most frequent types including ventilator-associated pneumonia (VAP), central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI) and surgical site infections (SSI) [2] (Table 1). Sometimes, ventilator-associated respiratory infections (VARI) is also used as a

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DOI: 10.32895/UMP.MPR.4.2.1

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more general type than VAP or a combination of VAP and ventilator-associated tracheobronchitis (VAT).

Today, HAI is a growing problem all around the world particularly for countries with aging and high-density population. It was estimated by the CDC that nearly 1.7 million hospitalized patients acquire HAIs and more than 98,000 of them die due to these annually [2, 3]. The situation is more severe in developing countries compared with the developed ones with the rate of HAIs fallen between 5- 20% for the first and only 3.5- 12.0% for the second [1] [4]. HAI can result in prolonged hospital stay, increased usage of antibiotics followed by increased antibiotic resistance, high cost for patients and excess morbidity and mortality. At macroscopic level, HAI leads to an additional financial burden for the healthcare system, labor and economic loss which were estimated to be 7 billion euros for Europe and 6.5 billion USD for the US in 2004 [1].

For a country with limited resources, early aging population and other risk factors such as low hygiene practice and excessive antibiotic usage like Vietnam, it is urgent to establish efficient intervention to control HAIs. So far, managing and controlling methods in Vietnam are yet enough, gaps of information are also observed due to poorly developed national surveillance systems.

In this paper, we provide an overview of current situation of HAIs in Vietnam by summarizing prevailing data both in English and Vietnamese from accessible online resources. At the same time, we also discuss factors influencing HAIs, economic impacts of HAIs, current managing application and strategies in combating these infections, especially for Vietnamese settings.

2. CURRENT SITUATION OF HAIS IN VIETNAM

As there is no national surveillance system, data on HAIs in Vietnam were quite dispersed and limited.

In 2005, HAI prevalence was reported to be 6.0% in a point prevalence study conducted in 19 hospitals, including 4 tertiary and 15 provincial hospitals with 9,345 inpatients [5].

In 2006, HAI prevalence at 5 hospitals in the capital area was shown to be 10%. Respiratory tract infections, SSI and digestive tract infections were the three most common types with the rate of 36.5%, 29.9% and 19.6%, respectively. ICU was the unit with the highest prevalence of HAIs (25.8%) [6]. In the similar period, a survey in Bach Mai Hospital, a tertiary hospital in the same area for 1,354 inpatients, presented a prevalence of HAIs of 5.7% of which respiratory tract infection was also the most common (75%), followed by UTI (31.3%) and digestive tract infections (5%) [7]. ICU was again the unit with the highest HAI prevalence (31.3%) [7, 8].

In the period 2007-2009, a provincial hospital in the central Vietnam, Binh Dinh Hospital, showed that HAI prevalence was from 6-8%, in which SSI was of the highest rate 29.5% followed by skin and soft tissue infections (23.5%) and respiratory infections (20.6%) [9]. In a relatively systemic research on HAIs with data of 7,571 inpatients of 36 hospitals in 2008, HAI rate was 7.8% on average with the highest prevalence found in ICU (23.7%). Among all HAI cases, pneumonia was dominant (41.9%) followed by SSIs (27.5%) [10].

In 2014, HAIs prevalence was reported to be 2.7% in a southern Vietnam hospital, Dong Nai hospital, of which respiratory infections contributed highest rate (38.5%) [11].

In 2015, hospital "108" in Northern Vietnam reported the HAIs prevalence of 3.86% with highest rate for SSI (37.25%) followed by pneumonia (33.33%), UTI (19.61%), CLABSI (5.88%) and digestive tract infections (1.96%) [12].

Another report collecting data of 1,350 inpatients in northern provincial hospital, Vinh Phuc hospital in 2018 presented HAI prevalence of 12.1% where the rate of different infections was 52.1%, 21.47%, 12.27%, 5.52%, 4.91% and 3.68% for respiratory tract infections, SSI, skin and tissue infections, BSIs, UTIs and other infections, respectively [13].

Cross-sectional study results showed on the website of a secondary hospital in Hanoi, Duc Giang hospital, indicated that the HAIs in this hospital slowly decreased over the years with 3.5% in 2015, 3.07% in 2016, 2.9% in 2017 and 2.8% in 2018[14]. Most of HAIs cases found were VARI and SSIs[14].

Even though the data were quite varied, it seemed that HAIs in Vietnam remained quite stable or even decreased in recent years. Among all HAIs, respiratory tract infections are the most dominant.

Besides general HAI reports, some researches on specific HAIs were also noted such as VARI/ VAP, SSI CAUTI and BSI. A study on VARI in four ICUs of three tertiary referral hospitals in Vietnam between November 2013 and November 2015 reported HAI VARI of 24.6%, HAI VAP of 9.9% [15].

Regarding SSI HAIs, its prevalence was reported as 5.2%, 6.3%, and 2.2 %, in Hung Vuong Hospital in 2009, SaDec hospital in 2012, Nguyen Tri Phuong hospital in 2015, respectively [16-18]. For Hung Vuong Hospital, a decreased trend was somehow noted as a study of post-cesarean surgical site infections in 1997 on 969 women delivered by cesarean showed rate of infection of 9.8% [19].

In Cho Ray tertiary hospital, the SSI in general interestingly showed a decreasing trend with more than 10% (12.5%- 14.3%) in the 2000s to 6% in 2015 and 4% in 2016 [20-23]. A similar observation was seen in Bach Mai tertiary hospital with SSI rate of 10.9% in 2001 and 5.5% in 2010 [7, 8, 24, 25].

Regarding UTI HAIs, while high prevalence of CAUTI (51.3 %) was shown in 39 patients using bladder catheter in Bach Mai hospital in 2010 [26], much lower CAUTI prevalence (15.2%) was present in a similar study in An Giang hospital with 46 patients [27]. In the case of BSI, a study in Bach Mai hospital on showed that bacteremia not excluding community-acquired one was 13.9% in the period 2009- 2012 [28].

Regarding specific HAI report in ICUs, a research on 1,143 pediatric ICU inpatients in 3 tertiary hospitals in Hanoi and Ho Chi Minh city during 2012-2013 showed that the HAI prevalence was relatively high, 33.1%, with pneumonia (52.2%), BSI (26.4%), SSI (2%) and necrotizing enterocolitis (2%) [29]. Another study with data from 15 ICUs throughout Vietnam in the period 2012-2013 presented an average HAI rate of 29.5% among which pneumonia, BSI, SSI and UTI

accounted for 80.8%, 6.1%, 4.7% and 3.4%, respectively [30]. This research also pointed out that 42.5% of HAIs acquired before ICU admission and 57.5% developed after ICU admission. The most common HAI was pneumonia (79.4%), followed by BSI (4.4%) and SSI (4.2%) [30]. Recent data on HAIs of adult ICU in Ho Chi Minh City Hospital for Tropical Diseases, a tertiary referral hospital for infectious diseases serving Southern Vietnam showed the prevalence of 23.4% in the period 2014-2016 [31]. One found research on neonatal ICU of children hospital 1 studying 892 neonates showed a cumulative HAI rate of 12.4% of which VAP constituting 50% following by BSI, 31% and SSI, 10% [32].

In short, the prevalence of HAIs in Vietnam is about 10% of which VARI/VAP/VAT is of the most common type. HAIs are also most frequently found in ICUs with a range from 19.3- 31.3% (Table 1). It is understandable because most seriously ill patients are in ICUs where they are almost always on a certain type of invasive treatments and antibiotics therapy.

Table 1. Prevalence of some common types of HAIs. High income countries (HICs); Low and middle income countries (LMICs)

Type	Prevalence (of HAIs)		Risk factors	References
	Worldwide	Vietnam		
HAIs	~16% (HICs); ~33% (LMICs)	33% (pediatric ICU) 19.3- 31.3% (ICUs) 2-10% (in general)	Prolonged usage of tubes/ catheters and antibiotics; Infant, elderly and people with immunodeficiency or chronic diseases (cancer, diabetes etc.); Poor hygiene application;	[1-4] [13, 29, 32, 33]
Ventilator associated respiratory infection (VARI): Ventilator associated pneumonia (VAP) and ventilator-associated tracheobronchitis (VAT)	32% (VAP, ICU); ~9% (VAP, HICs); ~20% (VAP, LMICs)	9.9% (ICU); 30-80% of HAIs	Ventilation application; Hyperchlorhydria; chronic pulmonary diseases	[1-4] [15]
Central line associated / Catheter- related bloodstream infections (CLABSI/ CRBSI)	20% (ICU); ~4% (HICs); ~9% (LMICs)	4.4% (ICU); 6.6% (BSI, general) 10-30% of HAIs	Prolonged usage of catheters	[1-4] [13, 28, 33]
Catheter-associated urinary tract infections (CAUTI)	20% (ICU) ~4% (HICs); ~9% (LMICs)	10- 30% of HAIs (for UTI in general)	Prolonged usage of catheters; Diabetes; Renal failure; Pregnancy	[1-4] [13, 26-28, 33]
Surgical site infections (SSI)	6-12%	20- 40% of HAIs	Surgical techniques, Obesity; Malnourishment; Low hygiene of surgical equipment and post-operative wound care;	[1-4] [13, 16, 24, 25, 28, 33]

Regarding etiological causative agents of HAIs, bacteria are the most important and dominant ones accounting for more than 70% of all HAIs followed by fungi (~ 15%), viruses (~ 5%) and other parasites [34, 35]. The origin of these pathogens can be either exogenous (for a majority of cases), i.e. from inanimate hospital objects such as catheters, needles, etc. or animate such as other patients and health workers, or endogenous, i.e. from patients' flora. The bacterial agents which are the prevalent causes of HAIs are mainly Enterobacteria, Staphylococcus and Pseudomonas and Legionella while nosocomial viral agents can be named as Respiratory syncytial virus, Rotavirus, Hepatitis B and C Viruses, HIV, CMV, Influenza virus, Herpes [36, 37]. The significant nosocomial fungal agents include Aspergillus, Candida, Trichosporon, Fusarium, Malassezia, Mucorales [36, 38, 39]. On the other hand, nosocomial parasitic agents are Plasmodium, Giardia, Toxoplasma, Cryptosporidium and Sarcoptes scabies [36, 40].

Most Vietnamese the statistical data on etiology of HAIs focused on bacterial HAIs, mostly Candidiasis, whereas limited information was found on fungal infections, nosocomial viral and other parasitic infections. It is generally due to difficulties in the establishment and cost of the procedure and diagnostic tests for non-bacterial infections. Furthermore, the variable prevalence of these pathogens in the hospital settings also matters. The non-bacterial nosocomial causative agents can be dominant in the healthcare systems during their epidemics, in epidemic regions or within some special groups of patients, but their prevalence does not last for a long time, for many places or for the most hospitalized patients. Therefore, it is normally seen that the non-bacterial

HAI agents are only estimated in some special circumstances. For example, in 2003, where SARS and Influenza type A took peaks, it was reported that SARS and H1N1 caused dozens of healthcare workers infected [41]. HCV, HBV, HIV and few other parasites are also noted as Vietnam is in the epidemic region for these diseases [42]. The non-bacterial HAIs are obviously damaging and serious and it is no doubt that HAI viral and parasitic infections should be of more attention. Protection for healthcare workers from these HAIs is the combination of pre-requisite steps to prevent these non-bacterial HAIs from spreading.

During the period 2002-2009, it was reported in Bach Mai hospital that *A. baumannii, P. aeruginosa, K. pneumoniae* and *Candida spp.* were the four principal causative agents of HAIs [43]. The prevalence of *A. baumannii* was 29.4% in 2002 and 42.9% in 2009, *P. aeruginosa*, 28.6% and 17.7%, *K. pneumoniae* 11.9% and 6.1%, and *Candida spp.* 8.7% and 18.4% in 2002 and 2009, respectively. In this hospital in 2006, the four frequent bacterial causes of HAIs were still these with slightly different rate: *Pseudomonas aeruginosa* 28.6%, *Acinetobacter baumannii* 23.8%, *Klebsiella pneumoniae* 19.0%, and *Candida spp.* 14.3% [7]. Besides these four pathogens, *Enterococcus faecalis, Staphylococcus aureus, Burkholderia cepacia, Escherichia coli* were also among the significant pathogens that caused HAIs in Bach Mai hospital [43].

In general, it was estimated that 70-80% of HAIs were caused by Gram-negative bacteria, while 14-30 % of the cases were due to Gram-positive ones and about 11% were due to fungi [11, 33]. Among all nosocomial pathogens, *Klebsiella pneumoniae* caused 17.1% HAIs, *Acinetobacter spp*. - 16,9 %, *P. aeruginosa* - 16.9%, *Enterobacter*- 13.7%, *E. coli* - 11.3%, *S. aureus* - 8.8%, coagulase-negative *Staphylococci* - 7.30% and *Candida spp.* - 3.2% [11] (Figure 1). A similar pattern was found in ICUs. However, *Acinetobacter spp.* was the most dominant HAI causative pathogen (30.7%), followed by *P. aeruginosa* (13.8%), *K. pneumoniae* (11.6%), *E. coli* (5.4%), other Gram-negative bacteria (22.7%), *S. aureus* (5.4%), coagulase-negative *Staphylococci* (2.6%), Enterococcus (4 %), Streptococcus (1.5%) and Candida (1.4%) [33]. Similar bacteria pathogens were seen in neonatal ICU with the dominance of Gram-negative ones such as Klebsiella 36.5% and *Acinetobacter spp.* (20.5%) [32].

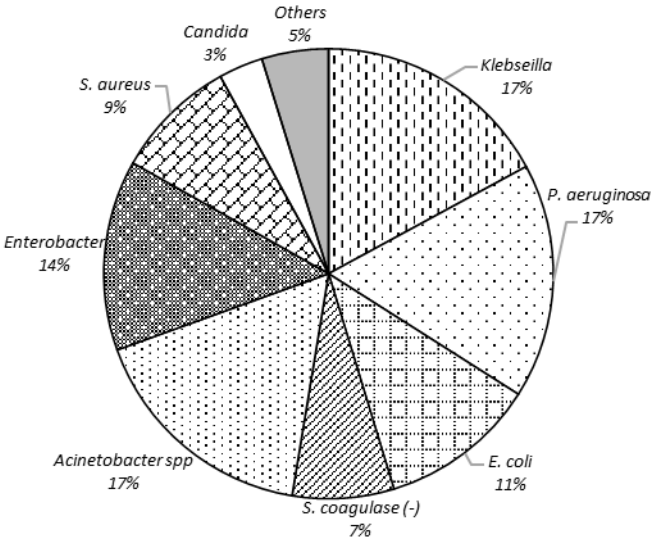

Figure 1. Estimated microbiological etiology of HAIs in Vietnam.

The etiological data of HAIs can be varied depending on types of infections. For SSIs, *S. aureus* was reported as the main pathogen (45.4 %), followed by *P. aeruginosa* (27.3%) and *Enterococcus spp.* (27.3%) [17]. For UTI, *E. coli* caused most of cases (85.7%) and the left was due to Enterococci [27]. For CLABSI, the main causative agent was *A. baumannii* (85.7%) and *K. pneumonia* (14.2%) [44]. For BSI in Bach Mai tertiary hospital (2009-2012), the major pathogens were coagulase-negative *Staphylococcus spp*. (16.7%), *Escherichia coli* (6.8%), *Staphylococcus aureus* (5.2%), *Klebsiella spp*. (4.2%) *Streptococcus spp.* excluding *Streptococcus pneumoniae* (3.8%) and *Acinetobacter spp.* (2.2%) [28].

3. INFLUENCING FACTORS OF HAIS

HAIs are transmitted via digestive, respiratory and urinary tract as well as via blood and skin. The most important transmission way for HAIs is through contact both directly and indirectly to patients from hands of healthcare personnel or visitors, injectors, needles, syringes, invasive medical tools, bandage, wound and patients' secretion. The other way is through droplets from infection sources due to talking, sneezing, coughing or manipulating…Therefore, from the hospital site, the risks of HAIs are associated tightly with hygiene, infrastructure, number, practice and knowledge of healthcare personnel, and patient density [45]. The presence of local and national guidelines and policies in the hospital setting is also another important factor. From the patient site, HAI risk factors include having pre-existing diseases such as diabetes, cardiovascular diseases and HIV, weigh problem (being obese or malnourished), pregnancy, surgery after admission, extended hospitalization duration, using tubes or catheters and using extensive antibiotics [45]. Besides, age is a well-noted influencing factor as infants and elderly have higher risk of getting HAIs mostly due to their inefficient immune defense [46, 47].

In Vietnam, most of data focus on evaluating the risk of HAIs regarding the patient site. A study at ICUs showed that the highest risk factor for HAIs to develop was intubation (27.6%), having surgery after admission- major surgery (up to 36.1%) and urinary catheterization (25.4%) [30]. Interestingly, this research also indicated that if family members involved in patient care, then the risk of developing HAIs decreases [30]. Another recent research in ICU indicated that ICU patients have a high risk of being colonized with antimicrobial-resistant organisms and subsequently infected by these same microorganisms with the contribution of 57.1% all HAIs. This study also emphasized that vascular catheterization is an important risk for HA-BSIs [31]. The data were also in agreement with a cross-hospital study on 1,070 inpatients in four hospitals and one kidney and dialysis center in the capital regions which showed that intubated, ICU and pediatric patients having high risks of acquiring HAIs [6].

Besides, the risk of developing HAIs in patients undertaken surgery was also frequently assessed. It was reported that rate of patients suffered from SSI was about 10.9% with the highest rate for cardiothoracic operation (33.3%) and lowest for obstetric-gynecologic procedures (2.4%). Surgery-related factors contributing to HAIs also include types of surgery, i.e. emergent surgery having 9 times higher risk than elective surgery; duration of surgery i.e. over-1- hour surgery having 3 times higher risk than a less-than-1 hour surgery and post-surgery intubation, i.e. with intubation having 9.6 times higher risk than without [17]. Besides, the incidence of SSIs was particularly high for the dirty wound (43.9- 44.6%) and low for clean wound (2- 8.3%) [22, 24]. It is estimated that emergency surgery and procedures with external fixation were especially prone for SSIs as well as HAIs [22]. It would be a big concern as motor-vehicle- related accidents are relatively high in Vietnam resulting in the high rate of emergency surgery. In addition, monitoring colonization should be carefully considered to reduce the risk of HAIs in surgery patients. Besides, it was also noted by a study on post-cesarean surgical site infection that increased surgical blood loss and higher body mass index are also important risk factors of SSIs [19].

Regarding medication usage, the patients who took corticoids before surgery would have 10.6 times higher risk of developing HAIs than the ones who did not. Particularly, antibiotics usage affects significantly HAIs. It was shown that appropriate doses of prophylactic antibiotics significantly reduced SSIs [23].

In a developing and aging country like Vietnam, age should be considered for a long-term HAI controlling plan as it was reported that HAIs increased with age [14, 47]. It is understandable as aging patients often have poor immune system and existing health problems such as high blood pressure, diabetes and chronic respiratory diseases. A study working on the relationship of HAIs and patient age in Dong Nai general hospital showed a significant difference in the rate of HAIs between the young and the elderly ($p< 0.05$) [11]. Generally, the HAI percentage of over 60-year-old patients was 5.4% while it was only 4.1% for 45-60-year-old group and this prevalence dropped down to 0.9% at the 30-45-year-old group (Figure 2) [11]. Besides, within ICU, the percentage of HAIs for 18-60 years old group was 15% while for over 60 years old group was slightly higher, 17.4% HAIs [33]. In a specific research studying the transmission of tuberculosis to healthcare workers, a special and alerting type of HAIs, besides educational level, body weight, age is also well-noted as a risk factor for this HAI type [48].

Regarding hospital site, it was thought that government tertiary/referral hospitals should have higher rate of HAIs than the primary ones due to higher patient density and the use of more invasive treatment. However, the data were quite varied, depending on years and medical practice at the hospitals. Among provincial hospital reports, low HAI prevalence was found in Dong Nai hospital in 2013 (3.3%)., medium HAI prevalence in Binh Dinh general hospital, 5.9%, Sa Dec Hospital 6.3% and high prevalence in Vinh Phuc (12.1%) [9, 11, 13, 17]. Similar situation was observed in group of tertiary/ referral hospitals like Cho Ray and Bach Mai hospital.

In general, the common point that most data revealed was that once a hygiene practice is strictly followed, HAIs can be markedly reduced. A study at Cho Ray Hospital was carried on two neurosurgical wards of which, in one ward (ward A), healthcare workers were introduced and trained to use a hand sanitizer with 70% isopropyl alcohol and 0.5% chlorhexidine gluconate while in the other (ward B) not. Results clearly showed that in ward A, SSI rate was reduced by 54% (from 8.3% to 3.8%; p=.09), and more than half of superficial SSIs were eliminated (7 of 13 in ward A vs. 0 of 6 in ward B; p=.007). In contrast, the SSI rate in ward B increased by 22% (from 7.2% to 9.2%; p=.8) [22].

So far, most clinics and hospitals concentrate on investment of modern and advanced medical equipment but not much attention was paid in improvement of infection control systems. The infection preventions only touched on laundry, sterilization and the management of medical waste instead of proper focus on infection prevention practices and reducing infection rate. In fact, in some cases, even the sterilization process for laundry, medical waste, medical instruments were handed on to service companies with limited evaluation of how it works. One study showed that the hygiene procedure at the hospital was not effective in removing the pathogens on the floor and surface [49]. In particular, the cleaning towels if reused could be the potential sources of pathogens [49]. This study also suggested that HAIs-susceptible departments such as ICU should only use one-time usage materials if possible. Furthermore, depending on the level of infections in each region, the cleaning materials for each place should be color-coded and the frequency of cleaning should be adjusted [49].

In addition, it is reported that most healthcare staffs though are acknowledged of hospital infection control did not receive appropriate training in infection control practices and were not aware of the situation of their own hospital [50]. Until 2016, there had been only 72.06% hospitals which have built up annually infection control plan. Nonetheless, the real infection control action was still very limited, only 35.29% hospitals had specialized infection control department [41, 51]. Medical facilities supporting for infection monitoring and prevention were still not in proper management. Around 40% of hospital lack of proper isolation room, 33.9% hospitals did not have centralized sterilization unit, 57.6% healthcare units did not have instant disinfection solution/ ethanol at public area [41, 51]. Poor quality of infection control execution led to difficulty in controlling HAIs. Besides, hospitals in Vietnam are often overloaded with patients while only limited number of beds is available [41, 51]. Consequently, patients' recovery is influenced.

The HAIs problem has been steadily recognized by the government and much work has been launched recently. This issue is further discussed in the followed section.

4. ECONOMIC IMPACTS OF HAIS AND WHY VIETNAM IS MORE LIKELY TO BE AFFECTED BY HAIS

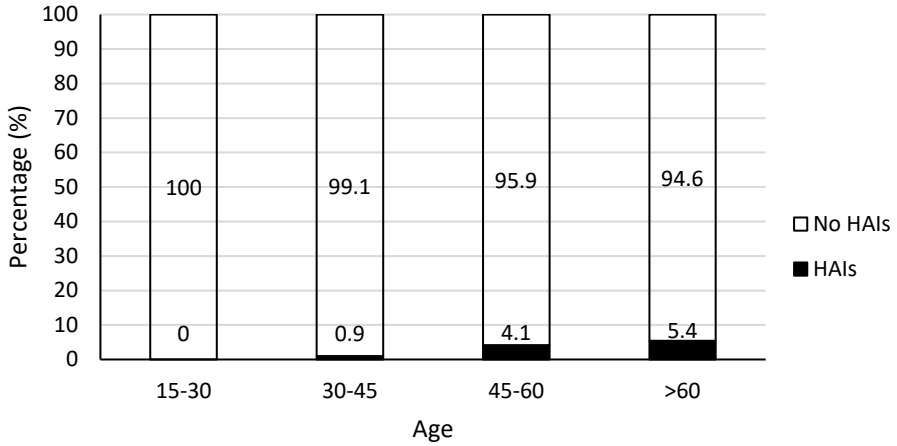

Figure 2: Relationship between HAIs and age of patients [11].

Increased HAIs rate will undoubtedly result in the increased length of hospital stay, extended antibiotic usage followed by rising antimicrobial resistance of pathogens, disease complication consequently increased lifelong disability and mortality rate. All of these push up cost of treatment and lead to loss of workforce and heavy public charge.

Worldwide, the increase in treatment cost due to HAIs is of billion dollars [1]. For example, a study in Mexico estimated that a patient with CRBSI has mean extra hospital stay of 6.1 days, mean extra cost of antibiotics of $US 598, mean extra hospital cost of $US 11,591, and the attributable extra mortality of 20% [52]. A systemic review on HAIs in Southeast Asia saw an extra length of stay from 5 to 21 days and attributed mortality from 7% to 46% due to HAIs [53].

In Vietnam, the loss is yet to be much described in national-level research. A study in 2008 at neonatal ICU of Children Hospital No1 presented an extra hospital stay of 9 days and extra cost of 13.4 million VND (about $US 560) in HAIs- suffered group compared to non-HAI suffered group [32]. A more recent and VARI-specific study estimated the excess cost due to VARI with counting for extra lengths of stay, diagnostics, VARI incidence, utilization of ventilators and antibiotic therapy [54]. It showed that the extra cost was about US$1,174.90 per VARI episode constituting a total annual excess cost of US$40.4 million. Most of the extra cost was for extra antimicrobial treatment (51.1%) and ICU stay (45.1%).

Some data were also found on the website of Ministry of Health showing data from the two largest public referral hospitals in Vietnam, Cho Ray and Bach Mai Hospital [41]. At Cho Ray hospital, HAIs prolonged extra hospitalization stay to 15 days with roughly US$9 hospital-bed fee a day and extra treatment fee due to HAIs of US$150. At Bach Mai hospital, BSI increased hospital length of 24.3 days and treatment fee of US$1,400 while the number for HA-respiratory infections was 23.6 days and US$1,000 and SSI was 11.4 days and US$80. All the estimated extra fees shown were certainly not a small amount for a resident of an LMIC like Vietnam.

In short, economic loss due to HAIs is significant all over the world including Vietnam. However, due to some noted factors indicated below, Vietnam is highly prone to HAIs' economic effect compared to other countries.

At first, as mentioned, Vietnam is still in the lower part of the low-middle income country (LMIC) with gross national income per capita per year about US$5030[55]. Total public expenditure on health per capita is US$ 390 USD, around 7.1% GDP [55].

Secondly, that Vietnam population is high, reaching 97 million by 2020 and condensed in big cities brings significant pressure on the healthcare system. It has been clearly seen over the years that the national healthcare system has not yet met the demand. Until the end of 2016, Vietnam has had 13,591 healthcare stations, of which 1,077 are hospitals, 609 are local general clinics and 11,812 medical stations [51]. There were only 7.8 doctors, 10.8 nurses and 25.6 beds per 10,000 population [51]. The overload situation is usually seen in public tertiary hospitals. It was estimated that hospital bed occupancy in public hospitals is up to 170% [41].

Furthermore, Vietnam is passing the golden age structure of population so the number of elderly is quickly increasing. It was estimated that the percentage of elderly (> 65 years old) was 10.45% among population in 2014 and is expected to triple into >30% in 2050 [56]. The number of people over 80 years old will also increase to more than 6 % of the population by then. Elderly is highly prone to HAIs due to existing chronic diseases, immune dysfunction, prolonged hospitalization and the use of anti-microbial agents. It was reported that a majority of Vietnamese elderly (65.4%) self-valuated their health as weak and very weak, 29.8% as normal and only 4.8% as good and very good [56]. In fact, the rate of chronic diseases in Vietnam elderly is high and tends to increase for some diseases. It was estimated that hypertension in the elderly has increased from 16- 20% in 2003 to nearly 46% in 2011. The same trend was seen for cancer. Other chronic diseases like obstructive pulmonary diseases (COPD) and diabetes are also of relatively high prevalence with approximate rate of 20% and 6%, respectively [56]. Besides, medical treatment cost for elderly was 7 to 10 times higher than younger adults and approximately 50% of total

medicines are used for aging people [57]. The increasing number of the elderly, the low health quality and the treatment cost of this group would bring a lot pressure to healthcare system, making the system more prone to HAIs and their economic impact.

Last but not least is the behaviors of Vietnamese in using antibiotics and hygiene practice. It was estimated that 88% of drugs including antibiotics in cities and 91% in countrysides were sold without prescription [58]. The fact that antibiotics were not only used in human medical treatments but also in other fields like sanitation and agriculture made the situation worse. Besides, even though many hygiene protocols have been applied in hospitals, hygiene and hygiene practice are still a big problems in most hospitals [59]. Antibiotics and hygiene issues undoubtedly contribute significantly to the increased risk and severity of HAIs, thus also dampen the economic loss due to HAIs.

5. HAIS CONTROL SOLUTIONS

Despite continuous efforts in providing successful treatments to patients, hospital infection control and prevention are still challenging regarding Vietnam public health sectors. High frequency of HAIs observed in some hospital reports in Vietnam is the proof of poor health service quality resulting in extra cost for patients. It should be well noted that effective HAI management and prevention is an important criterion for quality service in all medical health care systems.

In recent years, high attention has been drawn on HAIs control with effort in turning it into the responsibility of not only healthcare sectors but also the whole community. HAI control activity include surveillance and prevention activities, together with staff training, medical networking and public education. More supports from national and regional level are paid in managing HAIs control.

Table 2: Current HAIs control solutions

HAIs control solutions		Notable Actions	Impacts
National program	Infection control program [60]	2018: Launching the Circular of infection control in hospitals.	Improving the limitation in infection control and orienting the development of infection control actions in hospital sectors. Clarifying the responsibilities of health authorities in supervising and updating the guidelines, regulations about HAIs controls situation and outbreak investigation.
	Practicing family doctors [61]	2014: Piloting family doctor model in 8 provinces/ cities in Vietnam. Until 2016: There are 336 family doctor clinics in 6 provinces/ cities.	Reducing treatment cost and hospital overloading situation. Reducing the possibility of patients being infected to HAIs due to coming to hospitals.
Hospital program	Staff training and practices [62]	Providing health staff and doctors with initial and continuing training program on infection control. Organize regular meeting to share information and educating infection control practices to clinicians and infection specialists.	Maintaining hygiene and good nursing practices
	Annual infection monitoring plan [60]	Evaluating and promoting epidemiological surveillances among healthcare sectors. Focusing on funds for medical equipment sterilization and technical maintenance.	Acknowledging healthcare personnel and community on the status of infectious diseases in general and HAIs in particular.
	New hospitals construction [63]	2015: 287.9 million USD loan was signed for the construction of Cho Ray Hospital No.2 in Binh Chanh, Ho Chi Minh city	Reducing the hospital overloading situation
Health care for elderly	National-wide Insurance program [64]	2002: Implementing healthcare funds policy for the poor. Implementing social health insurance scheme, Encouraging a healthy lifestyle, applying practice of hygiene and promoting basic knowledge in healthcare at household level. Improving public awareness about illness management and how to take care for elderly.	Decreasing healthcare cost burden for insured and low- resource people. Improving life quality of elderly Maintaining ability of elderly to continuously contribute to the society

5.1. National program

Control and prevention of HAIs are the responsibility of not only healthcare systems but also the whole society. It is necessary to develop an efficient national program to reinforce healthcare sectors in reducing the risk of HAIs. To be effective, the program must be comprehensive and include specific surveillance and prevention activities. At current, with the purpose of improving the limitation in infection control and orienting the development of infection control actions in hospital sectors, the Ministry of Health has launched the Circular of infection control in hospitals, to replace the old circular number 18/2009/TT-BYT, in 2018 [60]. Accordingly, each hospital needs at least 150 beds with infection control committee and infection control department. Hospitals with lower than 150 beds require to have infection control section with full-time working responsible person. Besides, the Circular also regulates clearly about the responsibility of department of health in each city/province and responsibility of the head person in each hospital or clinics. People who are responsible for infection control must strictly follow the procedure in monitoring and reducing infections while health authorities are in charge of supervising and updating the guidelines, regulations frequently to meet the current infection control situation and outbreak investigation [60].

Another effort from Vietnamese ministry of health to reduce the risk of HAIs is the practice of family doctors [61]. This model has been piloted in Vietnam in 8 provinces and city since July 2014. Doctors in family doctor system are required to have comprehensive training to treat patients as well as ability to keep and understand the health profiles of the patients and their whole family. Until 2016, there have been 336 family doctor clinics at 6 cities/ provinces. At the same time, family doctor model helps in reducing treatment costs and hospital overloading. Family doctors not only treat the disease but also educate patients about disease infection and help them controlling chronic diseases. People who need specialist treatment will be referred to experts in different medical fields, which help to reduce the overload at tertiary hospitals and the chances of patients being exposed to HAIs when they must frequently come to hospitals.

5.2. Hospital program

Crucial preventive effort should be concentrated on hospitals and related healthcare facilities as they are roots of HAIs. The hospital program can be divided into staff training and practice and an annual application of infection monitoring plan.

Staff practice driven by knowledge plays an important role in hospital infection control. Most of the tertiary hospitals also have their guidance to instruct their staffs working properly to monitor and prevent HAIs beside the general instructions established by the ministry of health [65].

The HAIs prevention should be concerned with all patients as well as staffs. At the same time, it requires to be supported at the senior administration level. Healthcare staffs and doctors should be provided with initial and continuous certified training program/ course on infection control and safety. Clinicians and infection specialists should meet regularly to share information and educate other staff members on the best practices. Nursing staffs are responsible for maintaining hygiene, consistent with hospital policies and good nursing practices. Indeed, the continuous training programs are currently quite well executed and maintained in big hospitals following the circular of Ministry of Health in 2013 [62]. The circular said that all healthcare staffs are required to participate in continuous approved training programs by qualified training centers, at least 12 hours a year [62]. The training hours can be derived from some programs such as Safety for Patients, Safety in Medical Laboratory or annual hospital/ medical conferences/ meetings approved/accepted by Ministry of Health.

Additionally, to reduce HAI risks, an annual infection monitoring plan to evaluate and promote good healthcare, appropriate isolation, sterilization, staff training, and epidemiological surveillance should be developed. Hospitals and health clinics must strictly comply with those programs and regulations. Central sterilization department duty is to clean, test, decontaminate, sterilize and store all sterile hospital tools and equipment to ensure the sterilization process and technical maintenance for the next use. The intra- and inter- transport of patients should also be well controlled to reduce the risk of HAIs.

Obviously, poor general infection control practices poor are the result of deficient facilities, limited surgical instruments, and a lack of proper supplies for wound care and personal hygiene. Therefore, funds for medical equipment to implement infection prevention practices should also be increased particularly for public medical healthcare system.

Moreover, constructing new hospitals helps reducing patient density and overloading situation in big general hospitals in Vietnam. In 2015, 287.9 million USD loan was signed for the construction of Cho Ray Hospital No.2 in Binh Chanh, Ho Chi Minh city. Until 2019, in Ho Chi Minh City only, 13 general hospitals and 1 center for disease control (CDC) are build or initiated for building [63]. Much has been done in the Vietnamese main cities like Ho Chi Minh and Hanoi to control HAIs, however, neglection is still observed in small cities and rural areas.

5.3. Healthcare for the elderly

Unlike other geriatric syndromes, HAIs can be a result of multiple risk factors such as patient conditions, environmental and care-related risk factors. Additionally, the aged body is different physiologically from the younger adult body. During aging, the decline of various organ systems becomes manifested, thus diseases in the elderly result in more complications [47]. Improving healthcare for the elderly is one of the efficient ways to reduce HAIs as it could help to prevent this HAIs-high-risk group from being hospitalized. The improvement can be made via increasing the access of the elderly to healthcare system for chronic disease control and health check-up, relieving healthcare cost for the elderly with health insurance program, effective guidance for healthy aging and regular health checks, and treatment regime specialized for elderly.

So far, the access to health services for the elderly is still limited in Vietnam, especially to those who live in rural area [56]. In the whole country, there were only 302 geriatric clinics which are mainly for treatment and usually overloaded, with a very small number of geriatric departments in provincial hospitals [56].

Regarding health insurance for the elderly, Vietnam has made a milestone with more than 11 million of elderly having health insurance card in 2018 [56]. This would promote elderly to perform health examinations more frequently and seek treatment earlier. However, due to limited financial resource, periodical health examinations are still not covered by health insurance and insurance payment protocol is still not widely welcome.

Data showed that elderly normally requires long-term care facilities which need an infection prevention approach different from what is established for acute care facilities [47]. Furthermore, it was also indicated that in long-term care facilities, multi-drug resistance develops and transmits more easily than in acute care facilities due to the long-term treatment, overuse of antibiotics, mobility of patients and even less strictly hygiene practice of the healthcare personnel [47]. It is necessary to establish treatment regime or guidance specialized for the elderly to reduce HAIs in long-term care facilities and for this group of patients.

Health service for the elderly, insurance or guidance would not work efficiently without the hand of the whole society. Caring for the elderly is now mainly performed by their family members who are mostly lack of knowledge on the elderly healthcare. Therefore, it is necessary to improve public awareness about illness management, promoting healthy lifestyle, promoting basic knowledge in healthcare at household level, considering geriatrics care, establish effective elderly healthcare guidance and improving the aging population's quality of life.

Besides, delivering a healthy lifestyle education to the population is an effective practice in preventing infection from the beginning, thus reduce the rate of hospitalization in elderly and as a result, the rate of HAIs. People are advised to apply appropriate practice of hygiene, for example, good hand hygiene and good respiratory etiquette, and to maintain their vaccination status to be up to date on immunization to prevent later complications. At the same time, Vietnamese patients and families should change their habit in using antibiotics by being aware of the proper use of antibiotics and avoiding taking any medicine without doctor's advices.

6. CONCLUSION

HAI in Vietnam is a recognizable problem with a very high rate in ICU and surgery departments. Much effort of HAI controlling has been done in tertiary but not in provincial hospitals. With an increased number of the elderly together with dense population and rising antimicrobial resistance, the healthcare administrations in Vietnam are facing challenges in control and reduction of HAIs. More specific methods for controlling infection transmission and sound practice should be performed by infection control committees to reduce the number of HAIs cases. Health authorities and medical experts are needed to perform specific programs at both national and hospital levels to prevent the outbreak of HAIs. Appropriate bio-safety training for hospital staff, proper waste treatment, increasing general public health awareness and education together with medical support for elderly are appropriate interventions for reducing endemic HAIs. Finally, controlling HAIs requires firm decision and persistence of leaders and managers to settle down short-term and long-term plans.

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