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# Perspectives of Infection Control Specialists Regarding Electronic Surveillance Reduce Respiratory Infections in Hospitalized Patients in Saudi Arabia 2024

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**Abstract:**
**Background:** The Saudi Health Electronic Surveillance Network's (HESN) stated goals are to help prevent and manage various health incidents and to make it easier to carry out other public health initiatives. HESN collects multiple patient data from hospital software to assist infection control specialists in the prevention and control of hospital-associated infections. **This study aimed:** To understand the perspectives of respiratory infection control specialists and the facilitators and barriers related to a profitable HESN and to assess its usability.
**Methods:** A mixed-method research approach was accepted among infection control specialists from January to August after the application of HESN in the hospitals in Taif at Saudi Arabia. To gather the opinions of experts on HESN and to comprehend the obstacles and enablers, a qualitative analysis based on individual semi-structured interviews was carried out. Thematic analysis and systematic coding were used to examine the qualitative data. The System Usability Scale (SUS) was used to conduct a quantitative analysis.
**Results:** There were thirteen experts in infection control. Technical, organizational, and human obstacles to the installation and use phases were identified through qualitative analysis, while five key facilitators were identified: the HESN's pertinent design, the enhancement of infection prevention and control procedures, the appointment of a specialist champion, training, and cooperation with the development team. With an overall median SUS score of 85/100, quantitative analysis showed that the assessed HESN was a "good" system in terms of perceived ease of use.
**Conclusions:** This study demonstrates how infection control experts view HESN's value in supporting inpatient respiratory infections. Both obstacles and enablers to the adoption and execution of HESN are revealed. To make it easier for other hospitals to deploy the software, these obstacles and enablers should be taken into account.
**Keywords:** Infection prevention and control Electronic surveillance

## Introduction:

For infection prevention and control (IPC), hospital-associated infection (HAI) surveillance is essential. It offers the epidemiological data required to determine the level of infectious risk in hospitals, establish the prevention strategies that hospital IPC teams will employ, evaluate the success of these strategies, share surveillance data with medical professionals, and enhance patient safety and care quality (1, 2). Standard manual HAI surveillance techniques require a lot of time and resources from infection control professionals (ICPs) and produce data of inconsistent quality (3). These manual techniques involved the microbiology lab sending emails to ICPs whenever a microbe with the potential to cause an epidemic or a probable HAI was found. After that, ICPs looked over the electronic patient records, created a paper survey on the ward, and used proprietary software to find additional patients who had been into contact with XDR-infected patients (4).

Effective electronic health surveillance and reporting systems are crucial for public health, and nations all over the world have begun to realize this in recent years. As a result, practitioners, legislators, and other pertinent parties are increasingly realizing how urgently such systems must be implemented (5). The rising incidence of newly and re-emerging diseases has been the main cause of this global worry during the past 20 years. Numerous of these illnesses have the capacity to spread quickly over national borders; notable examples include cholera, the Zika virus disease, the Middle East respiratory disease (MERS), the Ebola virus disease (EVD), and severe acute respiratory syndrome (SARS) (6-9).

Additionally, the fact that traditional surveillance systems are outdated, dispersed, non-standardized, and inefficiently integrated into epidemiologic functions, many countries' limited infrastructures and resources have caused novel electronic health surveillance system improvements to be sluggish, and the literature is still lacking (5, 10). However, such systems are anticipated to become one of the major and necessary components of public health in the near future. In order to promote national health security and strengthen the Saudi Arabia public health services' capacity to handle persistent global health concerns, the Health Electronic Surveillance Network (HESN) was implemented. It has done this by helping to generate theories, track disease trends over long periods of time, and quickly identify clusters and outbreaks (11).

Furthermore, it is anticipated that HESN will support the nation's public health services in addressing health risks, biological terrorism, and supporting other health initiatives such as vaccination and general health research. For HESN to be effective, communication between frontline users in designated health facilities, headquarters specialists and health officers, and the central leadership in the Ministry of Health (MOH) in Riyadh—which is under the Deputy Ministry for Public Health—must be efficient and timely. HESN was initially established in the Kingdom of Saudi Arabia to manage individual cases, outbreaks, immunizations, and vaccine stocks. Numerous useful tools are integrated into HESN to assist healthcare professionals in monitoring, managing, and reporting on public health issues (11, 12).

At the international level, HESN is still developing and innovating. It is noteworthy that comparatively few nations have yet to take this important and fruitful step (13). A comprehensive set of preparatory steps must be taken before establishing a strong and effective electronic health system, which goes beyond merely adding or improving a new technical feature (13). This includes having enough sophisticated infrastructure, human resources with public health training, and the capacity to create sensitive and targeted algorithms, and the ability to obtain long-term funding and resources (14, 15). This study aimed to understand the perceptions of infection control professionals in relation to a profitable HESN to support inpatient infections that was recently implemented in hospital. The secondary aims were to assess usability and to compare usability scores according to participants' characteristics (age, gender, position).

## Methods

A mixed-method research approach was accepted among infection control specialists from January to August after the application of HESN to support inpatient respiratory infections and a computerized decision support system to facilitate antibiotic stewardship in the prescription of antibiotics in the hospitals in Taif at Saudi Arabia. To gather the opinions of experts on HESN and to comprehend the obstacles and enablers, a qualitative analysis based on individual semi-structured interviews and two structured questionnaires were carried out. Thematic analysis and systematic coding were used to examine the qualitative data. The System Usability Scale (SUS) was used to conduct a quantitative analysis.

The study was conducted among the ICPs of hospitals in Taif at Saudi Arabia. All HESN infection control professionals were invited to participate in the study by the inclusion criteria consisted of ICPs from medical and paramedical staff who used the HESN for at least one month and who signed an informed consent form. The exclusion criteria consist of IPCs who refused to participate in the study and who did not personally use the HESN (e.g., secretaries, the data manager).

The HESN monitors the microbiological information of inpatients and facilitates the surveillance of their infection and diseases with epidemic potential, especially multidrug-resistant bacteria and other pathogens, such as Clotridioides difficile, COVID-19 and measles. All relevant administrative, clinical and microbiological electronic hospital data are automatically sent to the HESN. It allows for real-time identification and follow-up of inpatients suspected of having a contagious illness or HAI. Moreover, it easily identifies a list of contact patients based on a definition of contact time with the infected patient. Alerts are generated by the HESN for the identification of microorganisms requiring additional precautions.

The qualitative part of the study was based on semi-structured face-to-face individual interviews with eligible IPC team members. All interviews were conducted by researchers. The interviews lasted 12 to 30 min and were recorded in a closed hospital office. The interviews were conducted using a semi-structured interview guide adapted from Jung et al. (2020) [16]. The interview guide consisted of open-ended questions to explore the perceptions of ICPs about the use of the implemented HESN and to understand barriers and facilitators related to its use. Data saturation was reached when no new information that could inform the domains of discussion emerged from the last two interviews (data obtained during the last interviews with a medical staff member and a paramedical staff member did not lead to new themes). The analysis of transcripts was subject to a grounded and inductive thematic analysis [17, 18].

Prior to the interviews, the participants completed a short questionnaire including socio-demographic questions and the Arabic version of the System Usability Scale (F-SUS). The F-SUS is a translated and validated version of the System Usability Scale (SUS), which is one of the most widely used scales to measure the perceived ease of use of inter- active systems [19]. The SUS is a ten-item scale developed by Brooke to quickly and easily provide a global view of the user's subjective assessments of usability [20]. The items alternate between positive and negative statements. The respondent states his or her position on a 5-point Likert scale ranging from "1 = Strongly Disagree" to "5 = Strongly Agree". The global SUS score is interpreted as indicated by Bangor et al. according to the seven-item adjective rating scale [21, 22].

The data are described as numbers and percentages for categorical variables and as medians with ranges (min–max) for continuous variables. The association between the SUS scores and participants' characteristics were tested using Mann–Whitney U test or Kruskal-Wallis test for categorical variables and with Spearman's correlation coefficient for continuous variables. The statistical significance was fixed at $p < 0.05$. This study was approved by the ethics committee of the university. The participants were informed about the purpose of the study, and all participants signed an informed consent form prior to the start of each interview. Participation was voluntary and not compensated.

## Results

**Table (1**) presents the demographic and professional characteristics of all interviewed ICPs. Among the 13 participants, seven were medical staff and six were paramedical staff. The participants had a median age of 38 years (range: 25–56), and they had worked as ICPs for an average of 2.5 years (range: 2 months-14 years). Among them, 11 used the HESN every day when they worked in the IPC ward (only the department head physician and the health executive midwife used the HESN less often, each week and less than once a week, respectively).

**Table (1):** Characteristics of the participants (N = 13)

| **Characteristics** | | n | % |
|---|---|---|---|
| **Sex** | Female | 10 | 77 |
| | Male | 3 | 23 |
| **Age (years)** | 25–34 | 5 | 38 |
| | 35–44 | 4 | 31 |
| | ≥45 | 4 | 31 |
| **Years of hospital experience (years)** | <5 | 3 | 23 |
| | 5–10 | 4 | 31 |
| | >10 | 6 | 46 |
| **Years of experience in IPC ward (years)** | <1 | 4 | 31 |
| | 1–5 | 6 | 46 |
| | >5 | 3 | 23 |
| **Position Medical staff** | Physician | 2 | 15 |
| | Pharmacist | 3 | 23 |
| | Resident in medicine | 1 | 8 |
| | Resident in pharmacy | 1 | 8 |
| **Paramedical staff** | Nurse | 4 | 31 |
| | Midwife | 1 | 8 |
| | Pharmacist technician | 1 | 8 |
| **Use of the ESS during working days** | Every day | 11 | 85 |
| | <1/day and ≥1/week | 1 | 8 |
| | <1/week | 1 | 8 |
| **Use of electronic tools at home** | Every day | 11 | 85 |
| | <1/day and ≥1/week | 0 | 0 |
| | <1/week | 2 | 15 |

HESN infection control specialists reported technical, organizational and human barriers to the installation and use stages. At the time of installation, the two medical staff members in charge of HESN implementation noted technical barriers concerning the data flow interfacing and the information technology equipment. The main barrier was the data flow interfacing from electronic hospital data (medical, microbiological and administrative patient records) to the HESN due to internal and external difficulties.

ICPs reported four significant technical barriers to use: i) the need to consult the electronic patient record in addition to the HESN to see textual data ii) duplicate work for clinical investigation on the HESN; iii) inadequate information technology equipment among medical staff .

In use, the main organizational barrier was the workflow transition of the IPC team. The HESN modified IPC activities with important modifications of team practices and an adjustment period. The workflow transition was complexities by the growing number of alerts requiring prioritization of ICP tasks and the absence of management tools included in the HESN. At the time of installation, the main human barrier was the low involvement of some people, which could have compromised all the implementation: 'It's [because of] the [lack of] involvement of a microbiologist in the deployment of the software that we missed out on so many things'. The lack of involvement could be explained by the lack of dedicated time to the HESN installation and the lack of explanation of the HESN, which can start infection control specialists and generate reluctance. Furthermore, several members of the paramedical staff indicated poor computer skills.

In use, the main human barrier was the difficulty of treating all the alerts generated by the HESN, and the ICPs reported. A more anecdotal human barrier was the language barrier with the foreign developer team. Despite barriers, the ICPs were very enthusiastic about the HESN, especially medical staff members. Five themes concerned facilitators of HESN adoption: i) the HESN was well designed, ii) it improved IPC practices, iii) a champion was designated among ICPs, iv) training sessions were provided, and v) the developer team was helpful.

According to the ICPs, the relevant design of the HESN contributed strongly to its adoption. Ease of learning, ease of use and navigation were important facilitators for infection control specialists.

**Table (2**) presents the usability test results. The overall median score was 85/100 (range = 60–95), indicating a 'good' system in terms of perceived ease of use. Half of the items obtained an optimal median score (items 1, 2, 3, 6 and 8). The median SUS score was higher for medical staff than for paramedical staff (90 vs. 80, $p = 0.002$), and it decreased with the age of the infection control specialists ($r = -0.7$, $p = 0.006$). The median SUS score was not associated with the gender ($p = 0.2$), the frequencies of use of the HESN during working days ($p = 0.3$) or of electronic tools at home ($p = 0.4$). It was not correlated with years of experience in the hospital ($p = 0.3$) or in the IPC ward ($p = 0.1$).

**Table (2):** Usability test results

| Items rated on a 5-point Likert scale | Median | Q1-Q3 | Range |
|---|---|---|---|
| I would like to continue using this system frequently | 5 | 5-5 | 4-5 |
| I found this system unnecessarily complex | 1 | 1-1 | 1-3 |
| I thought this system was easy to use | 5 | 4-5 | 2-5 |
| I need the support of a technical person to be able to use this system | 2 | 1-3 | 1-4 |
| I found the various functions in this system were well integrated | 4 | 4-4 | 2-5 |
| I thought there was too much inconsistency in this system | 1 | 1-2 | 1-4 |
| I would imagine that most people would learn to use this system very quickly | 4 | 4-5 | 2-5 |
| I found the system very cumbersome to use | 1 | 1-2 | 1-3 |
| I felt very confident using the system | 4 | 4-5 | 2-5 |
| I needed to learn a lot of things before I could get going with this system | 2 | 1-3 | 1-5 |

## Discussion

Using a mixed-method research approach, this study found a number of important findings on the facilitators and hurdles infection control specialists reported for a HESN that supported inpatient infections. The installation and use phases were hampered by organizational, technological, and human issues. The HESN's pertinent design, the enhancement of IPC procedures, the identification of an ICP champion, training, and cooperation with the development team were found to be the five primary facilitators. The qualitative study and the quantitative analysis, which included a usability scale, agreed.

A prior qualitative investigation on the use of computerized decision support systems for managing prescription drugs found a number of obstacles, including alert fatigue, inaccurate information, a poorly designed user interface, and a lack of customization (16). Therefore, it was advised to concentrate the design on usability, ergonomics, workflow integration, and decision-making process transparency in order to increase the adoption of computerized decision support systems (23). However, other barriers were reported by infection control specialists in our qualitative study, including technical, organizational and human barriers. Yusof et al. (2008) (24) identified and developed frameworks for technical, organizational and human factors for health information systems through a review of the literature (24).

Technical barriers reported at the time of installation generated delays in the implementation of the profitable HESN. This delay was long but not surprising for the implementation of this type of software. Indeed, the successful implementation of a new system, such as a computerized decision support system, can be challenging due to the hospital environment, which is characterized by a complex interaction of systems associated with technological, human and organizational factors (25, 26). Wisniewski et al., (2003) (27) reported that the development of a clinical data warehouse for a hospital IPC took two years, and Apte et al., (2011) (28) reported almost two years to develop and integrate an electronic system studying HAIs.

The workflow adaptation of the IPC team is an unavoidable issue when ICPs switch from traditional manual surveillance of HAIs to an HESN. Thus, tasks and their distribution were modified among medical and paramedical staff members in our study, and prioritization of the workflow was implemented. It is crucial to define and standardize the process to ensure that each end user can easily identify which tasks need to be completed to avoid forgetting to take HAIs into account and to avoid duplication of work.

A previous study has already highlighted that the age significantly affects the SUS score with a negative impact on the usability of the interfaces (21). No institutional barriers were reported in our study because they occurred after the implementation stage. Before the installation of an HESN, institutional approval should be obtained and may involve severe barriers. Institutional concerns include security, confidentiality and medico-legal problems (27). Economic considerations with return-on-investment expectations are also determinants of the decision to implement, maintain, or discontinue an HESN (29).

In the present study, the ICPs perceived that the HESN enabled them to save time and improve practices compared with traditional manual surveillance. This was objectively demonstrated in other studies: the HESN produced a mean reduction in time spent to surveillance of 74 % (30) with a 61 % reduction in time spent on surveillance for surgical site infection (31). Moreover, it provided epidemiological and statistical data that were priority elements for ICPs. HESN adoption also contributed to the quality of care by increasing appropriate isolation precaution rates for patients with antibiotic-resistant bacteria (32, 33).

Moreover, HESN adoption in hospitals was significantly and positively associated with the implementation of evidence-based practices for HAIs (including methicillin-resistant Staphylococcus aureus and ventilator-associated pneumonia) and for IPCs (including hand hygiene, contact precautions and surgical care improvement) (34). Improved practices are enabled by the performance of this type of system. The HESN presents good sensitivity (range: 63 to 91 %) and excellent specificity (range: 87 to >99 %) for laboratory-based surveillance of HAIs (35).

**Conclusions**

The HESN is a useful tool for enhancing inpatient infection surveillance, ICP productivity, and patient care quality. However, one should not undervalue the challenges of deploying and utilizing new software to gather numerous patient data from different hospital software packages. To help other hospitals use software, the study's highlighted facilitators and impediments should be taken into account. The HESN's pertinent design, the software's ability to improve IPC practices, the time slots allotted for software implementation, the appointment of a professional champion, training, cooperation with the development team and the hospital's IT department, and workflow adaptation are the primary requirements for success.

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