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Practice Forum

Slow adoption of automated infection prevention surveillance: Are human factors contributing?

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Although automated surveillance technology has been evolving for decades, adoption of these technologies is in a nascent state. The current trajectory of public reporting, continued emergence of multidrug-resistant organisms, and mandated antimicrobial stewardship initiatives will result in an increased surveillance workload for ICPs. The use of traditional surveillance methods will be inefficient in meeting the demands for more data and are potentially flawed by subjective interpretation. An examination is offered of the slow adoption of automated surveillance technology from a system perspective with the inherent ambiguities that may operate within the ICP work structure. Formal qualitative research is needed to assess the human factors associated with lack of acceptance of automated surveillance systems. Identification of these factors will allow the National Healthcare Safety Network and professional organizations to offer educational programs and mentoring to the ICP community that target knowledge deficits and the embedded culture that embraces the status quo. With the current focus on fully electronic surveillance systems that perform surveillance in its entirety without case review, effective use of the data will be dependent on ICP skills and their understanding of the strengths and limitations of output from algorithmic detection models.

The trajectory of public reporting of health care-associated infection (HAI) rates, the emergence of new multidrug-resistant organisms and communicable diseases, and mandated antimicrobial stewardship programs forecast a heightened surveillance workload for infection control professionals (ICPs). Currently, the percentage of time spent on surveillance and analysis has been estimated at 45% of the total infection prevention activity, with many ICPs not well resourced for this commitment of effort. For example, only 35% have assistance with data management.[1]

MAKING THE CASE FOR AUTOMATED INFECTION PREVENTION SURVEILLANCE

The majority of surveillance continues to be performed manually, as evidenced by recent findings that only 23%-56% of surveyed facilities were using automated surveillance systems.[2-4] The slow adoption of automated technology seems surprising in light of the time-consuming nature of manual surveillance and nearly 3 decades having passed since the first report detailing a computer system using microbiology data to identify patients with possible HAIs.[5] In recent years, supportive evidence for the use of automated surveillance includes a 61% reduction in time spent on surveillance activities,[6] achievement of greater depth in the implementation of evidence-based infection control practices,[3] and improvement in implementation of isolation practices.[7]

Along with the supportive evidence for automated surveillance, is the evidence that the subjective nature of manual surveillance is potentially biased and has led to interinstitutional variability in the use of surveillance techniques and the interpretation of infection definitions by ICPs. Keller et al[8] identified substantial heterogeneity among members of the Society for Healthcare Epidemiology of America Research Network who applied National Healthcare Safety Network (NHSN) HAI definitions to several clinical vignettes. The mean percentage of correct responses for all vignettes was only 61.1% with a range of 27.4%-97.3%. Wright et al[9] reported a similar correct response rate of 64.1% from ICPs who voluntarily responded to 5 published case studies. Several other authors have identified significant variability in the application of the NHSN standard infection criteria across medical centers, highlighting the potential fallibility of traditional ICP surveillance methods that may use partially subjective clinical criteria.[10,11] Clearly, these inconsistencies

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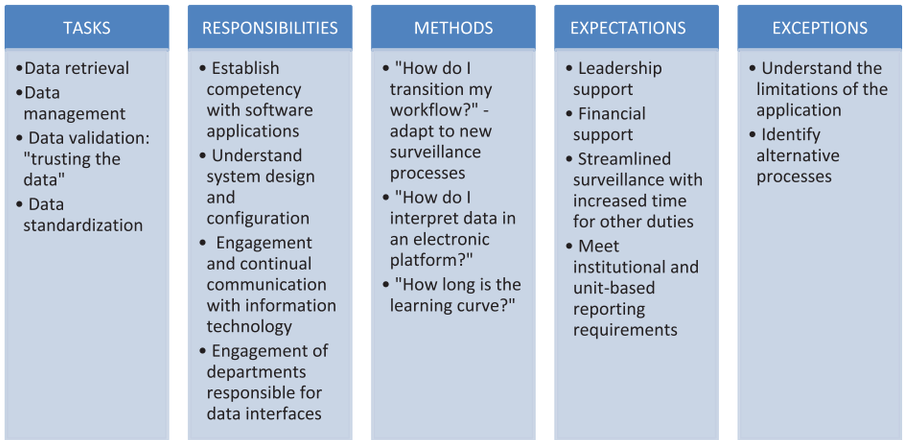

Fig 1. Proposed types of ambiguities associated with the adoption of automated surveillance technology.

affect the validity of publicly reported HAI data that should be defined by consistently applied objective criteria. NHSN has responded by revising HAI definitions in ways that reduce complexity, maintain clinical relevance, and avoid potential case misclassification. NHSN is also supporting the development of computer-based detection algorithms and use of electronic health care data for HAI surveillance.[12]

Proponents of automated surveillance technology cite standardization of ICP workflow and consistent and accurate case finding as a solution to potentially biased manual processes. A recent qualitative analysis of the evolving role of ICPs concluded that data standardization would lessen the tension that ICPs experience due to expanding responsibilities that outstrip resources. The authors noted that streamlining surveillance would aid ICPs in achieving a better balance with competing priorities.[13] An equally important advantage to automated surveillance is the capture of discrete data elements from the electronic medical record that prevents the reliability problems inherent in traditional surveillance based on human interpretation.[14]

EXAMINING THE ROLE OF HUMAN FACTORS IN THE MODIFICATION OF SURVEILLANCE PROCESSES: IS AMBIGUITY A CONTRIBUTOR?

An examination of factors that may be contributing to the slow adoption by ICPs of automated surveillance technology can be viewed in the context of the Systems Engineering Initiative for Patient Safety described by Carayon et al.[15] The human factors field is concerned with the interaction between people, machines, and their work environments. In the Systems Engineering Initiative for Patient Safety model, the modification of processes intended to produce improved staff, patient, and organizational outcomes requires viewing the work system holistically by evaluating multiple factors; specifically, organization, people, task, environment, and tools and technology. In their commentary on the translation of evidence into practice for infection prevention using a systems engineering framework, Yanke et al[16] note the complexity of the modern health care system and ambiguity as factors that may impede the implementation of interventions. The concept of systems ambiguity emerged in a qualitative study conducted by Gurses et al,[17] which explored the causes of noncompliance with evidence-based practice guidelines for the prevention of HAIs by intensive care unit clinicians. In-depth interviews were conducted with 20 intensive care unit staff members to gain insight into the cultural and behavior factors linked to practice compliance. Characterizing the behavior and attitude factors provided critical information regarding the readiness of the clinicians to consider alternative care processes. The researchers concluded that ambiguity related to tasks, responsibilities, methods, expectations, and exceptions hindered consistent compliance. I propose that these same ambiguities may be barriers to ICPs embracing automated technology (see Fig 1).

Automated technology is a generic term used for the process of obtaining useful information from larger interrelated databases by identifying abnormal distributions of variables within a defined setting.[18] Although ICPs are familiar with the tasks associated with traditional manual surveillance—reviewing microbiology reports and using the electronic medical record to obtain additional information for decision making—many are unfamiliar with the tasks of data retrieval and management inherent to automated systems and must adapt their workflow to a different way of doing things. In a recent report examining ICPs' awareness of and engagement in health information exchange to improve public health surveillance, <20% of respondents with access to an electronic health record reported being involved in the design, selection, or implementation of the system.[19] The authors concluded that these findings may limit an ICP's ability to influence or utilize key information technologies to facilitate transition to paperless surveillance processes. Further, an essential but unfamiliar task when using an automated system is the need for data validation that must be performed at start-up and whenever upgrades or changes are made to the foundational databases. Validation is necessary to ensure that the received data are complete and accurate and establish trust in the system. The majority of programs in use currently by ICPs are semiautomated surveillance systems that deliver user alerts based on large inputs of data and require additional tasks for HAI classification.[20] When multiple ICPs are using the system, it is imperative that the surveillance process be standardized to ensure that each user can easily identify which tasks need to be completed to avoid duplication of work. An example of a way to reduce task ambiguity is to use visual cues to highlight completed data review.

The use of automated surveillance technology will require the ICP team to reexamine roles and responsibilities. As described in the Association for Professionals in Infection Control and Epidemiology competency model,[21] professional and practice standards assume that ICPs will have access to information technology hardware and some degree of experience in the use of software applications. However, it is recognized that the ICPs performing surveillance will have varying degrees of competency and it is proficient ICPs who can integrate both manual and electronic

findings for comprehensive reporting and expert ICPs who can apply principles of information management to emerging technology. Before implementing the system, the experience and skill set of each ICP should be assessed because 1 or more members of the team may be at the proficient or above competency level and could be identified as "superusers" to assist the other team members with the workflow transition. The team also needs to discuss who has the authority to make decisions regarding system design and configuration; for example, modifications to the data feeds, revision of user alerts, and report development. It is important to recognize that other departments have responsibility for the automated surveillance system and good communication must be maintained. ICPs will require information technology to provide the necessary data interfaces to develop alerts with high sensitivity and specificity. The microbiology laboratory is responsible for notification of the ICP team of any software updates and/or changes to data management that may interfere with how microbiology data are received in the automated system. Members of the nursing department are responsible for providing notification of changes made to their electronic documentation; for example, if information about the invasive devices being used on a patient is relocated from 1 area of nursing documentation to another area, the data will not be transferred to the automated surveillance system without a change to the data mapping configuration.

Method ambiguity relates to the how of a transition from manual to automated surveillance processes and can be facilitated by comprehensive training that is based on the end users' workflow and program goals and objectives. ICPs need to know the sources of the data being viewed, how their traditional surveillance processes will be modified, and how the data generated electronically must be interpreted to be translated into knowledge and guide decision making. ICPs have acknowledged that the investment of time spent learning and adapting information systems to meet an organization's reporting needs is high and keeps them at the computer and away from clinical units.[13] Another cited concern is the abundance of data available from the system that may lead to an expansion of surveillance activities.

Expectation ambiguity can be viewed in the context of the organization, the patient care providers, and the infection prevention team. Grota et al[2] surveyed acute-care hospital infection prevention and control departments in California to assess ICP satisfaction with an electronic surveillance system. Organizational support, which was defined by measures of ease of use, accuracy, and perceptions of improved patient care, was highly correlated with ICP satisfaction. The financial support for automated surveillance from the organizational leadership may be the result of potential economic and reputation-related consequences associated with poor HAI rates. Regardless, this support is essential for securing access to the key administrative and clinical databases needed for accurate and reliable surveillance data. The support is aligned with the expectation that the benefit of this technology will be a reallocation of the ICP team's time from data collection to HAI prevention activities in collaboration with patient care providers, resulting in reduced HAI rates. However, Furuno et al[22] reported that the data were insufficient on the cost-effectiveness of electronic surveillance systems and whether use of these systems contributed to patient safety. The absence of these data may be a barrier for ICPs who need to develop a return-on-investment proposal for automated surveillance to their executive staff.

Patient care providers want unit-specific data and have an expectation that the data provided will be accurate. The provision of unit-level data reporting was perceived as a time-consuming task for the ICPs, but they acknowledged that meaningful data establish credibility.[13] Gurses et al[17] reported that the feedback of central line-associated bloodstream infection rates using per 1,000 device-days was not perceived as directly relevant to the nurses' practice in the intensive care unit. ICPs transitioning to automated surveillance will need to know the reporting capabilities of the system and determine how they can deliver information that prompts action to improve patient care.

Exception ambiguity relates to the identification of specific surveillance needs that cannot be addressed by the automated surveillance system. These exclusionary conditions may be the result of delayed data interfaces (eg, surgery reports or lack of electronic data elements), the presence of invasive devices not available from nursing documentation, or absent functionality in the system. ICPs will need to continue with aspects of their manual surveillance process to ensure that their case finding is consistent and complete until these technology issues are resolved.

Although automated surveillance technology has been evolving for decades, adoption of these technologies is in a nascent state. The current trajectory of public reporting, continued emergence of multidrug-resistant organisms, and mandated antimicrobial stewardship initiatives will result in an increased surveillance workload for ICPs. The use of traditional surveillance methods will be inefficient in meeting the demands for more data and are potentially flawed by subjective interpretation. An examination has been offered the slow adoption of automated surveillance technology from a system perspective with the inherent ambiguities that may operate within the ICP work structure. Formal qualitative research is needed to assess the human factors associated with lack of acceptance of automated surveillance systems. Identification of these factors will allow the NHSN and professional organizations to offer educational programs and mentoring to the ICP community that target knowledge deficits and the embedded culture that embraces the status quo. With the current focus on fully electronic surveillance systems that perform surveillance in its entirety without case review, effective use of the data will be dependent on ICPs' skills and their understanding of the strengths and limitations of output from algorithmic detection models.

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