Published in final edited form as:
Am J Infect Control. 2011 December ; 39(10): 839–843. doi:10.1016/j.ajic.2011.01.020.

Methods of Measuring Compliance with Transmission-Based Isolation Precautions: Comparison of Paper-Based and Electronic Data Collection

Abstract

Background—Decreasing transmission of resistant organisms in hospitals is a key goal of infection prevention plans. Studies have shown that health care worker (HCW) compliance with isolation precautions is inadequate. Direct observation of HCW behavior for measuring adherence is considered the "gold standard" but is labor intensive, requiring the collection and analysis of a large volume of observations.

Methods—Two methods of data collection were evaluated to asses HCW compliance: a manual method using a paper form (PF) with subsequent data entry into a database, and an electronic method using a web-based form (WBF) with real-time data recording. Observations were conducted at four hospitals (2,065 beds) to assess availability of gloves, gowns and masks, isolation sign postings, and HCW isolation practices.

Results—A total of 13,878 isolation rooms were observed in 2009. The median number of rooms observed/day for PF and WBF were 61 and 60 and the mean observation times/room were 149sec and 60sec, respectively. The WBF provided a time savings of 89 sec/room.

Conclusions—Simple electronic forms can significantly decrease resources needed to monitor HCW adherence to hospital policies. The WBF decreased observation time by 60%, allowing for an increase in frequency and expansion of surveillance activities.

Keywords

Isolation precautions; electronic surveillance; adherence; compliance

Introduction

Antimicrobial resistance in pathogens that cause health care-associated infections (HAIs) is a growing problem in health care institutions worldwide. Up to 16% of all US HAIs reported through the National Health Care Safety Network during 2006–2007 were associated with nine multi-drug resistant organisms (MDROs), and these continue to pose serious therapeutic challenges. [1] Other studies report that antimicrobial resistance has increased in certain organisms by as much as 47% since the 1990s. [1–3] Recently, novel pathogens such as the H1N1 influenza virus and coronavirus (severe acute respiratory syndrome as well as changes in virulence in recognized pathogens such as *Clostridium difficile* are concerning in hospitalized patients. The Healthcare Infection Control Advisory Committee of the Centers for Disease Control and Prevention (CDC) recommends placing patients with MDROs and other communicable conditions on isolation precautions. Conditions requiring isolation include: MDROs and *Clostridium difficile* (contact isolation), influenza and meningococcal meningitis (droplet isolation) and tuberculosis and measles (airborne isolation). The CDC also recommends that health care workers (HCW) and visitors perform hand hygiene before and after contact with any patient or the patient's equipment/environment. [4] Breaches in technique may lead to spread of organisms directly to patients via HCW hands or by contact with the contaminated environment or equipment.

Studies have shown that HCW compliance with isolation precautions and hand hygiene is often inadequate and some form of behavior monitoring is necessary.[5–11] Direct observation of HCW behavior is considered the "gold standard" for measuring adherence to these standards, but it is labor intensive, costly, and lacks standardized data collection tools.[5, 6, 12] Electronic data collection tools show promise for automating the process of identifying patients who require isolation and providing a venue for collecting real-time data efficiently.[13] The aim of this study was to evaluate the data quality and time efficiency of two methods of data collection--one using a paper form (PF) and one using a web-based form (WBF)--for measuring hospital-wide adherence to transmission-based isolation precautions and hand hygiene.

Methods

Setting

This study was conducted at four sites within the New York-Presbyterian Hospital (NYP) system in New York City: (1) a 221-bed community hospital; (2) a 283-bed free-standing pediatric acute care facility; (3) a 647-bed adult academic tertiary care facility, and (4) 914-bed pediatric/adult academic tertiary care facility. All inpatient units at these sites were included in the study, except psychiatric and maternity wards. The institutional review boards of Weill Cornell Medical Center and Columbia University Medical Center approved this study.

Infection Prevention System (IPS)

The IPS is a web-based, epidemiology decision support system developed by members of the Departments of Infection Prevention and Control and Information Services of NYP, and the Department of Biomedical Informatics of Columbia University. The IPS electronically identified patients who required isolation by capturing demographic information from the admission/discharge/transfer system and merging it with microbiology data, physicians' isolation orders from the hospital's electronic medical record, and isolation information from prior admissions. Rules and logic were applied to monitor the need for isolation precautions. For example, organisms of interest were automatically linked to the correct category of isolation based on CDC criteria and institutional policy. Also, patients with a previous history of an infection requiring isolation were automatically placed back on the isolation patient list upon re-admission to the respective institution. Patient-specific clinical information was also gathered from the systems and displayed in a summarized format accessible from a single screen.[14] The hospital's infection preventionists confirmed isolation information for patients on the IPS list at least twice daily. When a patient did not have positive microbiologic results suggestive of an infectious process, but clinicians suspected that the patient had a communicable illness (e.g. signs and symptoms of tuberculosis or diarrhea), clinical indications were entered by the infection preventionists into the IPS for monitoring.

Instrument and procedure

Direct observations of rooms housing isolated patients were performed by a trained observer in five-consecutive-day increments (including weekends) during varying times of the day (7am to 10 pm) at each of the study sites over a 10-month interval in 2009. Observer training included reviewing the observation protocols and conducting inter-rater reliability with research staff who had conducted similar observations in previous research. [11] Throughout the study, the quality and consistency of observation methods were monitored by study investigators. The observer recorded data on the appropriateness of isolation sign postings, the availability of personal protective equipment (PPE), and HCW adherence with recommended isolation precautions as part of a larger study, "Impact of Automated

Surveillance on MRSA Isolation," funded by a cooperative agreement with the Association for Prevention Training and Research (APTR) and CDC (5 U50 CD3000-860-21).

Two methods of recording observations of adherence to isolation precautions were evaluated. Each phase of the study included a period of time for the observer to become comfortable with the study tool. For both phases, the observer followed the same pattern at each hospital site, starting at the top floor and working downward. Rooms that were known or expected to house isolated patients were reviewed, along with any other rooms where the staff had placed isolation signs but had not informed the infection preventionists. Each room was evaluated for the presence of an isolation supply cart or anteroom and for the existence of PPE, including small, medium, and large gloves, isolation gowns, and if appropriate, masks and protective eyewear. If HCWs were seen entering or exiting a patients' room, the observer documented whether they performed hand hygiene and wore PPE upon entering and whether they removed the PPE on exit and performed hand hygiene after removing gloves. If the HCW did not remove his/her attire prior to leaving the room, the observer noted whether they touched the inanimate environment or patient care equipment outside the room. If a group of staff or visitors entered or exited an isolation room, a maximum of 3 people were observed for a total of 6 observations per room. Staff and visitor adherence to isolation precautions were recorded only when they could be directly observed.

Paper Form (PF)

During the first phase of the study, a PF was utilized to record study observations. Each day, the observer printed a daily census of patients requiring isolation using the IPS and manually transcribed patients' unit, room, and bed information onto the PF. The observer visited each patient's room listed on the isolation census. These visits were generally made on week days during the day or evening shift, although they were occasionally made on weekends. A schedule was developed on a monthly basis by the observer. If the observer found additional patients who had been placed on isolation by the medical team but were not listed on the IPS, the observer added the room and bed information to the PF and conducted observations on those patients as well. If the observer identified inconsistencies between the expected isolation status for a room/bed on the IPS list, such as an unoccupied room or missing sign, then a staff member was approached to confirm the patient's information. Adjustments were made on the PF based on changes to patient location, isolation status, or patient discharge. The observer recorded HCW and visitor compliance with hand hygiene and transmission-based precautions, and whether the appropriate PPE were available for each patient. Periodically, the observer transcribed the observations into anExcel (Microsoft, Redmond, WA) database, and these data were re-matched to the IPS to merge additional information on visit admission and discharge dates and isolation start and end dates. Mismatches and data entry errors such as incorrect medical record number or isolation category were retrospectively adjusted to ensure that observations were being made on the correct patient.

Web-Based Form (WBF)

The WBF was developed to display room/bed and isolation categories from the IPS system. The WBF captured the same data elements listed on the PF but provided structured data fields that contained all possible responses to eliminate variability in recording and to prompt the observer to look for PPE and staff compliance that were appropriate for the specific isolation category. Radio buttons were used to collect binary data elements, check boxes were used for the fields requiring multiple responses, and text fields were used for documenting notes. A wireless networked, hospital-approved tablet computer (Lenovo ThinkPad X200) was used to collect data in real time while rounding on the unit. The tablet computer rather than a non-networked electronic device, such as a palm pilot, was chosen because the WBF was available through the hospital's intranet. Accessing the WBF via the

tablet computer also allowed for quicker recording of observations using a direct input method as compared to curser button or mouse which would have been ergonomically challenging to do.

The WBF was accessed by logging on to the application's password-protected web site. The form was linked to the IPS and was pre-populated with rooms identified as housing isolated patients. The WBF displayed the correct category of isolation as determined by the IPS logic and the institution's infection preventionists. Initially, the WBF was defaulted to load all beds within the building being observed. Since a large amount of time was required to load information on the tablet computer, the system was adjusted to allow the observer to select only the units they were going to observe. The observer conducted rounds as in the PF phase and observations were recorded directly into the database. Blank forms were also included for the observer to add patients on isolation but not yet listed in the IPS system. Observations and date/time stamps were automatically linked to patient information in the isolation system and archived in the IPS database.

Analysis

During the four-month PF phase, the observer recorded the overall amount of time spent performing observations while rounding on the units each day as well as any time spent entering the information into the Excel database. Observations recorded during the six-month WBF phase were archived in the IPS structured tables and date/time stamps were used to evaluate the time required for conducting observations on each room. This information was extracted into the Excel database for comparison to the PF data.

The total number of observation days, unique patients observed, number of observations, and time for observations was calculated for each phase. For the PF phase, the total observation time was added to the total data entry time and the mean time per room observed was then determined by dividing the total amount of time by the total number of observations per day. The WBF phase had no additional time required for data entry, so the time needed to make each individual observation was used to calculate mean time per room observed. The time saved per room was calculated by subtracting the mean observation time per room for the WBF from the mean observation time per room for the PF. The total time saved in hours per year was calculated by multiplying the time saved per room by the total number of observations conducted in the 10-month study period dividing by 10 and multiplying by 12 to extrapolate from 10 months to a year.

Results

A total of 13,878 isolation rooms were observed for 3,969 unique patients between January and November 2009. The total number of days observed for the PF and the WBF were 85 and 123, the total number of patient rooms observed were 5,207 and 8,671, the median number of rooms observed per day were 60 and 61 (PF range: 19–128; WBF range: 15-154) and the average observation time per room was 149 seconds and 60 seconds, respectively. Overall, the WBF provided a time savings of 89 seconds per room of observation and data entry time, which, for this project, extrapolated to 412 hrs per year a—60% savings. Using a salary of $31/hour for an observer or $50/hour for a nurse, utilizing the WBF for observations would provide an annual savings of $12,772 or $20,600 per year, respectively.

Discussion

In order to decrease the spread of MDROs and other communicable conditions, infection preventionists must be able to identify patients who are colonized or infected with these organisms in a timely fashion and communicate information for isolation precautions to the

appropriate teams. Two important factors for adequate isolation are: (1) placement of patients in single rooms or, if necessary due to limited availability of single rooms, cohorting patients with like organisms; and (2) consistent use of proper protective attire and hand hygiene by HCW when providing care. The responsibility for compliance with wearing protective attire and performing hand hygiene ultimately rests with the direct care-giver.

Surveillance of HAIs and MDROs is time consuming and limits the ability of infection preventionists to focus on prevention activities such as education, assessment of current practice, and performance improvement initiatives.[15] In fact, a recent survey concluded that most healthcare epidemiology and infection prevention and control programs are understaffed and lack adequate resources to address the increased mandate for reporting of HAIs and prevention efforts.[16] Several external factors have placed hospital leadership under increasing pressure to reduce HAIs without increasing infection prevention and control staffing. These factors include mandatory public reporting of HAIs from federal and state agencies, adherence to performance standards associated with The Joint Commission patient safety goals, decrease in Medicare reimbursement, and increased public accountability.[17]

The increase in such demand forces each institution to evaluate current workflow and process patterns and identify new ways to streamline their activities. Evaluating the advantages and disadvantages of performing surveillance using a PF versus a WBF (Table 1) should occur. Each method has its advantages and disadvantages. For example, a PF requires transcription time, data entry time, and has the potential for lost data through misplaced data collection forms or transcription errors from the PF to an electronic database or software package. The PF can not control for user variability in documenting observations since only free text is allowed. On the other hand, the PF does not require technical expertise, a portable tablet computer, or special software and it can be easily created and adjusted as needed. Initial development time therefore is minimal.

The WBF requires information technology expertise or support and there is the potential for slow network connections or equipment failures. The tablet may be costly, heavy, and may have a short battery life. The design of the WBF requires forethought in order to ensure adequate and appropriate output. The WBF, however, has significant advantages in that it does not require either transcription or additional data entry time and minimizes incorrect or incomplete entries by providing structured choices. The WBF avoids data loss and increased security since the records can be saved on a hospital server. Initial start-up costs for the WBF, including the cost of the tablet, an extra battery, replacement batteries, and per month charge for a wireless card was approximately $3200. Other incidental costs associated with the WBF were consistent with those that would occur with any computer.

In this study, the WBF decreased observation time by 60%. Savings in salary at this study site was $12,772 per year. The savings in either time or salary would allow for an increase in frequency of observations and expansion of surveillance activities.

A limitation of this study may be that the PF was used first and the observer could have gained expertise in navigating the hospital units and conducting the observations during the first phase which might have allowed a decrease in the amount of time spent on each unit/observation in the WBF phase. Also, although total observation time per day and per data entry session was documented for the PF, observation times on individual patients were not documented. For the WBF, time stamps of all activities could be reviewed. It is also important to note that the surveillance activities described in this paper was conducted for research purposes. For clinical purposes, surveillance must be accompanied by feedback for

the purposes of behavior change. The time saved in surveillance activities using automated methods could be used for such feedback and other educational activities.

Conclusions and Recommendations

Electronic solutions, such as the WBF, can significantly decrease resources needed to monitor HCW adherence to hospital policies. The methods described here can be replicated by other institutions with an electronic spreadsheet or IPS. Additional systematic and objective comparative studies of the costs and data accuracy of each of these methods are needed to assist infection preventionists in choosing the optimal data collection tool and method for their institution. Standard forms could be developed to facilitate uniform data collection practices and allow comparisons across settings. The cost effectiveness and clinical outcomes of such data collection systems should be studied further.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Support

TL was supported by a training grant from the National Institute of Nursing Research (5T90NR010824-02) as a fellow in the Center for Interdisciplinary Research to Reduce Antimicrobial Resistance at the Columbia University School of Nursing.

Funding for this study was provided by a cooperative agreement with The Association for Prevention Teaching and Research and the Centers and for Disease Control and Prevention (APTR-CDC Cooperative Agreement, 5U50CD3000-860-21). We are grateful to other members of our research team, including E. Yoko Furuya, MD, David Vawdrey, PhD, and Haomiao Jia, PhD and the members of the Department of Infection Prevention and Control of New York-Presbyterian Hospital.

References

1. Hidron A, Edwards J, Patel J, Horan T, Sievert D, Pollock D, et al. Antimicrobial-resistant pathogens associated with healthcare-associated infections: Annual summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2006 2007. Infect Control Hosp Epidemiol. 2008; 29:996–1011. [PubMed: 18947320]
2. Nelson R. Antibiotic development pipeline runs dry. Lancet. 2003; 362:1726–1727. [PubMed: 14655659]
3. National Nosocomial Infections Surveillance. National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004. Am J Infect Control. 2004; 32:470–485. [PubMed: 15573054]
4. Siegel JD, Rhinehart E, Jackson LR, Chiarello L. Health Care Infection Control Practices Advisory Committee. 2007 Guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings. Am J Infect Control. 2007; 35(10 suppl 2):S65–S164. [PubMed: 18068815]
5. Larson EL, Quiros D, Lin SX. Dissemination of the CDC's Hand Hygiene Guideline and impact on infection rates. Am J Infect Control. 2007; 35:666–675. [PubMed: 18063132]
6. World Health Organization. WHO guidelines for hand hygiene in health care. World Health Organization; Geneva, Switzerland: 2009.
7. Haas JP, Larson EL. Measurement of compliance with hand hygiene. J Hosp Infec. 2007; 66:6–14. [PubMed: 17276546]
8. Eveillard M, Grandin S, Zihoune N, et al. Evaluation of compliance with preventive barrier precautions to control methicillin-resistant *Staphylococcus aureus* cross-transmission in four non-intensive acute-care wards of a French teaching hospital. J Hosp Infect. 2007; 65:81–83. [PubMed: 17145097]

9. Manian FA, Ponzillo JJ. Compliance with routine use of gowns by healthcare workers (HCWs) and non-HCW visitors on entry into the rooms of patients under contact precautions. Infect Control Hosp Epidemiol. 2007; 28:337–340. [PubMed: 17326026]

10. Weber DJ, Sickbert-Bennett EE, Brown VM, et al. Compliance with isolation precautions at a university hospital. Infect Control Hosp Epidemiol. 2007; 28:358–361. [PubMed: 17326031]

11. Clock SA, Cohen B, Behta M, Ross B, Larson EL. Contact precautions for multidrug-resistant organisms: Current recommendations and actual practice. Am J Infect Control. 2010; 38:105–11. [PubMed: 19913329]

12. Larson EL, Cohen B, Ross B, Behta M. Isolation precautions for methicillin-resistant *Staphylococcus aureus*: Electronic surveillance to monitor adherence. Am J Crit Care. 2010; 19:16–26. [PubMed: 19234098]

13. Wright M. Automated surveillance and infection control: toward a better tomorrow. Am J Infect Control. 2008; 36:S1–5.

14. Ross, B.; Chaudhry, R.; Hong, F.; Behta, M. The impact of automated identification and monitoring of multi-drug resistant organisms (MDRO) on surveillance activities at a large academic center. 18th Annual Scientific Meeting of the Society for Healthcare Epidemiology of America; Orlando, FL. April 2008; (Abstract 081–459)

15. Greene LR, Cain TA, Khoury R, Krystofiak SP, Patrick M, Streed S. APIC position paper: the importance of surveillance technologies in the prevention of health care–associated infections. Am J Infect Control. 2009; 37:510–3.

16. Stone PW, Dick A, Pogorzelska M, Horan TC, Furuya Y, Larson E. Staf ng and structure of infection prevention and control programs. Am J Infect Control. 2009; 37:351–7. [PubMed: 19201510]

17. Stone PW, Glied SA, McNair PD, Matthes N, Cohen B, Landers TF, Larson EL. CMS changes in reimbursement for HAIs: setting a research agenda. Med Care. 2010 May.48:433–9. [PubMed: 20351584]

Table 1

Comparison of Data Collection Tools

Category	Detail	Greater for (PF)	Greater for (WF)	PF and WF equivalent
Design and Implementation	• Initial development needed		*	
	• Technical expertise needed		*	
	• Instrument cost		*	
	• Adaptability of data collection tool			*
	• Ability to reprocess previously entered data			*
User Features	• Computer training required		*	
	• Issues with network connectivity/speed		*	
	• Weight of data collection tool		*	
	• Problem with network connections/speed		*	
	• Time required to manually copy information from IPS to PF	*		
Data Entry/Processing	• Time needed to perform observations	*		
	• Potential for data entry errors	*		
	• Potential for data loss			*
	• Post observation manual data entry/processing time	*		
Special Features	• Level of detail on data collection time provided		*	
	• Ability to prevent incorrect or missing data points		*	
	• Alert for missed/omitted observation data		*	
	• Automated compliance report generation		*	