Use of a Regional Health Information Exchange to Detect Crossover of Patients with MRSA between Urban Hospitals

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Research Paper ■

Use of a Regional Health Information Exchange to Detect Crossover of Patients with MRSA between Urban Hospitals

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Abstract **Background:** A significant portion of patients already known to be colonized or infected with Methicillin-Resistant *Staphylococcus aureus* (MRSA) may not be identified at admission by neighboring hospitals.

Methods: We utilized data from a Regional Health Information Exchange to assess the frequency that patients known to have MRSA at one healthcare system are admitted to a neighboring healthcare system unaware of their MRSA status. We conducted a retrospective, registry trial from January 1999 through January 2006 involving three healthcare systems in central Indianapolis, representing six hospitals.

Results: Over one year, 286 unique patients generated 587 admissions accounting for 4,335 inpatient days where the receiving hospital was not aware of the prior history of MRSA. The patients accounted for an additional 10% of MRSA admissions received by study hospitals over one year and over 3,600 inpatient days without contact isolation.

Conclusions: Information exchange could improve timely identification of known MRSA patients within an urban setting.

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Introduction

Rates of colonization or infections with drug-resistant organisms continue to rise.[1] Patients with methicillin-resistant *Staphylococcus aureus* (MRSA) infections suffer increased morbidity and mortality, longer lengths of stay and greater healthcare costs.[2] Resistant organisms are transmitted patient-to-patient, often through transiently colonized providers and this spread can be prevented by identifying patients with MRSA and placing them in contact isolation.[3,4] However, most patients who are colonized or infected do not know their infectious status and travel among healthcare institutions without warning labels.

In addition to enforcing universal precautions and hand hygiene for all patients, a hospital's infection control team is responsible for identifying and tracking MRSA colonization/infection and stopping its spread. Typically, infection control maintains a list of patients known to be infected or colonized with MRSA based on past and current positive MRSA cultures. Infection control providers (ICPs) use this list to alert the admissions office or care providers and to initiate contact isolation.

Particularly in urban settings, patients often receive care at multiple hospitals.[5] A patient may be admitted to hospital A and be noted to be infected or colonized with MRSA. The same colonized/infected patient may later present to hospital B for the same or another problem, and may never be known to be MRSA positive, all the while serving as a potential source of infection at this naïve hospital. Active surveillance, whereby all presenting patients are screened for MRSA, is one potential solution, but is often resource-limited to certain hospital units (e.g., Intensive Care Units).[6]

Health information exchange has been proposed as a means to improve healthcare quality, safety, and efficiency.[7,8,9] In 1994, investigators at the Regenstrief Institute began building the Indiana Network for Patient Care (INPC), which is now one of the major health information exchange successes.[10] The system currently includes data from 17 hospitals in five healthcare systems and includes 95% of all inpatient care provided in Indianapolis. The core set of data received from all participants includes demographics, laboratory data, radiology reports, hospital dictation, ED and inpatient encounter data including chief complaint, coded diagnoses and coded procedures.

As part of an exploration of the value of sharing infection control MRSA lists to improve patient safety, we obtained

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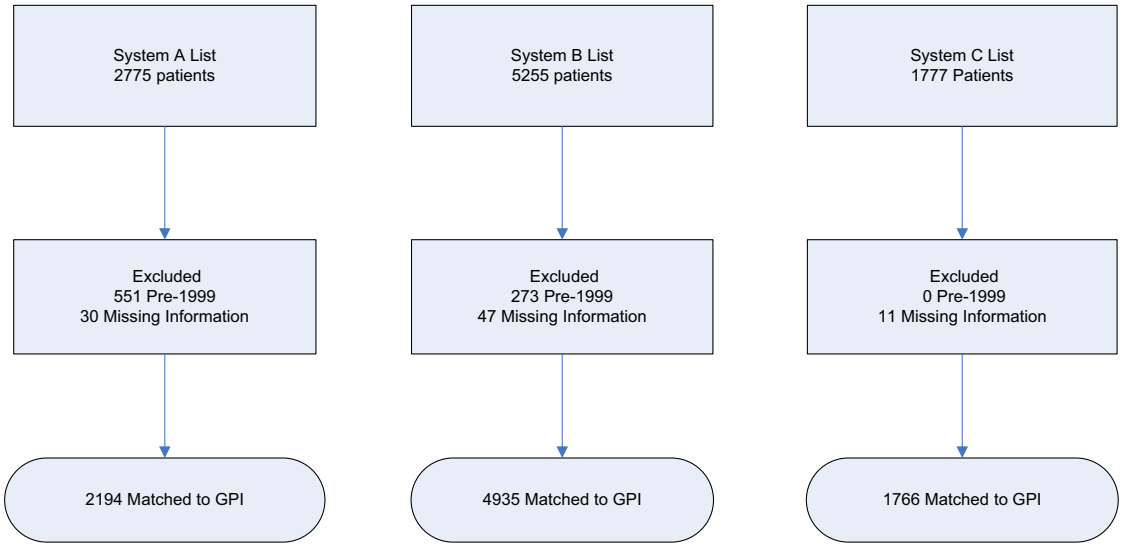

Figure 1. Institutional MRSA lists matched to a global patient index.

the MRSA lists from the infection control departments of three closely located urban hospital systems in central Indianapolis to determine how often patients with MRSA travel from a hospital where their MRSA positive status was known to one where it was not. Here we report the results of our analysis.

Methods

Setting and Participants

We obtained lists of patients with a prior history of infection or colonization with MRSA from the infection control departments of three healthcare systems located within central Indianapolis, as of January 2006. The other two hospital systems were located outside of central Indianapolis. Patients on these lists represent known infectious threats and are routinely placed in contact isolation when admitted to that institution. During the study period, none of the healthcare systems practiced routine active surveillance; patients on these lists were determined to have MRSA by routine clinical cultures.

The three healthcare systems operated six total hospitals, ranging in size from 300 to 1,400 beds. Healthcare systems that operated more than one hospital had a common information system and shared information about MRSA status with all of their "in system" hospitals, but did not share these records with the other healthcare systems. Culture data across all institutions was available through the INPC, but only to emergency care providers focused on the emergency care of patients. As a result, each institution relied on their own infection control teams to determine which patients required contact isolation based on their expert interpretation of the institution's own laboratory data to generate a list of MRSA-positive patients. We included patients on these lists with positive cultures dating back to 1999, the year by which all study healthcare systems had joined the INPC. This excluded 824 (0 to 551) patients whose most recent culture results predated 1999.

Global Patient Matching

The INPC has a tool to identify the same patient within or across participating systems. It uses a number of patient attributes including name, birthdate, and gender to identify matches. Studies conducted on a test population resulted in a 92% sensitivity and 100% specificity for true matches.[11] Between the three systems, 88 patients (11 to 47) had missing data, and could not be matched to a global patient index (Figure 1). We matched the common global identifiers from each system's MRSA list to those on the MRSA lists of the other two in order to determine the subsets of patients held in common on each list, and to determine patients that were only on the list at one system.

We did not focus analysis on patients who were on the list at all systems (regions of overlap in Figure 2); presumably, these patients would be detected when they presented at each hospital by their current isolation process.

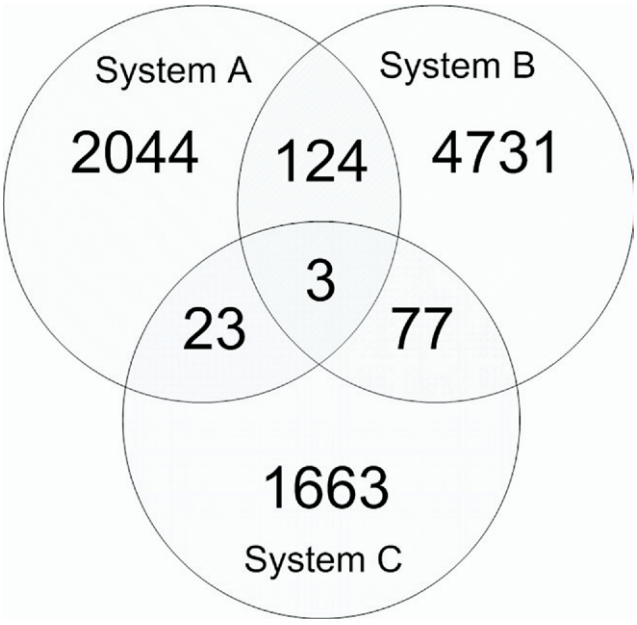

Figure 2. Overlap of MRSA lists from three health care systems. Central area of overlap represents patients known by multiple systems to have a history of MRSA. The bulk of patients on the list were unknown to neighboring systems.

For the patients whom we matched to a global patient index and who were not identified by all systems as MRSA positive, we extracted the registration records from the three systems. We compared registration dates against date of first positive MRSA culture results from the systems' lists to ensure that MRSA status of the patient at one system was known prior to the patient's visit at the other system. We determined the number of unique patients presenting at each system, and the kind and duration of visits at each system over one calendar year (2005).

Chart Review

For healthcare systems A and C, infection control providers reviewed patient charts to determine which patients, despite not being on the system's isolation list, were placed in isolation for other reasons. For healthcare system B, a 20% chart sample representing a similar sample size was reviewed for this same purpose. For comparison, infection control providers determined the number of known patients on their MRSA lists admitted to their healthcare system over the same calendar year.

The Institutional Review Board of Indiana University, Purdue University, Indianapolis (IUPUI) approved the study.

Results

We identified a total of 8,895 patients with a history of infection or colonization with MRSA since 1999 based on the infection control lists from all three healthcare systems. 227 patients were on the MRSA lists of at least two systems. Only three MRSA positive patients, a mere 0.03% of the total MRSA patients in the pool, were on the MRSA lists of all three (Figure 2). The remaining 8,438 (1,663 to 4,731) patients were only on the MRSA list of their "home" system. The three patients known by all three systems generated 17 admissions in 2005, and were placed in contact isolation during each admission.

Over a 12 month period, 286 unique MRSA positive patients were admitted 587 times to hospitals that did not know their MRSA status, and had an average LOS of 7.2 days. In each of these cases, the patients did not appear on the system's MRSA list as of the end of January 2006, i.e., after their admission.

However, in system C, 14% (7/49) of these patients *were* placed in isolation at admission, five of whom were identified as MRSA positive by either verbal communication with the patient or other providers, or by identification of active infection. The other two were placed in contact isolation at admission for other reasons (one for *Clostridium difficile* infection, and the other for unclear reasons). In system A, 10% (6/62) of infectious patients were placed in contact isolation upon admission, half for presence or history of non-MRSA infection (*Clostridium difficile* or active herpes zoster). At system B, out of a 20% sample, 15% (14/96) of patients were placed in isolation during admission based on presence of other infections, or by notification of MRSA status by non-electronic means.

We estimate that this accounts for approximately 3600 patient days where patients known in one system to have a transmissible infection passed unknown through the wards of another healthcare system. Notably, the exchange of patients was asymmetric; patients from system C accounted for 356 (61%) of the 587 admissions. The same system only received 42 (7%) of the total admissions.

Over the study period, the three systems received a total of 5,244 admissions of MRSA patients known by the receiving systems. The admission of patients known to other systems but not to the receiving system represented an additional 10% of MRSA admissions over the known cases at these healthcare systems.

Discussion

Patients travel faster and further than their medical information. Evans and colleagues at LDS hospital in Utah created a surveillance system within a single healthcare system for MRSA patients and demonstrated the itinerant nature of MRSA patients, often across hundreds of miles.[12] Regional health information exchange can address this threat, by spanning the information gap and ensuring that information that is critical to the care of the patient, e.g., MRSA infection or colonization status, is available wherever, whenever patients present for care. Even sharing best practices without specific patient level information between hospitals can lead to significant benefits. Between 12 hospitals, this equated with a reduction in 103 cases of hospital-acquired MRSA transmissions over two years.[13] In this study we quantify the frequency of "cross contamination" of MRSA patients between three systems closely located within a single urban center.

Our results are likely conservative. At one hospital, only the most recent culture dates were available, and we excluded a number of admissions where a patient may have had a prior positive culture. Our matching algorithm achieves 100% specificity but only 92% sensitivity, so potential matches may have been excluded from analysis. All study systems also require contact isolation for patients with a history of infection or colonization with other organisms such as Vancomycin-resistant enterococci (VRE) which we did not include in this analysis. We included only the subset of three hospital systems located centrally within the city; inclusion of all healthcare facilities would likely increase our overall counts.

Hospitals contact isolate patients with a known history of MRSA by their own records. This approach misses patients known to have MRSA at other hospitals, as well as patients which are unknown to have MRSA at any hospital. Active surveillance involves prospectively testing patients suspected of infection or colonization with MRSA. This practice can determine all MRSA cases presenting to one hospital but requires significant investment of staff and resources.[14] Prior studies using active surveillance estimate that MRSA colonization is present in 0.18% to 6.4% of all admitted patients.[15–18] During 2005 the three healthcare systems (six hospitals) accounted for 120,000 admissions, of which 5,244 (4.4%) had a known prior history of MRSA. In this study, we identified an additional 587 admissions with a prior history of MRSA unknown by the receiving hospital. After exclusion of patients placed in isolation despite not being on the system's MRSA lists, this accounted for an additional 10% of admissions which would have required isolation for MRSA. Information sharing could identify this reservoir of colonization and focus active surveillance efforts on identifying the truly unknown reservoir of patients within a region.

Contact isolation reduces the spread of MRSA between patients by as much as 16-fold.[19] In patients not in contact isolation, MRSA spreads to other patients at a rate of 0.14 transmissions per patient day. In contrast, when patients were cared for in contact isolation, the rate of spread to other patients was 0.009 transmissions per day. Our results suggest that by sharing information just between three institutions, we could avoid 3,600 patient days where patients should be in contact isolation, and this could reduce the number of patient-patient MRSA transmissions by 472 cases per year. Conservatively estimating MRSA infections in 29% of 472 newly colonized patients,[20] failing to share information results in 136 avoidable infections per year. These transmission rates were derived from an epidemic situation, and may overestimate the transmission rates in a non-epidemic situation. However, estimating $17,000 to $34,000 per additional MRSA infection,[2,14,21] sharing historical information on MRSA infection could avoid up to $2.3 to $4.6 million in additional healthcare costs per year across these three healthcare systems.

There are a number of limitations to our study. We did not fully capture whether patients had orders for contact isolation written during their hospitalizations at all systems, selecting a 20% sample at the largest system. The accuracy of our patient MRSA lists was dependent on the record-keeping of the individual infection control departments, although these same lists were the standard for routine clinical care within each system. Contact isolation may itself pose a threat to patient safety[22] and distributing incorrect patient data may place inappropriately isolated patients at increased risk. Knowledge of the infectious status of a patient does not always translate into timely contact isolation, although research we have conducted at one study hospital suggests that well-designed electronic notification systems *within* hospitals efficiently translates knowledge into appropriate action.[23] Currently, few other cities or regions have access to such a robust information sharing network, although over 100 community efforts are underway nationwide.[7]

Information sharing clearly does not replace the critical role for universal precautions for all patients. The emergence of Community-Associated Methicillin-Resistant *Staphylococcus aureus* (CA-MRSA) underscores the need for increased vigilance and sustained infection control efforts on all patients.[24,25] However, information sharing may enable infection control personnel to make judicious use of contact isolation and active surveillance and improve follow-up across institutions. The INPC is a working example of a regional health information exchange in place for ten years. We currently share data for emergency care, and public health reporting purposes, with security and privacy of information enforced through strict inter-institutional agreements and audit policies. Our results strongly support including infection control data as a critical use case for information exchange.

Future Directions

We are developing a regional infection control network built within the existing INPC. We already deliver tailored clinical abstracts to emergency care providers throughout the INPC. We are expanding this to include delivery of prior MRSA/VRE status to both emergency care providers, and infection control providers at participating institutions. We are deliberately involving infection control providers to manually review which patients to include on our regional contact isolation list, to maintain consistency with current practice at each institution, and to minimize mistaken inclusion or exclusion of patients by automated means.

Our long term goal is to reverse the trend of hospitals acting as sources of infection. By instantly delivering critical infection control information, hospitals will be able to immediately identify patients with MRSA or VRE (and potentially other infectious threats) that are known to any hospital within the network and institute contact isolation to minimize exposure of staff and patients. We theorize that a comprehensive electronic network that delivers critical infection control knowledge anywhere patients present for care, can direct targeted active surveillance and effective population-based decontamination. Mathematical models describe the conditions under which isolation policies can control MRSA transmission through a community.[26] We believe our community-wide infection control network can convert a theoretical model into a testable application aimed at stemming decades of MRSA spread.

In this study, we demonstrate the potential benefit of sharing patients' MRSA status between three healthcare systems. Sharing information such as laboratory test results and medications, could help address the rising costs of care. By one estimate, nationwide health information exchange could save $78 billion per year in avoidable tests.[27] The challenge is to determine what shared data elements add value to patient care, and which lead to increased risk for loss of confidentiality. We deliver healthcare to an increasingly mobile population. Further research is needed to determine what critical information institutions should share to ensure appropriate care of our collective patients.

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