Process Failures That Increase the Risk of Infection Through Respiratory Droplets:

A Study of Patient Safety Events Reported by Hospitals Across Pennsylvania

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Respiratory pathogens can lead to pneumonia, bronchiolitis, and death. Rapid identification, along with appropriate standard and isolation precautions, are necessary to prevent the spread of infectious agents causing respiratory infections. We analyzed patient safety events reported to the Pennsylvania Patient Safety Reporting System that were related to viruses and bacteria spread through respiratory droplets. An analysis of events that occurred from January 1, 2019, through December 31, 2019, led to the identification of 338 events involving process failures related to recognizing infectious agents that are spread through respiratory droplets, implementing measures to prevent their spread, or providing timely treatment. Detailed analysis of the process failures showed that 54.9% were associated with processes in testing or processing of laboratory specimens; 29.7% were associated with isolation-related procedures; and 15.4% were associated with medications, triage/assessment, documentation/verbal communication, or not providing the standard of care for patients in missed/delayed orders, procedures, or referrals.

Implementation of risk-reduction strategies can help to further reduce the spread of pathogens through respiratory droplets in the hospital setting and further enhance patient safety. These strategies include evaluating collection processes for testing/laboratory specimens, consistently using empiric isolation precautions based on initial triage and patient presentation, and evaluating processes for admissions and transfers.

Keywords: respiratory, pneumonia, isolation, droplet precautions, influenza, syncytial

Introduction

In the United States, an estimated 21 million patients seek medical treatment for respiratory infections each year.1 Severe respiratory infections such as croup, bronchiolitis, and pneumonia are caused by bacterial and viral agents spread through respiratory droplets.2–4 Most viral pneumonias in the United States are caused by influenza and...
Most viral pneumonias in the United States are caused by influenza and respiratory syncytial virus (RSV), but other causes of viral pneumonia include human metapneumovirus, human parainfluenza virus, rhinovirus, coronavirus, adenovirus, and measles.6–9

respiratory syncytial virus (RSV), but other causes of viral pneumonia include human metapneumovirus, human parainfluenza virus, rhinovirus, coronavirus, adenovirus, and measles.10,11 Other infectious illnesses, such as mumps, rubella, meningitis, and pertussis, are also spread through respiratory droplets.12 Numerous outbreaks of infectious agents (e.g., influenza, rhinovirus, RSV, measles, and pertussis) have been described in hospital settings.13–16 Thus, streamlined processes to quickly identify patients and staff that may be contagious, effectively isolate or exclude those individuals, and efficiently treat the suspected infection have the potential to significantly reduce the spread of nosocomial (i.e., hospital-associated) infectious agents through respiratory droplets.21

In order to determine the types of process failures that may place patients and staff at the greatest risk for exposure to infectious agents that cause respiratory infections or are spread through respiratory droplets, we examined patient safety events submitted to the Pennsylvania Patient Safety Reporting System (PA-PSRS)* that were related to failures in the process of early identification and prevention of the spread of infectious agents through respiratory droplets. Based on our analysis and a review of the medical literature, we developed risk-reduction strategies to help guide facilities to improve staff and patient safety.

Methods

We queried the PA-PSRS acute care database for events that occurred from January 1, 2019, through December 31, 2019. We searched free-text fields (i.e., Event Details, Event Recommendations, and Event Comments) for keywords relating to viral or bacterial agents that are spread through respiratory droplets: “RSV,” “syncytial,” “influenza,” “adenovirus,” “coronavirus,” “rhinovirus,” “enterovirus,” “pertussis,” “metapneumovirus,” “meningitis,” “mumps,” “measles,” “rubella,” and “rubella.” These keywords were selected based on common viral agents detected in a typical laboratory respiratory panel and other highly infectious diseases that can be spread through droplets, such as pertussis, meningitis, mumps, and rubella.22,23,24 The keyword “rubella” was included because measles is also highly infectious; causes symptoms similar to rubella (e.g., cough, runny nose, sore throat, and rash); and is spread through small respiratory droplets.25

Results

The initial query of the PA-PSRS acute care database produced 602 events that occurred in 2019. An analyst manually reviewed the details for each event and identified 338 events that met inclusion criteria. All 338 events were reported by hospitals.

Patient age/gender

For the 338 event reports, 54.7% occurred in females and 45.3% occurred in males. In Figure 1, we present the number of events by the following age groups: 0 through 5 years (young children), 6 through 18 years (school-aged children), 19 through 35 years (young adults), 36 through 64 years (middle-aged adults), and 65 years and older (older adults). Patients 5 years and younger (22.2%) or 65 years and older (25.4%) were most frequently associated with the included events.

Harm Scores

Facilities assigned harm scores to each event at the time of reporting. Figure 2 summarizes the frequency of harm scores, which ranged from A–E. No events were assigned harm scores F–I, meaning that no events led to a temporary or permanent hospitalization, permanent harm, near-death, or death. Harm score C was most frequently associated with the events analyzed (50.9%, Figure 2).
Process Failure Analysis

To gain a better understanding of steps needed to prevent the spread of infectious agents through respiratory droplets and to enhance staff and patient safety, we further analyzed the types of process failures identified in the event reports. Eighteen events involved two or more process failures. Thus, a total of 357 process failures were further analyzed. The process failures were related to errors in three main categories: process failures in testing or processing of specimens (54.9%); process failures in isolation procedures (29.7%); and other process failures (15.4%), such as those related to medications; triage or initial assessment; documentation or verbal communication; or missed or delayed referrals (see Figure 3).

Specifications/Testing

We further subcategorized the types of process failures related to testing or specimens. A total of 38.8% (76 of 196) of process failures for testing or specimens were related to errors involving the specimen container, such as selection of the wrong tube, swab, or media for specimen collection, or labeling errors, such as no label, wrong patient identification, or a missing label for specimen source. Another 24.5% (48 of 196) of process failures were related to specimen collection and processing. These types of process failures involved delays in specimen collection, delays in processing of specimens in the laboratory, or the quality or quantity of the specimen received.

A total of 15.3% (30 of 196) of the process failures involved errors in entering orders by the bedside staff (i.e., physicians and nurses) or by laboratory staff when selecting laboratory tests based on paper requisitions or electronic orders. Specifically, events involved delays in entering orders; errors in entry from paper requisitions; confusion between similar types of respiratory panel tests (e.g., influenza/RSV, rapid influenza, and respiratory panels) or confusion among two tests for measles caused by different viruses (e.g., rubella versus rubeola). Another 12.8% (25 of 196) of these process failures were related to communication of incorrect laboratory results to the bedside team, missed alerts for critical results, or communication of incorrect lab results during verbal report.

An additional 8.2% (16 of 196) of the process failures were related to delays in transport of specimens to the laboratory, packaging of the specimens from several different patients into a single transport bag or container, or not attaching a printed order with the specimen.

Isolation/Precautions

We further subcategorized the process failures related to isolation or precautions. A total of 34.0% (66 of 196) of these process failures related to transfer of a patient with potentially contagious illness without placing a mask on the patient. Another 28.6% (30 of 106) of the events related to failures in isolating the patient while ruling out the diagnosis of an infectious agent spread through respiratory droplets. These types of errors related to not implementing isolation precautions while the patient was being tested for a potentially infectious agent, admission or transfer of a patient into a double occupancy room prior to completion of testing, or errors in following the protocols for isolation precautions while ruling out a diagnosis for a potential infectious agent.

A total of 18.9% (20 of 106) of these process failures were related to errors in following the isolation procedures when a patient already tested positive for an infectious agent spread through respiratory droplets. These types of process failures involved delays in isolating the patient; attempts to admit the patient into a double occupancy room; confusion in differences between contact, droplet, or airborne isolation protocols; or lack of signage for isolation or precautions.

Another 16.0% (17 of 106) related to process failures that resulted in exposure or development of a hospital-acquired infection (HAI) from infectious agent spread through respiratory droplets. For many of these, the specific process failure that occurred was difficult to determine from the event report description. These failures were identified as exposures to or development of an HAI when a patient and/or their roommate developed symptoms and tested positive for an infectious agent spread through respiratory droplets several days after admission, when the patient was later identified to have an infectious agent and had not been placed in isolation precautions, or when a patient who tested positive for an infectious agent was placed in a room with another patient because no other rooms were available to appropriately isolate the patient.

A total of 2.8% (3 of 106) of isolation process failures related to miscellaneous factors, including a visitor seeing multiple patients, a patient diagnosed with an infectious agent leaving the hospital, and lack of appropriate personal protective equipment (PPE) or supplies outside an isolation room for providers.

Other Process Failures

We further categorized the other types of process failures. A total of 45.5% (25 of 55) of these process failures were related to medications. These process failures were related to errors in dosing or timing, delays, or missed doses of antibiotics or antivirals. One medication process failure was related to the weight of the patient not being provided to the pharmacy. A total of 55.5% of other process failures were related to not recognizing signs or symptoms of a potential infectious agent spread through respiratory droplets during triage or during initial assessment. They were categorized separately from isolation failures because they relate to process failures in associating the signs and symptoms with those caused by an infectious agent versus process failures in the specific isolation steps. These types of process failures included patients that were later realized to have presented with signs or symptoms of a highly contagious infectious agent yet remained in the waiting room area or without appropriate isolation precautions following triage, were not recognized as potentially contagious upon assessment by the initial providers, or were admitted to inpatient areas before a provider recognized the symptoms and ordered appropriate testing and isolation.

Another 16.4% (9 of 55) of other process failures were related to errors in communication or documentation. These process failures included entry of incorrect test results or patient information into the chart, or errors in verbal reports at admission, transfer, or shift change. A total of 14.5% (8 of 55) of other process failures were related to errors in maintaining the standard of care, such as missed orders from the standard hospital protocol for isolation precautions, errors in completing tests (e.g., lumbar puncture) prior to transfer to another unit, or missed or delayed referrals.

Admission/Transfer

Of the 357 process failures, we also noted that a combined 22.7% of the process failures were related to admission or transfer of the patient. These process failures were related to admission and transferring across all three process failure categories, including testing/specimens (n=9), isolation (n=60), and other (n=12).
Process Failures by Care Area and Age Group

The 357 process failures were further analyzed based on the care area where the events occurred (Figure 4). The process failures occurred over 20 care area groups. Process failures were most frequently associated with the emergency department (31.9%; 114 of 357), the medical/surgical unit (21.3%; 76 of 357), laboratory (13.7%; 49 of 357), intensive care unit (ICU; 6.4%; 23 of 357), pediatric unit (5.3%; 19 of 357), and pediatric intensive care unit (PICU; 5.3%; 19 of 357). Testing or specimen-related errors most frequently occurred in the emergency department, which represents 36.2% (71 of 196) of the testing or specimen process failures. However, process failures also occurred in the laboratory, ICU, medical/surgical unit, pediatric unit, and PICU. A combined 69.8% (74 of 106) of process failures in establishing proper isolation or precautions occurred in the medical/surgical and emergency care area groups.

Figure 4: Cross Tabulation of Care Area Group with Process Failure Categories, N=357

| Care Area Group | Process Failure Category | Testing/Specimen | Isolation | Other | Grand Total |
|-----------------|--------------------------|------------------|-----------|-------|-------------|
| Administration  |                          | 1                | 1         | 2     |             |
| Emergency       |                          | 71               | 26        | 17    | 114         |
| ICU             |                          | 12               | 7         | 6     | 23          |
| Imaging/Diagnostic |                    | 2                | 1         | 3     |             |
| Intermediate Unit |                    | 5                | 4         | 1     | 10          |
| Labor and Delivery |                    | 3                | 2         | 1     | 6           |
| Laboratory      |                          | 48               | 32        | 14    | 94          |
| Med/Surg        |                          | 35               | 15        | 13    | 76          |
| NICU            |                          | 3                | 2         | 5     |             |
| OB-GYN Unit     |                          | 1                | 2         | 1     |             |
| Other           |                          | 2                | 3         | 9     |             |
| Outpatient/Clinic |                    | 2                | 3         | 9     |             |
| Pediatric       |                          | 13               | 4         | 2     | 19          |
| Pharmacy        |                          | 2                | 1         |       |             |
| PICU            |                          | 16               | 2         | 3     | 19          |
| Psychiatric Unit |                    | 1                | 1         |       |             |
| Rehab Unit      |                          | 1                | 1         |       |             |
| Respiratory     |                          | 1                | 1         |       |             |
| Specialty Unit  |                          | 3                | 3         | 6     |             |
| Surgical Services |                   | 3                | 4         | 2     |             |
| Grand Total     |                          | 196              | 106       | 55    | 357         |

Similarly, a combined 54.5% (30 of 55) of other process failures occurred in the medical/surgical and emergency care area groups.

Figure 5: Cross Tabulation of Age Group with Process Failure Categories, N=357

| Age Group | Process Failure Category | Testing/Specimen | Isolation | Other | Grand Total |
|-----------|--------------------------|------------------|-----------|-------|-------------|
| 0 - 5     |                          | 85               | 12        | 15    | 112         |
| 6 - 18    |                          | 21               | 2         | 4     | 27          |
| 19 - 35   |                          | 35               | 9         | 9     | 43          |
| 36 - 64   |                          | 34               | 32        | 14    | 80          |
| 65+       |                          | 31               | 51        | 13    | 95          |
| Grand Total |                      | 196              | 106       | 55    | 357         |

Discussion

Infection prevention requires efficient coordination of many hospital processes during a patient’s stay. Rapid diagnosis of a contagious illness is essential not only to ensure timely treatment of patients but also to prevent the spread of disease. In fact, processes that lead to timely identification of the signs and symptoms of a contagious illness (e.g., fever, cough, and rash) as well as recent travel history are ever more critical in preventing the spread of novel infectious diseases (e.g., COVID-19 or other emerging infectious diseases), which can quickly spread through communities, may have increased risk of morbidity, and for which initial testing may not be immediately available.20,21 Thus, accurate and timely assessment of signs and symptoms along with effective screening and surveillance programs are crucial for infection prevention.22,23 The laboratory plays a key role, especially when rapid testing and accurate results are essential to infection prevention.24,25 Furthermore, cohorting and isolation of patients with initial symptoms, along with appropriate use of standard, droplet, and contact precautions, may also significantly reduce the risk for spread of infections.26,27 Finally, efficient delivery of treatments, such as antibiotics and antivirals, may improve outcomes, and theoretically reduce infectiousness of the infectious agent.8,9

Figure 5: Cross Tabulation of Age Group with Process Failure Categories, N=357

| Age Group | Process Failure Category | Testing/Specimen | Isolation | Other | Grand Total |
|-----------|--------------------------|------------------|-----------|-------|-------------|
| 0 - 5     |                          | 85               | 12        | 15    | 112         |
| 6 - 18    |                          | 21               | 2         | 4     | 27          |
| 19 - 35   |                          | 35               | 9         | 9     | 43          |
| 36 - 64   |                          | 34               | 32        | 14    | 80          |
| 65+       |                          | 31               | 51        | 13    | 95          |
| Grand Total |                      | 196              | 106       | 55    | 357         |

Review of the literature shows that children ages 5 and younger and patients ages 65 and older to be at most risk for complications or death from respiratory pathogens.8,9 Given the increased risk of severity of respiratory illnesses in these age groups, it is concerning that we also found these same groups associated with more frequent event reports related to infectious agents spread through respiratory droplets (Figure 1). However, it is difficult to draw conclusions regarding this observation as the increased events related to respiratory pathogens also could have simply resulted because more patients in these age groups seek care, which could in turn increase the likelihood of a portable event. Our analysis of PA-PSRS-reported events identified process failures that were similar to those described in the literature as contributing factors to nosocomial outbreaks of infectious agents, such as influenza, rhinovirus, RSV, measles, and pertussis.14 These same process failures related to delayed suspicion, delayed identification, and delayed treatment of infectious agents.14 Thus, opportunities to reduce these types of process failures have the potential to reduce the spread of infectious agents in the hospital setting and to improve staff and patient safety.

Risk-Reduction Strategies

Our analysis has shown that the types of process failures identified in our study often involve systems problems, human factors, or knowledge deficiencies. Specific areas for implementation of process improvements or monitoring are outlined below and are summarized in Table 1.

Laboratory Samples

In our analysis of events related to agents spread through respiratory droplets, 54.9% of the 357 events involved testing or specimen process failures. Of these, 47.0% were related to the incorrect tube/media/swab used and instructions for how to properly enter orders for these tests, how to properly collect samples, which types of tubes/swabs/media are needed, and packaging/transport requirements for specimen delivery. Tables/charts of available tests and types of recommended swabs/media for collection could offer a way to stratify this information into easy-to-use references for staff to access.22

Reinforcing policies and procedures through staff and physician championing as well as through orientation and staff training programs are also important steps in quality improvement and error reduction methods.25 A hospital collaborative also specifically addressed labeling errors of blood samples and noted that changes in workflow for printing labels, changes in staffing workloads, use of a patient-specific binder system, monthly laboratory/nursing staff meetings, mandatory competencies for specimen labeling processes, information technology system improvements in label printing, and increased leadership involvement through dashboards.

Rapid diagnosis of a contagious illness is essential not only to ensure timely treatment of patients but also to prevent the spread of disease.
were all important interventions in changing the culture and improving specimen labeling processes.40-42

Isolation/Precautions

Nearly one-third (29.7%) of the 357 analyzed process failures were related to isolation procedures and use of PPE and resulted in HAIs or potential exposure of patients and staff to infectious agents spread through respiratory droplets. Moreover, 28.3% of the isolation-related process failures involved not initiating isolation precautions while waiting on test results. Although standard precautions include many effective infection prevention processes, such as handwashing and use of gloves, masks, or gowns when there is potential for contact with body fluids or splashes, these precautions alone may not be effective in preventing the spread of infectious agents through respiratory droplets. The use of eye protection in addition to masks and handwashing have been found to be key measures to prevent the spread of infectious agents through respiratory droplets to other healthcare workers or patients.52,53,54 Furthermore, standard precautions require that each provider uses assessment and critical thinking skills for each patient encounter to determine if PPE may be needed. Thus, other staff, such as laboratory, respiratory, radiology, nurse aides, or housekeepers, may be placed at additional risk for exposure when entering these patient rooms if isolation protocols are delayed until after testing is completed.

Thus, risk-reduction strategies include establishment of empiric processes to initiate isolation precautions based on triage and/or initial nursing or physician assessment.22 Bundling specific isolation orders with laboratory testing orders until the test results are returned can help ensure that the orders are not missed or delayed and that the appropriate type of precautions (such as airborne or droplet) are implemented.32,33 These types of processes, especially when implemented in all areas of the hospital (including the emergency department, physician offices, urgent care, and inpatient units) can ensure that other patients and staff are not exposed while the testing is performed to rule out the potentially infectious agent. Moreover, 52.9% of the isolation process failures were related to either errors in following isolation procedures or transferring patients who tested positive for an infectious agent without a mask. Again, bundling these isolation order sets together can help ensure that all steps for setting up isolation are implemented.26,27 Examples include bundling droplet precaution orders to include instructions for a mask for the patient during transfer; a private isolation room for admission; orders for droplet/contact precautions; specific PPE, such as mask, eye protection, gown, and gloves, to be worn during patient care; and signs or PPE to be placed outside the patient room. Similarly, bundled airborne precaution orders should also include orders to place a surgical mask on the patient during transfer.

### Table 1: Risk-Reduction Strategies to Reduce Process Failures that Contribute to Spread of Infectious Agents

| Risk-Reduction Strategies | Laboratory Samples | Isolation/Precautions | Admission and Transfer |
|---------------------------|--------------------|-----------------------|-----------------------|
| Autemate inclusion of instructions for specimen collection when laboratory orders are entered | Implement continuous quality improvement programs to monitor/improve | Establish empirical policies and procedures based on initial triage, assessment, and symptoms | Review system processes |
| Staff development training to include | 1. Available laboratory testing | Bundle isolation orders into sets | 1. Standard of care – protocols/order sets for each diagnosis |
| a. Recommended tubes/swabs/media | 2. How to order specific laboratory tests | | 2. Handoff/communication |
| b. Collection method | 3. How to collect samples/specimens | | a. Standardize handoff reports between nurses |
| c. Specific order names to select in electronic medical record (EMR) | 4. Types of tubes/swabs/media that are needed for each type of specimen | | b. Standardize handoff reports between physicians |
| Reinforce policies and procedures | 5. Packaging/transport requirements to specimens | | c. Standardize handoff for transport team |
| a. Identify staff and physician champions | 6. Reference tables and charts of available tests | | 3. Admission room assignment protocols |
| b. Orientation/residency programs | | | |
It is important to note that many other processes in the hospital are also key to the prevention of the spread of infectious agents, and despite mandatory event-reporting laws in Pennsylvania, our data are subject to the limitations of self-reporting. This may be more likely for process failures that occur when a specific patient was not identified. It is also important to note that harm and the significance related to process failures in the steps to isolate and contain potentially infectious agents may not be immediately realized, and therefore, not reported. Thus, the number of events and severity of the outcomes may be more substantial than those captured through event reporting.

Conclusion

Preventing the spread of infectious agents in the hospital involves coordination of many processes. Our study has identified process failures related to identification, isolation and treatment for infectious agents spread through respiratory droplets in hospital settings. Based on our findings, patients ages 0 through 5 years and 65 years and older were more frequently associated with events involving infectious agents spread through respiratory droplets. Furthermore, analysis of the process failures provided insight to various risk-reduction strategies that can be implemented to further reduce the risk for spread of infectious agents. Monitoring of these processes in continuous improvement programs, along with implementation of risk-reduction strategies, may help reduce the risk for the spread of infectious agents as well as support a culture of safety for both patients and staff.

Notes

This analysis was exempted from review by the Advarra Institutional Review Board.

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