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The Rationale for System-Level Strategies of Infection Control

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Current infection control strategies focus on the point of contact between individuals. We examine the magnitude of the movement of pathogens throughout the different geographic components of a prototypical hospital, and a rational for considering system-level strategies that reduce the spatial movement of pathogens.

Introduction

Hospitalized patients are at risk for the development of many different types of infections, particularly nosocomial infections associated with resistant organisms.[1-3] With reported prevalence rates as high as 11.6%, these infections are a significant source of potentially preventable prolonged length of stay, morbidity, and mortality. Interventions to prevent hospital-acquired infections have become increasingly important elements of hospital practice, with efforts ranging from hand-hygiene campaigns to the use of multi-pronged strategies called “bundles” to prevent pathogen transmission.[4,5] These infection control strategies share a common approach of focusing on the point of transfer within a patient’s local space, e.g. between a health care worker/provider and the patient, or between them and instruments in the local area.

More effective interventions are time-intensive and whether they can be translated successfully into routine practice remains to be demonstrated.[6-8] Even if successful, decreased rates of infections still impact large numbers of patients, suggesting the need for additional infection control strategies.

Here we present preliminary data to establish the rationale and importance of approaching infection control as a system issue, and discuss the implications of this approach for potential interventions. The essential concept is a focus on pathogen transmission between spatial areas of the hospital rather than the individuals that are within it. Through shadowing and observing different types of individuals moving through the system, we demonstrate that in hospital settings there are frequent contacts throughout the system that facilitate the spread of infection, and quantify these contacts. These contacts often involved clothing or other contacts that are not included in conventional protocols. We therefore propose reducing the pathogen transfer between different areas of the hospital by implementing system-level transfer reduction protocols. In conjunction with interventions focused on the individual patient these protocols should dramatically improve control of pathogens in the hospital environment.

Methods

We used three methods to demonstrate the movement of pathogens throughout parts of a hospital. First, based on our knowledge of prototypical nursing units and the daily workflow that occurs, we created a schematic of a prototypical hospital floor and the movement of individuals within and between them. Second, based on our knowledge and observation of the movement of different types of individuals through the hospital gleaned from years of working in inpatient units, we delineated the types of people who enter a hospital building daily, and the places that they are likely to go. Third, we conducted a pilot observation of a convenience sample of housestaff physicians, phlebotomists, and food service personnel as they traveled throughout the hospital, noting the types and numbers of contacts that each type of person had with a patient or the patient's immediate environment.

We conducted pilot observations at the Audie L. Muphy Hospital in the South Texas Veterans' Health Care System, a primary teaching affiliate of the University of Texas Health Science Center at San Antonio. Because housestaff have the greatest number of contacts with patients, they were the focus of the study. Three housestaff (one resident and two interns) were observed on 4 different days during the course of a one-month rotation on the General Medicine service. The observation consisted of counting the number of times physicians' hands, clothes, or personal equipment touched a patient, or items such as light switches or bed controls that a patient is also highly likely to touch.

We also observed three phlebotomists and two food service delivery personnel on daily rounds of blood drawing or food delivery.

Results

Currently individuals move among wards, or between wards and public spaces, facilitating the movement of pathogens without hesitation. Hospital personnel, physician teams and phlebotomists, care for patients in multiple spatial domains of the hospital. The movement of visitors, patients contribute to the flow. Estimated numbers of individuals entering a typical hospital who are likely to come into contact with a patient colonized with resistant organisms, and the places they are likely to go, are listed in Table 1.

The pilot physician observations revealed that physicians' rounds spanned at least two nursing units, often three. Table 2 quantifies the number of times physicians' hands, clothes, or personal equipment touched a patient or items in a patient's immediate bedside area that a patient is also highly likely to touch, such as light switches or bed controls, for each patient seen during rounds.

Each phlebotomist traveled between units on an individual floor. Though they uniformly followed proper gown and glove procedures for entering the rooms of patients on contact isolation, each phlebotomist placed his or her basket of equipment on the bed or table of each patient, prior to moving to the room of the next patient. The food service personnel typically left carts of trays outside of patient rooms and generally had little direct contact with patients, but their clothes frequently touched patient beds or bedclothes.

Discussion

These data illustrate the large number of contact points between individuals throughout geographic locations in the hospital. Our findings are consistent with published data reporting high rates of colonization in the hospital environment, such as on bedrails, sink handles, or personal digital assistants.[9,10] The many contacts allow multiple opportunities for the transfer of infectious material throughout an institution, The pervasive pathogenic materials imply that each contact between individuals must be considered a contact between carriers. In order to dramatically lower the pervasive presence of pathogenic materials, we propose blocking transfer at the points of communication between areas of the hospital. This is particularly important since many of the contacts are not traditional contacts by hand, but contact between clothing or equipment.

Interventions that would achieve system-wide reductions in pathogens prevent their movement throughout the system. The most straightforward to implement is to create Pathogenic barriers at the entry points to the system, and between nursing units, floors and buildings. These barriers might go beyond hand washing to include decontamination of clothing or equipment such as white coats or personal digital assistants. Other strategies include assigning physicians to specific geographic units, or changing nursing workflows to involve less mobility between areas of the hospital. Additional isolation techniques might be used to separate patients colonized or infected with resistant organisms, such as cohorting subsets of medical or surgical patients colonized with methicillin-resistant Staphylococcus aureus in a single unit on contact isolation at the point of entry to the unit. Finally, approaches to large-scale pathogen decontamination may be considered.

The feasibility and effectiveness of system-level interventions to prevent the spread of pathogenic materials is not known. However, such approaches can dramatically reduce the overall prevalence of pathogens and thus decrease the spread of pathogens within and between institutions to enhance interventions that reduce the likelihood of infection in a single contact.

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Table 1: Types of people entering hospital spaces

Type of Person	Places they visit
Patients	Patient care unit Emergency department Diagnostic services Rehabilitation Procedural suites / OR's Cafeteria
Nurses	Patient care unit Public spaces Pharmacy Cafeteria Nursing admin office May accompany patients who leave unit
Physicians	Multiple patient care units Public spaces Emergency department Diagnostic services Procedural suites / OR's Cafeteria Physicians' offices
Ward clerks	Patient care units Public spaces Administrative Offices Cafeteria / lounge
Social Workers	Patient care units Public spaces Family meeting rooms Offices
Food Services	Multiple patient care units Public spaces Central food supply
Housekeeping	Multiple patient care units Public spaces Laundry areas Potentially all hospital areas
Phlebotomists	Multiple patient care units Public spaces Lab
X-ray technicians	Multiple patient care units Public spaces Diagnostic services / X-ray
Visitors	Patient care units Public spaces Cafeteria Waiting rooms

Table 2: Types and numbers of housestaff contacts with individual patients during daily rounds

Type of Contacts		Percent of time that contact occurred	Median number of contacts	Range of number of contacts
Physician Hand Contact	**Patient**	94%	4	0 – 9
	Bed / Bedrails	71%	2	0 – 5
	Bedclothes	70%	2	0 – 4
	Tray	32%	1	0 – 3
	Light	29%	1	0 – 2
	Other*	23%	1	0 – 2
Physician White Coat / Clothes	**Patient**	10%	1	0 – 2
	Bed / bedclothes	100%	2	1 – 7
	Other*	10%	1	0 – 3
Other**	**Any contact**	48%	1	0 – 3
Total	**All types**	100%	**16**	**4-20**

* includes bedside equipment, e.g., nasal cannula, IV pole

** includes stethoscope or clipboard

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