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Assessment of health care personnel needs for training in infection control: One size does not fit all

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To guide development of infection control education, we conducted a pilot needs assessment to determine current infection control knowledge, identify potential gaps between knowledge and practice, and identify perceived training needs among a varied group of health care personnel. A total of 23 health care personnel from various disciplines and health care settings completed the self-administered Web-based survey. Differences in knowledge and self-identified training needs were found among disciplines. Future research may well focus on further exploring specific needs of different disciplines. These results will be used to inform topics to cover in infection control curricula for clinicians, public health professionals, and allied health personnel. (*Am J Infect Control* 2008;36:757-60.)

Transmission-based isolation precautions along with Standard Precautions form the foundation of infection control practice. Previous publications, including the Centers for Disease Control and Prevention's (CDC) *Guideline for Isolation Precautions in Hospitals*, have addressed infection control practices in hospitals.^{1,2} However, the shift of health care delivery from hospitals to other settings has broadened the types and numbers of health care personnel who require training in appropriate infection control practices. Increasingly, infection control training is needed for a broader array of personnel, including nonclinical personnel, such as public health professionals, who may be involved in response efforts to large-scale infectious disease events/outbreaks, such as severe acute respiratory syndrome (SARS) and pandemic influenza.

Although guidelines are an important component of effective infection control programs, the availability of guidelines alone has been shown to have only a limited impact on the knowledge and behavior of health care personnel.^{3,4} According to Cabana et al,⁵ lack of

awareness and lack of familiarity with guidelines are barriers to adherence. Supplementing guidelines with tailored educational tools may be one way to improve knowledge and the application of recommended practices.⁶

To guide the development of infection control educational tools and curricula, we conducted an assessment to determine current infection control knowledge, identify potential gaps between knowledge and practice, and identify perceived training needs among a varied group of health care personnel including clinicians, public health professionals, and allied health personnel. By developing tailored courses that address gaps between knowledge and practices, educational efforts may be able to improve the adoption of guidelines by health care personnel and, ultimately, patient outcomes.

METHODS

We recruited a convenience sample of health care personnel nationwide by referral. Participants chosen to complete the survey included clinicians, public health professionals, and allied health personnel. Data were collected using a self-administered, Web-based survey between August and October 2005. Information collected included: job category (eg, nurse, physician), years in the profession, type of facility, degree of involvement in "hands-on" patient care duties, knowledge of hand hygiene recommendations, knowledge of CDC-recommended isolation categories, timing and type of previous infection control training, and perceived infection control training needs. We then assessed participants' ability to apply their knowledge of isolation precautions to the care of patients presenting with specific clinical syndromes/conditions

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Table 1. Participants' reported hand hygiene knowledge and practices by discipline, August to October 2005

Question	Response choices	Participants with correct responses			Overall
		Physicians (n = 9)	Nurses (n = 8)	Other* (n = 5)	
In which situations are alcohol-based hand rubs recommended?	Before touching equipment in patients' room	5 (56%)	3 (38%)	3 (60%)	12 (55%)
	Before inserting catheters	6 (67%)	3 (38%)	1 (20%)	11 (50%)
	After removing gloves	4 (44%)	7 (88%)	3 (60%)	15 (68%)
Which statements are true about alcohol-based hand rubs?	They reduce bacterial count better than plain soap	3 (33%)	7 (88%)	2 (40%)	12 (55%)
	More accessible	7 (78%)	8 (100%)	3 (60%)	18 (82%)
	Require less time than soap	5 (56%)	5 (63%)	3 (60%)	13 (59%)
	Rubs less irritating than soap	5 (56%)	3 (38%)	3 (60%)	12 (55%)

*Other includes nurse practitioner, paramedic, respiratory therapist, dialysis technician, and medical student.

by asking them to identify the appropriate category of precautions (Standard, Contact, Droplet, Airborne) and the type of personal protective equipment (PPE) to be used with each precaution. Internet-based data files containing participants' anonymous responses were downloaded into an Excel (Microsoft, Redmond, WA) database and analyzed.

RESULTS

Of the 29 health care personnel who received the survey, 23 (79%) completed and returned it. Of the 23 participants, 9 (39%) classified themselves as physicians, 8 (35%) as registered nurses (RNs), and 6 (26%) as other health care personnel, including 1 nurse practitioner, 1 paramedic, 1 respiratory therapist, 1 dialysis technician, 1 medical student, and 1 infection control professional. The infection control professional's responses were excluded from this analysis.

The remaining 22 participants represented a variety of health care settings, including hospitals (45%), outpatient clinics/facilities (18%), long-term care facilities (14%), federal and local public health agencies (14%), and prehospital care (9%). Most of the participants (82%) had more than 10 years experience in health care, and 50% had experience in public health. All but 1 participant was involved in providing some "hands-on" patient care.

Hand hygiene knowledge and practices

When asked about the most often used hand hygiene products, participants cited antiseptic soap and water (36%), plain soap and water (32%), and alcohol-based hand rubs (27%). One participant was not involved in clinical practice and did not respond. There were no substantial differences in product use by discipline.

However, differences were found among the disciplines in terms of knowledge-based questions (Table 1). RNs (88%) answered correctly about the use of

alcohol-based hand rubs after removing gloves twice as often as physicians (44%); however, physicians (67%) answered correctly that alcohol-based hand rub use is recommended before catheter insertion more often than RNs (38%) and other personnel (20%). Overall, most of the participants (range, 12 to 19 [55% to 82%]) correctly identified true statements about alcohol-based hand rubs; however, physicians (33%) were less likely than RNs (88%) to correctly respond that alcohol-based hand rubs reduce bacterial counts better than plain soap.

Knowledge of isolation categories

Most of the participants correctly identified Standard Precautions (77%) and Droplet Precautions (59%) as categories of isolation recommended by the CDC during patient care. However, many also incorrectly identified Universal (59%), Respiratory (55%), and Enteric (45%) Precautions as CDC-recommended categories of isolation precautions. Data for different disciplines closely resembled the overall data, except 7 physicians (78%) incorrectly chose Universal Precautions, compared with only 3 RNs (39%).

Knowledge of PPE

When participants were asked to identify which of 7 types of PPE (gown, surgical mask, respirator, goggles/face shield, gloves, private room, and negative-pressure room) should be used with each category of precautions, the ability to identify recommended PPE varied by precaution (Table 2). Most of the participants (86%) were unable to correctly identify the PPE that should be used with Standard Precautions. All but 2 participants (91%) were able to identify the recommended PPE for Airborne Precautions; however, 18 of these participants identified unnecessary PPE in addition to the recommended PPE. There were no notable differences in knowledge among the disciplines except in terms of PPE for Contact Precautions; more than half

Table 2. Participants' ability to correctly identify recommended PPE for each category of isolation, August to October 2005

Isolation category	Participants with a given response, n (%)		
	Correct PPE	Correct PPE plus additional PPE	Incorrect PPE
Standard	3 (14%)	0	19 (86%)
Contact	8 (36%)	6 (27%)	8 (36%)
Droplet	2 (9%)	10 (45%)	10 (45%)
Airborne	2 (9%)	18 (82%)	2 (9%)

of the RNs (62%) were able to correctly identify the recommended PPE for Contact Precautions, compared with only 33% of physicians.

Knowledge application

When asked to identify the recommended precautions to apply during the care of patients in situations of fecal incontinence, no known infection, shingles/herpes zoster localized, and human immunodeficiency virus infection, many of the participants correctly identified Standard Precautions; however, many participants also cited unnecessary isolation precautions with some clinical presentations (Table 3). When asked about clinical presentations requiring multiple isolation precautions, between 2 (9%) and 11 (50%) participants were able to correctly identify recommended precautions, depending on the given presentation; for example, 11 participants (50%) correctly identified that Airborne and Standard Precautions should be followed when treating a patient with tuberculosis, and 9 participants (41%) recognized the need for Contact and Standard Precautions when treating a patient with a draining wound known to be infected with a multidrug-resistant organism. Droplet and Standard Precautions were correctly identified for treating undiagnosed respiratory illness with fever by 36% of the participants, for influenza by 18%, and for undiagnosed rash illness with fever by 9%. Only 3 participants (14%) knew that a presentation of chickenpox required Airborne, Contact, and Standard Precautions.

Infection control training and training needs

Of the 22 participants, 15 (68%) reported having received previous training in infection control: 3 of 9 physicians (33%), 8 of 8 RNs (100%), and 4 of 5 other health care personnel (80%). Of the 15 participants with training, most (60%) had received training within the past year, addressing bloodborne pathogens (100%), hand hygiene (87%), needlestick injuries (80%), Standard Precautions (60%), and tuberculosis (53%).

Overall, the participants indicated that they had a moderate to great need for training regarding transmission of infectious agents (68%), multidrug-resistant organisms (55%), disinfection/sterilization (50%), bloodborne pathogens (45%), hand hygiene (45%), and principles of disease transmission (41%). Physicians reported the greatest need for training in isolation precautions to prevent transmission of infectious agents (67%) and disinfection/sterilization (56%). The topics most mentioned by RNs included isolation precautions (63%), disinfection/sterilization (50%), and multidrug-resistant organisms (50%). The other health care personnel reported the greatest need for training in bloodborne pathogens (100%), principles of disease transmission (100%), multidrug-resistant organisms (80%), isolation precautions to prevent transmission of infectious agents (80%), and hand hygiene practices (80%).

When asked where they would access online training, participants cited the workplace (73%) and home (50%). Responses did not differ notably by job category.

DISCUSSION

We conducted an assessment of the infection control knowledge and educational needs of health care personnel in various settings and disciplines, including those in both clinical and public health practice. Overall, the results indicate that almost half of the participants could not identify clinical situations that warrant the use alcohol-based hand rubs. Furthermore, the participants were unable to clearly identify appropriate recommended precautions for specific clinical presentations and the PPE to be used with each precaution. Almost all participants engaged in some degree of "hands-on" patient care, in which knowledge and appropriate application of hand hygiene and other infection control practices is essential. The number of incorrect responses and inability to apply knowledge to practice supports the need for training in all areas evaluated, including hand hygiene, isolation precaution recommendations, and the selection and use of PPE.

Although most of the participants could correctly identify that Standard Precautions should be used with specific clinical presentations, many also identified unnecessary precautions. Furthermore, when asked about clinical presentations requiring multiple isolation precautions, less than half could identify recommended precautions, indicating that the participants were not familiar with or did not understand existing infection control guidelines. Because unfamiliarity with guidelines is a known barrier to compliance, course topics in isolation guideline recommendations may be a first step in improving guideline compliance.⁵

Table 3. Participants' selection of isolation precautions to be used during the care of patients with specific clinical presentations, August to October 2005

Clinical presentation	Participants with a given response, n (%)			
	Standard only*	Standard plus transmission-based [†]	Transmission-based only	None apply
Fecal incontinence	9 (41%)	5 (23%)	6 (27%)	2 (9%)
No known infection	18 (82%)	0	0	4 (18%)
Localized shingles/ herpes zoster	2 (9%)	12 (55%)	8 (36%)	0
HIV infection	17 (77%)	1 (5%)	4 (18%)	0

*Standard Precautions are recommended during the care of patients with each of the clinical presentations listed.

[†]Transmission-based precautions include Contact, Droplet, and Airborne Precautions.

Not unexpectedly, physicians were less likely than RNs to have infection control training and were more likely to answer incorrectly on certain questions. In designing infection control courses, it may be necessary to tailor content to meet the specific needs of physicians untrained in infection control, as well as the needs of health care personnel with previous training. By tailoring courses to the audience's needs, job duties, and educational level, courses can improve the likelihood of successful integration of new recommendations into clinical practice.⁷ Future research should focus on further exploring the specific needs of different disciplines and possible reasons for lack of infection control training for physicians, such as gaps in medical education and the challenges of providing training to personnel who are not based at specific facilities.

Furthermore, as medical terms evolve, future needs assessments may examine the impact of medical jargon on participants' ability to answer correctly. Assessments such as these could be augmented by evaluating attitudes and beliefs toward infection control practices, because health care personnel are likely to alter their practices only when knowledge, beliefs, and attitudes are aligned.^{4,8-10}

This pilot assessment was small and comprised a convenience sample of health care personnel. Although the findings indicate what some health care personnel know and do not know with regard to infection control and, more importantly, their ability to competently identify the precautions indicated for specific clinical conditions/presentations, these findings may not be representative of the knowledge, competency, or training experience of personnel in clinical and public health practices in general or those in the specific disciplines included in the survey. To apply the findings to larger populations, this needs assessment should be replicated on a larger scale.

In summary, this pilot needs assessment identified some gaps in knowledge and between knowledge and

practice in terms of infection control. The findings will be used to inform topics to be covered in CDC infection control curricula for clinicians, public health professionals, and other allied health personnel. Although education may not ensure adherence to guidelines, infection control training tailored to address specific gaps in knowledge and gaps between knowledge and practice may improve the infection control practices of health care personnel and, consequently, patient outcomes.

References

- Garner JS. Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. *Infect Control Hosp Epidemiol* 1996;17:53-80.
- Siegel J, Rhinehart E, Jackson M, Chiarello L, and the Healthcare Infection Control Practices Advisory Committee. Guideline for isolation precautions: Preventing transmission of infectious agents in healthcare settings, 2007. Available from: http://www.cdc.gov/ncidod/dhqp/gl_isolation.html. Accessed May 5, 2008.
- Osborne S. Influences on compliance with standard precautions among operating room nurses. *Am J Infect Control* 2003;31:415-23.
- Pittet D. The Lowbury Lecture: Behaviour in infection control. *J Hosp Infect* 2004;58:1-13.
- Cabana MD, Rand CS, Powe NR, Wu AW, Wilson AH, Abboud PA, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA* 1999;282:1458-65.
- Cabana MD, Rand CS, Oren JB, Haya RR. Reasons for pediatrician nonadherence to asthma guidelines. *Arch Pediatr Adolesc Med* 2001;155:1057-62.
- Bloom BS. Effects of continuing medical education on improving physician clinical care and patient health: a review of systematic reviews. *Int J Technol Assess Health Care* 2005;21:380-5.
- Giblin TB, Sinkowitz-Cochran RL, Harris PL, Jacobs S, Liberatore K, Palfreyman MA, et al. Clinicians' perceptions of the problem of antimicrobial resistance in health care facilities. *Arch Intern Med* 2004;164:1662-8.
- Srinivasan A, Song X, Richards A, Cardo DM, Rand CS. A survey of knowledge, attitudes, and beliefs of house staff physicians from various specialties concerning antimicrobial use and resistance. *Arch Intern Med* 2004;164:1451-6.
- Wester CW, Durairaj L, Evans AT, Schwartz DN, Husain S, Martinez E. Antibiotic resistance: a survey of physician perceptions. *Arch Intern Med* 2002;162:2210-6.