Healthcare Quality Reporting Program

HOSPITAL-ACQUIRED INFECTIONS AND PREVENTION ADVISORY SUBCOMMITTEE

8:00-9:00am, 5/20/13 at Healthcentric Advisors

Goals/Objectives
▪ To discuss HAI work to date and make policy recommendations for pending and upcoming reports

Members		
☐ Nicole Alexander, MD	☐ Maureen Marsella, RN, BS	☐ Lee Ann Quinn, RN, BS, CIC
☐ Rosa Baier, MPH	☐ Linda McDonald, RN	☐ Janet Robinson, RN, Med, CIC
☐ Utpala Bandy, MD	☐ Leonard Mermel, DO, ScM	☐ Nancy Vallande, MSM, MT, CIC
☐ Emily Cooper, MPH	☐ Pat Mastors	☐ Cindy Vanner
☐ Marlene Fishman, MPH, CIC	☐ Robin Neale, MT (ASCP), SM,CIC	☐ Samara Viner-Brown, MS
☐ Yongwen Jiang	☐ Kathleen O'Connell, RN,BSN,CIC	
☐ Julie Jefferson, RN, MPH, CIC	☐ Sheila Turner, RN, MA	

Time	Topic/Notes
8:00am	**Welcome & Administrative Updates** *Leonard Mermel, DO, ScM* *Samara Viner-Brown, MS* - Today's objectives - Previous meeting's action items: • Share published letter to the editor, when available (Rosa/Len) • Share summary of Yongwen's CDI article (Rosa/Yongwen) • Outreach to partners re: potential CRE point-prevalence survey funding (Len) • Discuss potential CRE surveillance project (Len/Nicole/Sam)
8:05am	**Discussion Topics** *Rosa Baier, MPH* - Meeting Frequency - MRSA CLABSI Data Submission
8:35am	**Presentation by Yongwen Jiang** - Burden of Hospital-onset Clostridium difficile Infections in RI: Application of Present-on-Admission Indicators
8:55am	**Open Forum & Action Items** *Rosa Baier, MPH* - **Next meeting TBD**

Burden of Hospital-onset *Clostridium difficile* Infections in RI: Application of Present-on-Admission Indicators

Yongwen Jiang, Samara Viner-Brown, Rosa Baier

Disclaimer

- The contents of this presentation are not yet published by the Infection Control and Hospital Epidemiology.
- For the use of the current presentation only. Please not to distribute.

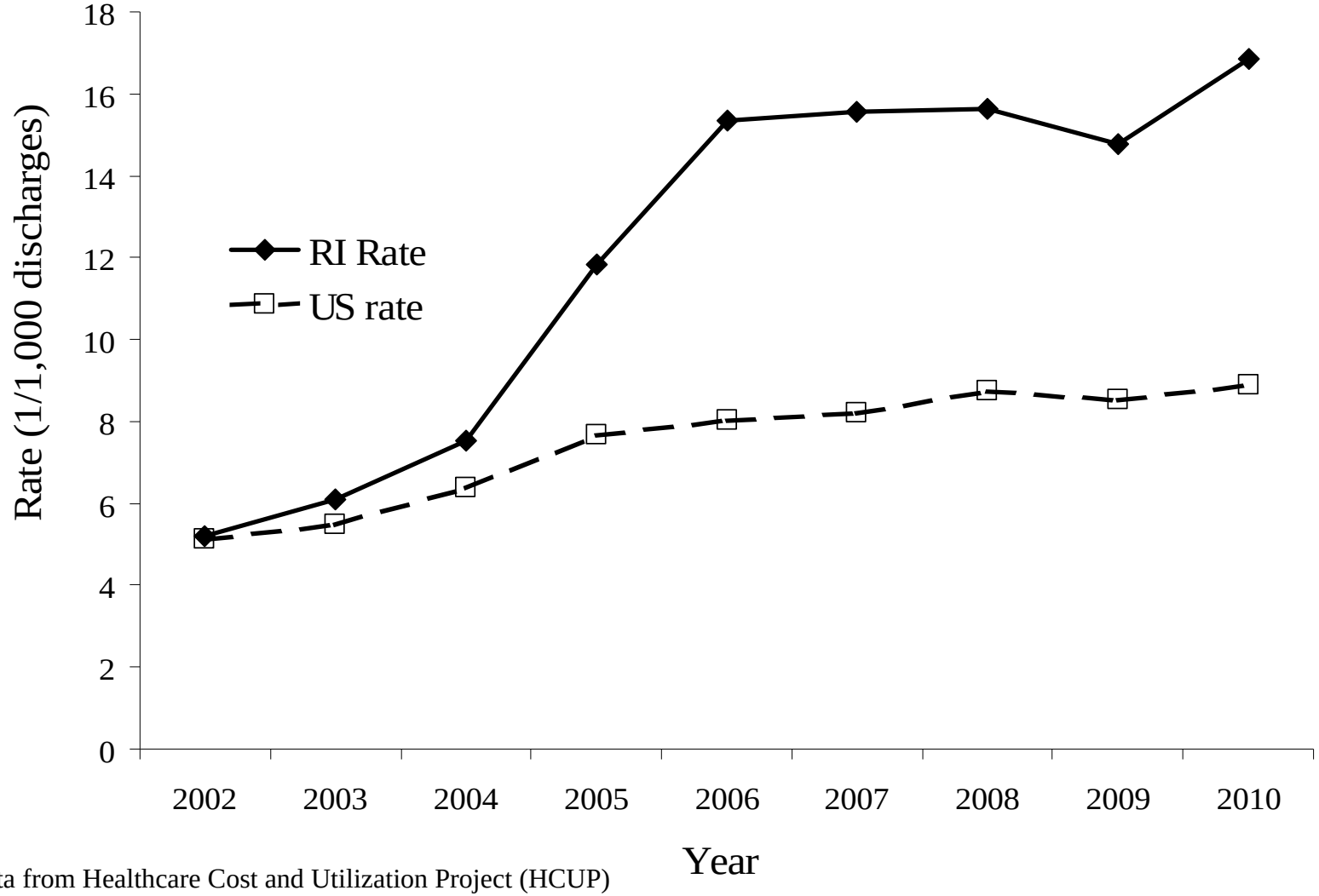
Acknowledgments

- We would like to express our particular thanks to **Ms. Kathy Taylor** who provided the 2010-2011 dataset for our use.
- We also greatly appreciate **Dr. Rebekah Gardner** who reviewed this manuscript and provided clinical input.

Outlines

- Background
- Methods
- Results
- Strengths
- Limitations

Background



Note: Data from Healthcare Cost and Utilization Project (HCUP)

Figure 1. *Clostridium difficile* Infection Rate, Rhode Island and U.S. 2002-2010

Methods

- Data Sources: RI's 11 acute-care hospitals
- Two groups: Hospital-onset CDI vs. No CDI
- Outcomes: mortality, length of stay and cost
- Propensity score matching method (PSM)

Results (1)

Table 1. Patient characteristics, before and after propensity score matching

Patient characteristics	Before Matching			After Matching		
	No CDI n(%)	HO CDI n(%)	P value	No CDI n(%)	HO CDI n(%)	P value
Total, n	221,468	1,211		6,053	1,211	
Age, Mean (SD)	58.6(21.2)	71.4(15.8)	<.0001	72.8(15.4)	71.4(15.8)	0.005
Medicare	105,731(47.7%)	915(75.6%)	<.0001	4,723(78.0%)	915(75.6%)	0.0598
MS-DRG[a]						
871.septicemia or severe sepsis w/o mv 96+ hours w mcc	3,427(1.5%)	81(6.7%)	<.0001	452(7.5%)	81(6.7%)	0.3428
291.heart failure & shock w mcc	2,448(1.1%)	34(2.8%)	<.0001	182(3.0%)	34(2.8%)	0.7095
193.simple pneumonia & pleurisy w mcc	1,534(0.7%)	32(2.6%)	<.0001	179(3.0%)	32(2.6%)	0.5516
329.major small & large bowel procedures w mcc	704(0.3%)	28(2.3%)	<.0001	141(2.3%)	28(2.3%)	0.9709
853.infectious & parasitic diseases w o.r. procedure w mcc	474(0.2%)	28(2.3%)	<.0001	117(1.9%)	28(2.3%)	0.3891
Comorbidities						
Congestive heart failure	16,023(7.2%)	268(22.1%)	<.0001	1,365(22.6%)	268(22.1%)	0.7491
Other neurological disorders	15,663(7.1%)	159(13.1%)	<.0001	770(12.7%)	159(13.1%)	0.6975
Diabetes w/o chronic complications	38,824(17.5%)	307(25.4%)	<.0001	1,640(27.1%)	307(25.4%)	0.2113
Hypothyroidism	22,006(9.9%)	198(16.4%)	<.0001	1,018(16.8%)	198(16.4%)	0.6905
Renal failure	20,474(9.2%)	302(24.9%)	<.0001	1,569(25.9%)	302(24.9%)	0.4752
Fluid and electrolyte disorders	32,085(14.5%)	374(30.9%)	<.0001	1,948(32.2%)	374(30.9%)	0.3763
Deficiency Anemias	29,543(13.3%)	379(31.3%)	<.0001	1,903(31.4%)	379(31.3%)	0.9223
Depression	28,161(12.7%)	190(15.7%)	0.002	954(15.8%)	190(15.7%)	0.9504

Abbreviations: CDI, *Clostridium Difficile* Infection; HO, hospital-onset; MSDRGs, Medical Severity Diagnosis-Related Groups; MV, multiple ventilators; MCC, major complications and comorbidities; CC, complications and comorbidities.

Results (2)

Table 2. Study outcomes, before and after propensity score matching

	Before Matching			After Matching		
Outcomes	**No CDI**	**HO CDI**	**P value**	**No CDI**	**HO CDI**	**P value**
Total, n	221,468	1,211		6,053	1,211	
Mortality*, n (%)	5,093 (2.3%)	136 (11.2%)	<.0001	491 (8.1%)	136 (11.2%)	0.0004
Length of stay (days), mean(sd)	4.9(6.8)	18.9(21.7)	<.0001	8.6(11.3)	18.9(21.7)	<.0001
Length of stay (days), median	3	13		5	13	
Cost ($), mean (sd)	$9,703(12,831)	$34,736(41,656)	<.0001	$17,111(26,505)	$34,736(41,656)	<.0001
Cost ($), median	$6,552	$20,562		$9,512	$20,562	

Abbreviations: CDI, *Clostridium Difficile* Infection; LOS: length of stay.
[a]In-hospital mortality, as determined by discharge disposition.

Strengths

- *Clostridium difficile* Infections
- Present-on-Admission Indicators (POA)
- Propensity score matching method (PSM)
- State-wide

Limitations

- No date of CDI onset in HDD.
- Accuracy of POA coding in HDD.
- Our size is smaller than other states and our results may not be generalizable to states with different healthcare landscapes.

Thank you!

Chatting with Skeptics: Evaluating Vaccine-related Educational Materials through Patient Opinion

Erica Braverman, BA
Alpert Medical School of Brown University

Background

- Vaccination rates in the United States are 75% for receiving all childhood vaccines [1]
- The anti-vaccination movement is prominent in the media,[2] more and more patients are questioning vaccine safety and utility
- Current requirement for physicians is to distribute vaccine information sheets at the time of vaccination, which do not address many key parental concerns
- So much available information makes it difficult to identify proper sources for specific health literacy and parental concerns
- Improving the physician's ability to educate patients by understanding the best sources may help improve vaccination rates

Study Aims

- To understand the information patients are seeking about vaccines
- To understand the best format in which to present this information
- To ultimately guide providers in how to educate their patients about vaccines

Methods

- Emails sent to successful IVF patients from a Long Island, NY practice
- Email content requested participation in focus group about vaccine education and did not offer any incentives for patients to attend
- Materials classified by:
  - Source: CDC [3], CHOP [4], IAC [5], Nnii [6]
  - Type: information sheet, Q&A, video, website
  - Content: disease and/or vaccine information
- VIS given first, then package insert, then sources
- Measles used when specific disease required
- Order of materials modified based on group discussion about specific concerns
- Patient opinions and topics of concern were recorded

Results

	Group 1	Group 2	Group 3
Number per Group	5	6	5
Age Distribution	28-36	31-37	28-41

Group Distribution:
- Balanced as to numbers and ages
- Distributed evenly amongst similarly affluent neighborhoods in Long Island, NY.

1.VIS (MMRV): Good amount of info, but does not answer major question about autism and vaccine content.
2.Package Insert (MMRV): "Terrifying!"; too much info; nothing about disease. Too scientific. Not useful. Wouldn't read.

3. CDC

"I'm not sure I trust the government… they're the ones pushing vaccines.."

Pros:
- Generally liked most written materials
- Q&As easy to read
- Enjoyed longer guides for more info
- Including references felt more trustworthy

Cons:
- Confusing website design; difficult to locate materials
- Brushed over certain information; sounded paternalistic "Don't worry because I said it's OK." – too one-sided

4. The Children's Hospital of Philadelphia

"I like this source… I mean, it is a children's hospital…"

Pros:
- Information more geared towards major concerns
- Website easier to navigate; more inviting looking
- Liked multimedia approach

Cons:
- Q$A with small print; hard to read
- Videos too basic; good for background loop in waiting room
- Material seemed too simplified

5. Immunization Action Coalition

"Based on the name… 'coalition' sounds like [they] want to persuade me…"

Pros:
- Book excerpt overwhelming favorite; trustworty, good info, conversational tone
- Liked info in Q&As

Cons:
- Hated front and center personal testimonies; felt "cheap and manipulative."
- Don't immediately trust info based on name of source – would need to be recommended

6. NNii National Network for Immunization Information

"I've never heard of this… [but] I'd read it if my doctor recommended it."

Pros
- Loved breakdown of current research
- Liked having vaccine and disease info together and easy to find
- Website inviting and well organized
- Liked side-by-side disease vs vaccine risk

Cons
- Never heard of it – unsure if they could trust research descriptions

Discussion

- VIS too basic; Package insert overwhelming
  - More concerned parents need supplemental material
- Most agreed they weren't comfortable doing their own internet searches; didn't know what information to trust
- Preferred to have physician recommend sources
- Certain websites better than others, but difficult if parents were simply concerned and didn't have specific questions
- Definite differences in information content and tone between materials; this group disliked too simplified and sounding like the material was "talking down to them" (CHOP, CDC)
- More comfortable when primary research was cited
- Liked having both disease and vaccine information
- All groups disliked 'personal testimony' approach – felt it was manipulative and an inappropriate 'scare tactic'
- Overwhelming favorite was Dr. Ari Brown chapter; respected opinion of pediatrician and appreciated conversational tone and practical comparisons

Future Directions

- Continue focus groups with other patient demographics to further assess current materials
- Make recommendations to physicians based on findings and make materials available in local pediatrician offices
- Assess for any change in patient behavior and physician comfort based on new materials

References

1. "Kaiser State Health Facts." *Kaiser State Health Facts*. Kaiser Family Foundation, 2010.
2. Kata A. A postmodern Pandora's box: anti-vaccination misinformation on the Internet. Vaccine. 2010 Feb 17;28(7):1709-16.
3. *Centers for Disease Control and Prevention*. Centers for Disease Control and Prevention, n.d.
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5. Immunization Action Coalition. http://www.vaccineinformation.org/
6. INational Network for Immunization Information. http://www.immunizationinfo.org/

Acknowledgements

I would like to thank Dr. Patricia Nolan for her help with ideas and study design, Patricia Raymond for her guidance, and Braverman Reproductive Immunology for helping to recruit patients

CHATTING WITH SKEPTICS: EVALUATING VACCINE-RELATED EDUCATIONAL MATERIALS THROUGH PATIENT OPINION

Erica Braverman

Community Health Clerkship

3/13/13

TODAY'S AGENDA

- Background:
  - Childhood vaccinations: how are we doing?
    - Could be better
  - How strong is this "anti-vaccine movement"?
    - Strong.
  - What information are we currently providing patients?
    - Ever heard of the VIS? Ever read one?
  - Is education really the answer?
    - Yes. Well, okay, part of it.
    - **MAJOR POINT: are we providing what they're looking for?**
- Study design
  - Focus groups!
- Results
- Discussion/Conclusions
- Future Directions
- Questions/Comments

CHILDHOOD VACCINATION

- Percent of children 19-35 months old receiving vaccinations for[1]:
  - Diphtheria, Tetanus, Pertussis (4+ doses DTP, DT, or DTaP): 84%
  - Polio (3+ doses): 93%
  - Measles (MMR) (1+ doses): 90%
  - Haemophilus influenzae type b (Hib) (primary series +booster dose): 55%
  - Hepatitis B (Hep B) (3+ doses): 92%
  - Chickenpox (1+ Varicella doses): 90%
  - Pneumococcal conjugate vaccine (PCV) (4+doses): 80%
- And how many receive all vaccinations?
  - 75%!![2]
  - RI? Also 75%.
- … and this doesn't even cover whether they were received on time…

1. National Center for Health Statistics, Data for 2009, United States
2. Kaiser Health Foundation, Data for 2009

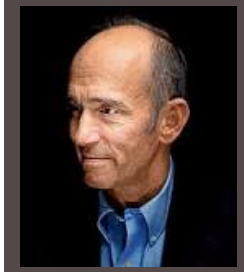
Table 1
Presence of content criteria on analyzed anti-vaccination websites.

Website analysis criteria	n	%
Content attributes		
Safety and effectiveness		
Poisons: Vaccines contain poisons/toxins/contaminants	8	100
Idiopathic illnesses: Vaccines cause illnesses of unknown origin (e.g. autism, SIDS)	8	100
Immunity: Vaccines erode immunity, create only temporary/ineffective immunity	7	88
Simultaneous vaccinations: Multiple vaccines at once increase adverse events	3	38
"Hot lots": Supposedly contaminated vaccine lots have more adverse events	3	38
Underreporting: Vaccine reactions are underreported	5	63
Disease decreases: Disease incidences declined without vaccines (i.e. from improved hygiene)	7	88
Trivial diseases: Vaccine-preventable diseases are uncommon/not contagious/relatively mild	4	50
Alternative medicine		
Alternative treatments: Promoting treatments superior to vaccination (e.g. homeopathy)	7	88
Critiquing biomedicine: Established medical knowledge is wrong (e.g. germ theory is untrue)	6	75
Implied debate: Suggesting debates over if vaccination is effective/necessary	3	38
"Back to nature": Promoting "natural" approaches (e.g. children should get diseases naturally)	7	88
Products for sale: Promoting alternative products (e.g. vitamins, essential oils)	1	13
Civil liberties		
Parental rights: Civil liberties violated by taking away parental choice	6	75
Monitoring: Vaccine programs harass parents who do not vaccinate	2	25
Totalitarianism: Vaccine mandates are excessive government control	5	63
Conspiracy theories/search for truth		
Profit: Vaccination policies motivated by profit	6	75
Collusion: Vaccine promoters benefit from illnesses caused by vaccines	5	63
Protection: Government protects doctors/manufacturers from liability	4	50
Cover-ups: Vaccine information withheld from the public	6	75
Rebel doctors: "Enlightened" doctors break away from the medical establishment	4	50
Foolish doctors: Doctors are ignorant, fearful of sanctions	2	25
Fear-mongering: Dangers of diseases exaggerated to frighten parents	4	50
Unusual theories: Unique theories about purposes of vaccination (e.g. sterilization)	3	38
Privileged knowledge: Presenting information the medical world is unaware of/rejects	4	50
Anti-science: Biomedicine is wrong; other ways of "knowing" (i.e. intuition, instinct)	3	38
Informed choices: Encouragement to make educated decisions for oneself/one's children	3	38
Morality, religion, and ideology		
Religious tenets: Vaccination is against God's will	2	25
Immoral acts: Vaccination involves immoral acts (e.g. child experimentation)	3	38
Anti-utilitarianism: Universal vaccination sacrifices a few to benefit many	1	13
Misinformation and falsehoods		
Outdated sources: Sources cited are outdated, have been disproven	6	75
Misrepresentations: Sources not used truthfully, false conclusions drawn	7	88
Self-referencing: Links/references to anti-vaccination "experts"	7	88
No references: No statistics/citations provided to support claims	3	38
Falsehoods: Unsupported statements made	7	88

Kata A. A postmodern Pandora's box: anti-vaccination misinformation on the Internet. Vaccine. 2010 Feb 17;28(7):1709-16

THE ANTI-VACCINATION MOVEMENT

What is the content being viewed by our patients?



And who is writing it?

CURRENT PHYSICIAN REQUIREMENTS?

- The VIS – required to be handed out to patients prior to vaccination being administered
- Problems?
  - 1. Timing.
    - "By the way, your child is due for a shot today. Here is an information sheet. Look it over while we prepare the vaccine. We'll be back in 2 minutes."
    - Reasonable?
  - 2. Content.
    - Anti-vaccine movement: MMR causes autism. Any mention in VIS?
    - Health literacy level?
- So why don't physicians do more?
  - No time!
  - Best sources?

ERICA'S ARGUMENT FOR EDUCATION

- Majority POV: Education does not change behavior.
  - I know you're all thinking it.
- Current studies on vaccine education?
  - Yes, they exist.
  - Most show no benefit to patient health literacy by providing more material
  - Fall into the trap of one size fits all education
    - If you have specific concerns and the educational material provided to you does not address these concerns, are you going to change your mind? Didn't think so.
- Why are vaccines different?
  - We are not talking about the usual lifestyle changes
    - "I know it's healthier to not smoke, but I like smoking."
  - People usually have very specific concerns
    - "I want to protect my child, but I'm worried about injecting her with eggs. Are they raw?"*

* Real concern.

THE BIG QUESTION

- Erica insists that if we provide patients with the information they seek (and in a format they understand), we can change their behavior.
- BIG QUESTION: What information do they seek?
- BEST ANSWER: I have no idea. That's why I'm going to ask them.

STUDY DESIGN

Emails sent to successful patients of IVF clinic in NY requesting participation in vaccine focus group

↓ 16 Patients Recruited

Patients divided into 3 groups (5,5,and 6) with similar age ranges

↓

Each group met for one hour and was presented with same materials. Opinions were recorded.

- **Why IVF Patients?**
  - IVF patients, especially those with immunological issues, are particularly well-read in everything anti-vaccine.
  - Good group to help understand the kinds of materials these patients are seeking (and to really hear their concerns first-hand).

WHAT MATERIALS DID ERICA USE?

- Materials gathered from combination of suggestions from DOH and my own internet research.
- When a specific vaccine was required, I chose the MMR(V).
- First presented with VIS, then package insert, then chosen materials.
- Materials classified by:
  - Source: CDC, CHOP, IAC, NNii
  - Type: information sheet, Q&A, video, website
  - Content: disease and/or vaccine information

RESULTS: VIS AND PACKAGE INSERT

- VIS:
  - "I've never seen this before."
  - "I've gotten plenty of these. But they hand them to me right before the vaccine, and I'm too busy dealing with my child to actually read them… The whole experience is overwhelming."
  - "This seems like a good amount of information. I'd probably ask my doctor for more though."
  - "It brushes over the major issues. Nothing about autism, thimerosal, mercury…"
- Package Insert:
  - "If my doctor handed this to me, I'd walk out and find a new one."
  - "Terrifying!"
  - "I don't even know what half of this stuff means."
  - "This makes me more nervous…"

RESULTS: CDC

- General: "I'm not sure I trust the government… they're the ones pushing vaccines.."

- Website:
  - Unfriendly layout
  - Overwhelming amount of information – difficult to navigate if you don't have a specific question to enter into the search bar
- Materials:
  - Generally well liked, good amount of information on diseases and vaccines; just difficult to find on their own
  - Tended to favor Q&A format over longer sources
  - At times, tone could be very 'paternalistic'; tended to gloss over major concerns – made it sound very "one-sided"
  - Preferred those sources that included primary research references

The Children's Hospital of Philadelphia

RESULTS: CHOP

- General: "I like this source… I mean, it is a children's hospital…"
- Website:
  - Preferred appearance to CDC, but still appeared wordy and overwhelming
  - Enjoyed access to multimedia, although found that videos were too basic
  - Liked list of safety "hot topics"
- Materials:
  - Appreciated information in Q&A series, but found them to be very wordy and overwhelming
  - Felt like a lot of "physician opinion," but still felt confident in data
  - Videos would be good "on a loop in the doctor's waiting room"

RESULTS: IAC

- General: "Based on the name… 'coalition' sounds like [they] want to persuade me…"

- Website:
  - Found the layout to be much "friendlier" due to use of colors and fewer words on the initial page
  - Liked multimedia access – especially pictures of disease
  - Did not like how prominent testimonials were – felt like they were "cheap" and "manipulative"
  - Paucity of information about actual diseases
- Materials:
  - LOVED chapter from *Baby 411* author Dr. Brown – content with practical examples, conversational tone, source (physician)
  - Liked info in fact sheets, but didn't like prominence of testimonials here too

RESULTS: NNII

- General: "I've never heard of this… [but] I'd read it if my doctor recommended it."

- Website:
  - Loved the layout – very easy to navigate
  - Great information about diseases and vaccines – easy to find and navigate
  - Loved the access to primary research with summaries – also well organized by either date or by specific vaccine
  - Liked seeing vaccine risk side by side with disease risk – put things "in perspective"
- No printable materials

DISCUSSION/CONCLUSION

- Many patients are satisfied with the VIS, but those at highest risk for rejecting vaccines require more
- Patients don't know what to trust online
- Having physicians familiar with online sources would help enable them to recommend those that cover specific concerns and are written at the proper level
  - Could potentially hand patients a list of preferred online materials and allow them to choose the ones they like best

CONCLUSION/DISCUSSION

- Take-home points for these patients:
  - Rejected "dumbed down" material – did not like "this is not dangerous. Trust us." (CDC)
  - Preferred cited primary research and concrete numbers (NNii)
  - More trusting of hospital/physician sources (CHOP) vs. government and groups (CDC, IAC)
  - Q&A format preferred
  - Wanted recommendations from physician about whom to trust online
- Favorite Material: Book chapter from Dr. Brown (provided by IAC)
- Favorite Website: NNii

FUTURE DIRECTIONS

- Target other populations to understand what, if any, additional materials they would want
- Distribute compilations of sources to local pediatricians/family medicine physicians
- Assess what, if any, impact this has on decisions to vaccinate amongst parents.

REFERENCES

1. "Kaiser State Health Facts." *Kaiser State Health Facts*. Kaiser Family Foundation, 2010.
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6. National Network for Immunization Information. http://www.immunizationinfo.org

QUESTIONS?

Overtreatment of Presumed Urinary Tract Infection in Older Women Presenting to the Emergency Department

Lesley B. Gordon, MS, Michael J. Waxman, MD,† Luna Ragsdale, MD MPH,‡ and Leonard A. Mermel, DO, ScM*§*

OBJECTIVES: To determine how often older women presenting to an emergency department (ED) are diagnosed with a urinary tract infection (UTI) without a positive urine culture and to investigate whether collecting urine by catheterization instead of clean catch improves the accuracy of the urinalysis (UA).

DESIGN: Retrospective chart review.

SETTING: Academic-affiliated ED in Providence, Rhode Island.

PARTICIPANTS: One hundred fifty-three women aged 70 and older with diagnosis of UTI in the ED between December 1, 2008, and March 1, 2010.

MEASUREMENTS: Chief complaint, review of systems, results of UA and culture, urine procurement (clean catch, straight catheter, or newly inserted Foley catheter), antibiotic administered or prescribed, and diagnosis. A confirmed UTI was defined as a positive urine culture, with microbial growth of 10,000 colony-forming units (CFU)/ mL or more for clean-catch specimens and 100 CFU/mL or more for newly inserted catheter specimens; an ED diagnosis of UTI was defined as the designation by an ED physician.

RESULTS: Of 153 individuals with an ED-diagnosed UTI, only 87 (57%) had confirmed UTI according to culture. Of the remaining 66 with negative cultures, 63 (95%) were administered or prescribed antibiotics in the ED. The method of urine procurement affected the ability of a UA to predict the culture result ($P = .02$), with catheterization yielding a lower proportion of false-positive UA (31%) than clean catch (48%).

CONCLUSION: Nearly half of older women diagnosed with a UTI in an ED setting did not have confirmatory findings on urine culture and were therefore inappropriately treated. Catheterization improved the accuracy of UA when assessing older women for possible UTI.

J Am Geriatr Soc 2013.

Key words: urinary tract infection; emergency department; elderly

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DOI: 10.1111/jgs.12203

Older adults are an important and growing demographic of the emergency department (ED) patient population, using services at a higher rate than other groups. EDs face the challenge of customizing standards of care to the unique needs of this age group.[1] Urinary tract infections (UTIs) are a major cause of ED visits, representing the fourth most common diagnosis in women aged 65 and older.[2] UTIs can also progress to a serious health concern, with the urinary tract representing the most common source of bacteremia in this age group.[3,4]

For community-dwelling, cognitively intact older women, the diagnosis of a UTI requires genitourinary symptoms plus significant bacteriuria established by urine culture.[5] Nevertheless, it is common for ED physicians to evaluate older women with nonspecific symptoms and signs for UTI. The motivation for this practice may be in part the consensus-based criteria for diagnosing UTI in skilled nursing facility (SNF) residents, which previously included a change in mental status,[6] but this definition was recently revised to remove this component for residents without indwelling catheters.[7] In addition, some observational data suggest a greater frequency of generalized symptoms in elderly adults with a UTI. In a study of 196 ambulatory women diagnosed with a UTI, postmenopausal women were more likely than premenopausal women to display lower abdominal pain, chills, and lower back pain.[8] However, no relationship was found between bacteriuria and fatigue, malaise, or weakness in a prospective study,[9] and it remains controversial whether nonspecific symptoms in isolation can be attributed to UTIs in elderly adults.[10] A

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0002-8614/13/$15.00

prospective, observational study in an ED found that individuals with generalized symptoms or symptoms consistent with infection had only slightly higher rates of positive urine cultures (19%) than those with symptoms clearly unrelated to infection (14%).[11]

Because physicians must rely upon the information gathered during an individual's ED stay, the quick turnaround time for a urinalysis (UA) plays an important role in the diagnosis and treatment of UTIs. Although urine culture is the reference standard for diagnosing a UTI, the culture results are not available during the visit and thus do not inform ED clinical care. Despite its widespread use, the sensitivity of pyuria and bacteriuria according to UA in the diagnosis of a UTI in elderly adults is unclear, and it may be more useful to exclude rather than to diagnose such infections.[12,13] The positive predictive value (PPV) of UA reagent strip testing of leukocyte esterase and nitrite for a positive urine culture is generally low[13] but varies depending on the setting, population, and definition of a positive urine culture.[14,15] In a cohort study of individuals in the ED aged 65 and older with infectious or generalized symptoms, a positive UA reagent strip had a 37% PPV for a positive urine culture.[11] In contrast, the negative predictive value of reagent testing is high, 92% in this population[11] and 100% in SNF residents with presumed UTI.[15]

In the ED setting, urine is procured using the clean-catch midstream method or straight catheterization. Although the clean catch is simple, inexpensive, and noninvasive, it requires that the urine travel through the distal urethra, increasing risk of inoculation by commensal flora, especially in elderly adults. Catheterizing women is invasive but reduces contamination of the culture.[13]

The primary objective of this project was to investigate the accuracy of ED diagnosis of UTI in older women. A secondary analysis included whether urine collected using a straight catheter or through a newly inserted Foley catheter instead of the clean-catch method improves the accuracy of UA in diagnosing a UTI in the ED.

It was hypothesized that a substantial proportion of older women diagnosed with UTI in the ED do not ultimately have UTI, with their urine cultures not meeting quantitative microbiological criteria. Furthermore, it was hypothesized that the method of urine collection would affect the accuracy of the UA, with catheterization reducing contamination of urine samples.

METHODS

Study Design

This was an institutional review board–approved retrospective chart review with a waiver of informed consent.

Study Setting and Population

This study was set in the ED of an academic-affiliated community hospital that receives approximately 50,000 visits annually. The study included women aged 70 and older who had an ED diagnosis of UTI between December 1, 2008, and March 1, 2010.

Study Protocol

Subjects were selected from the MEDHOST (Plano, TX) database using the search criteria of female, aged 70 and older, a urine culture ordered, and a new diagnosis of UTI assigned in the ED (*International Classification of Diseases, Ninth Revision,* code 599.0). Subject age and laboratory data were extracted from the MEDHOST database; all remaining data were obtained by examining electronic medical records, including nursing reports, microbiology culture reports, and scanned-in ED physicians' notes.

A positive urine culture was defined as 10,000 colony-forming units (CFU)/mL or more of microbial growth for clean-catch specimens; this threshold was selected to increase the sensitivity of diagnosing UTI by urine culture compared with the commonly used criterion of 100,000 CFU/mL or more.[13] For specimens from straight catheters or newly inserted Foley catheters, a positive culture was defined as 100 CFU/mL or more of microbial growth. These met the criteria for a confirmed UTI in this study, regardless of whether the specimen had polymicrobial growth.

A negative urine culture was defined as a urine culture with growth of less than 10,000 CFU/mL from a clean-catch specimen or less than 100 CFU/mL from a catheter specimen, no growth, or solely contaminated (e.g., multiple organism, mixed urogenital flora).

A UA was considered positive if it had a positive nitrite or leukocyte esterase. For microscopy, pyuria was defined as more than 10 white blood cells per high-power field of urine; bacteruria was defined as any level of bacteria detectable.

Nursing reports were referenced to determine whether urine samples were obtained using clean-catch midstream or catheterization. Data regarding urine samples collected using straight catheter and during Foley catheter insertion in the ED were pooled for the purposes of this study.

Data Analysis

All statistics were performed using Stata version 10 (Stata Corp., College Station, TX). The chi-square test was used for categorical data, including determining the relationships between the method of urine procurement and the ability of the UA to predict culture results, the method of procurement and contamination of negative urine cultures, and the presence of urinary symptoms and results of urine cultures. The Wilcoxon rank-sum was used to determine the relationship between the amount of squamous cell contamination and method of urine procurement. An alpha probability of .05 was used as the threshold for statistical significance in two-tailed comparisons.

RESULTS

General Characteristics of the Population

Of the 214 subject encounters meeting the search criteria, 61 were removed as follows: a second encounter of the same subject during the study period (8), electronic records unavailable (7), subject had permanent bladder catheters (7), the ED physician did not designate UTI diagnosis in

the clinical note (17), and the subject came to the ED with prior and ongoing diagnosis of a UTI (22). This study focuses on the remaining 153 encounters.

Mean age ± SD was 82.9 ± 6.4 (Table 1). One hundred two (67%) subjects were from the community and 51 (33%) from assisted living facilities or SNFs.

Urinalyses and Urine Cultures

One hundred forty-eight of the 153 subjects (97%) with an ED-diagnosed UTI had a positive UA, defined as a positive nitrite or positive leukocyte esterase (Table 1). One hundred twenty-three of these 153 (80%) had bacteriuria, and 132 (86%) had pyuria by microscopy. Eighty-seven (57%) had a positive urine culture meeting the above-noted quantitative microbiological criteria (confirmed UTI).

Of the 66 subjects (43%) with ED-diagnosed UTI but negative urine cultures, 63 (95%) were treated with antibiotics in the ED, prescribed antibiotics, or both (Table 1). Ciprofloxacin was administered or prescribed to 44 (67%), nitrofurantoin to 8 (12%), and trimethoprim with sulfamethoxazole to 5 (8%).

Method of Urine Procurement

Eighty-nine subjects (58%) had urine samples collected using clean catch and 64 using ED-inserted catheters (60 (94%) by straight catheterization; 4 (6%) during Foley insertion). The method of urine procurement affected the ability of UA to predict the culture result (chi-square, $P = .02$; Table 2), with catheterization providing a lower proportion of false-positive UA (31% vs 48% of clean catch) and a higher proportion of true-positive (61% vs 52% of clean catch) UA results.

In subjects with negative urine cultures as defined in this study (not meeting the quantitative microbiologic criteria), the method of urine procurement was associated with whether urine was contaminated with mixed flora or displayed no growth (chi-square, $P = .001$), with catheter specimens yielding a higher proportion of urine cultures with no growth (61% vs 21% of clean catch) and a lower proportion of urine cultures with contaminated or multiple organisms (39% vs 79% of clean catch). Contamination of the urine specimen with squamous epithelial cells differed for the two methods of urine procurement (two-sample Wilcoxon rank-sum test, $P = .05$), with a higher degree of contamination with clean catch than with catheter.

Table 1. Age, Urinalysis and Culture Results, Antibiotics

Characteristic	All, n = 153	UTI Confirmed,[a] n = 87	UTI Not Confirmed, n = 66
Age, mean	83	84	81
Positive urinalysis, n (%)[b]	148 (97)	85 (98)	63 (95)
Bacteriuria, n (%)[c]	123 (80)	77 (89)	46 (70)
Pyuria, n (%)[d]	132 (86)	76 (87)	56 (85)
Positive culture, n (%)[e]	87 (57)	87 (100)	0 (0)
Antibiotics prescribed or administered, n (%)	145 (95)	82 (94)	63 (95)

[a]Confirmed urinary tract infection (UTI) was defined as meeting quantitative criteria by urine culture.
[b]Positive leukocyte esterase or nitrite.
[c]Presence of bacteria by microscopy.
[d]$\geq$ 10 white blood cells per high-power field of urine.
[e]$\geq$ 10,000 colony-forming unit (CFU)/mL of microbial growth for clean-catch specimen and $\geq$ 100 CFU/mL of microbial growth for newly inserted catheter specimen, regardless of polymicrobial growth.

Table 2. Urinalysis According to Method of Urine Procurement

Urinalysis	Clean Catch, n = 89	Newly Inserted Catheter, n = 64	Chi-Square, *P*-Value
	n (%)		
True positive[a]	46 (52)	39 (61)	.02
False positive[b]	43 (48)	20 (31)	

[a]Positive leukocyte esterase or nitrite with corresponding positive urine culture.
[b]Positive leukocyte esterase or nitrite without corresponding positive urine culture.

Table 3. Chief Complaints (N = 153)

Chief Complaint	n (%)
Urinary symptoms	28 (18)
Altered mental status	27 (18)
Falls	20 (13)
Abdominal pain	14 (9)
Back pain or injury	11 (7)
Constitutional complaints	10 (7)
Focal neurological deficits	10 (7)
Gastrointestinal problems	9 (6)

Chief Complaints and Urinary Symptoms

One hundred fifty-three subjects registered 192 chief complaints. The three most common chief complaints were urinary symptoms (n = 28 subjects, 18%); change in mental status, confusion, or agitation (n = 27 subjects, 18%), and falls (n = 20 subjects, 13%) (Table 3).

Twenty of 153 subjects (13%) were not able to perform the review of systems (ROS) because of dementia, aphasia, or postictal status. Of the 133 subjects able to perform the ROS, 50 (38%) had urinary symptoms. There was no relationship between presence of urinary symptoms and urine culture results (chi-square, $P = .80$). Of the 73 subjects with a positive urine culture, 28 (38%) had urinary symptoms; of the 60 subjects with a negative urine culture, 22 (37%) had urinary symptoms. Three of the five subjects who had negative urinalyses reported urinary symptoms.

DISCUSSION

These results point to the overdiagnosis and overtreatment of UTI in older women presenting to the ED; 43% of older women with an ED diagnosis of UTI did not have a urine culture meeting our quantitative microbiological

criteria, and 95% of these women were prescribed or administered antibiotics. Furthermore, use of the definition of 10,000 CFU/mL to designate a positive urine culture may have led to underestimation of the number of subjects inappropriately diagnosed with a UTI and treated as such. These subjects were exposed to antibiotics unnecessarily, and the true etiology of their complaints may have gone undiagnosed. Inappropriate antibiotic use in the ED for presumed UTI has been associated with antimicrobial resistance[16] and undesired side effects because antibiotics are the second leading class of drugs to cause adverse events in individuals aged 65 and older.[17]

Although this is the first study that the authors are aware of that examines urine culture results as an indicator of ED appropriateness of diagnosis and treatment of UTI, decision-making has been more extensively evaluated in the SNF setting, where overtreatment has been consistently demonstrated. A prospective surveillance study of SNF residents found that 83% of clinical diagnoses of infections (predominantly UTI and pneumonia) did not meet the McGeer criteria or other consensus-based minimum criteria for infection.[6,18] Similarly, a retrospective review of SNF residents with positive UAs revealed that 41% who did not meet the McGeer criteria were nonetheless administered antibiotics.[6,19] In another study, 37% of SNF residents with a clinically suspected UTI but who lacked laboratory evidence were administered antibiotics.[20]

In the current study, the method of urine procurement affected the accuracy of the rapid-turnaround UA in diagnosing a UTI. Urine samples collected using catheterization had a higher likelihood of true-positive results. The data suggest less contamination as the mechanism for the greater reliability of this technique than with clean catch in this population. Catheterized urine contained less squamous cell contamination, and in subjects with negative urine cultures, it was more likely to display no growth of bacteria rather than contamination with mixed flora. However, it is unclear whether the benefits observed from using straight catheterization outweigh the nursing burden and discomfort associated with this procedure. Furthermore, there is the possibility that the procedure of catheterization may cause a nosocomial UTI in and of itself,[13] a complication that is known to be associated with intermittent and indwelling catheterization.[21,22]

Only 18% of the older women diagnosed with UTI came to the ED with a chief complaint of focal urinary symptoms; other common complaints included change in mental status and falls. Approximately one in three subjects had urinary symptoms recorded on the ROS; these symptoms were present in equal proportions in those meeting and not meeting urine quantitative microbiological criteria for a UTI. Thus, diagnosis of a UTI in the ED was not generally based upon presentation of urinary symptoms. This observation is consistent with a recent retrospective study of 7.2 million adults aged 65 and older with ED-diagnosed UTI, which identified urinary symptoms in 24% of individuals aged 65 to 84 and in 17% of those aged 85 and older.[23] Hospitalized individuals demonstrate a similar trend, with 32% of older adults reporting urinary symptoms.[24]

This scarcity of urinary symptoms is particularly meaningful given that older women commonly have asymptomatic bacteriuria (ASB) that the Infectious Diseases Society of America and the American Medical Directors Association recommend should not be treated.[5,25] Studies have reported ASB in approximately 6% of ambulatory older women[26] to as many as 57% of incontinent women in SNFs.[27] Given the likely prevalence of ASB in the group of subjects with positive urine cultures in the current study, it is possible that the degree of overtreatment was even higher than indicated by the number of subjects with negative cultures. The subjects in the current study with positive cultures and no urinary symptoms highlight the challenge of differentiating ASB from UTI in the acute care setting and demonstrate the importance of not routinely screening older women for UTI without significant clinical suspicion. Determining which symptoms should trigger ED physicians to order a UA and urine culture is a significant challenge. A cohort study of SNF residents found that dysuria, change in character of urine, and altered mental status were significantly associated with UTI.[28] It is unclear whether these findings translate to the ED setting.

There are several limitations inherent in this study's retrospective chart-based approach. The examination of medical records does not reveal which aspects of the subject's laboratory work and presentation the physician used to make the diagnosis of UTI. A positive UA was defined as a positive nitrate or leukocyte esterase in the context of an ED physician-diagnosed UTI, but it is possible that a physician relied entirely on other evidence. The method of urine procurement for each subject's culture and UA was determined based on what was stated in the nursing report. Ideally, future prospective studies will randomly assign the urine procurement method (clean catch vs straight catheter) to firmly establish the benefits of catheterization noted in the current study. The nature of the clinical records made it impossible to separate SNF from assisted living facility residents. Thus, it was not possible to analyze these populations individually, which has implications for diagnosis and management of UTI and the baseline level of ASB.

Because only individuals for whom a urine culture was ordered were included, those treated for a UTI without a urine culture were not assessed. Data regarding UA and culture from specimens obtained using straight catheterization and during insertion of a Foley catheter were combined sample of Foley specimens.

In conclusion, a large proportion of older women were overdiagnosed and overtreated for UTI in this ED. ED physicians cannot rely exclusively on a positive UA or the presentation of urinary symptoms as a predictor of a positive culture result. Further investigation is needed to confirm that straight catheterization is the optimal method of obtaining urine cultures in this population and to identify other strategies that will improve the accuracy of diagnosis of UTI.

ACKNOWLEDGMENTS

The authors thank Steven E. Reinert, MS, Lifespan Information Services, Providence, for his invaluable support in acquisition and analysis of data. Lynn McNicoll, MD, Alpert Medical School, Brown University, provided important revisions of the manuscript. Lesley Gordon was

supported by a summer assistantship from the Reynolds Foundation (2010).

Conflict of Interest: The editor in chief has reviewed the conflict of interest checklist provided by the authors and has determined that the authors have no financial or any other kind of personal conflicts with this paper.

Author Contributions: All authors drafted the article, revised it critically for intellectual content, or both. Waxman, Ragsdale, and Mermel originated the study concept and design. Gordon performed data acquisition and analysis and refinement of design and, along with Waxman and Ragsdale, interpreted the data.

Sponsor's Role: None.

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American Journal of Infection Control 41 (2013) 390-3

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Asymptomatic *Clostridium difficile* colonization in a tertiary care hospital: Admission prevalence and risk factors

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Key Words:
Healthcare epidemiology
Targeted screening
PCR
Surveillance

Background: The role of *Clostridium difficile* (CD) carriers in health care-associated CD transmission has been identified as an area needing research. We investigated the prevalence of, and risk factors for, asymptomatic CD colonization at hospital admission.

Methods: Adults admitted to a tertiary care hospital in Minnesota on predetermined study days between March 1 and April 30, 2009, and without symptoms of *C difficile* infection, were eligible. The first stool sample after admission was requested from each consenting patient and tested for toxigenic CD using polymerase chain reaction (PCR) that detects *tcdC*. Clinical data were obtained through interviews and chart reviews.

Results: Of 320 participants, 31 (9.7%) were positive for toxigenic CD. Using multivariate logistic regression, independent predictors of CD colonization were recent hospitalization (odds ratio [OR], 2.45; 95% confidence interval [CI]: 1.02-5.84), chronic dialysis (OR, 8.12; 95% CI: 1.80-36.65), and corticosteroid use (OR, 3.09; 95% CI: 1.24-7.73). Screening patients with risk factors (48% participants) would identify 74% (95% CI: 55%-88%) of CD carriers.

Conclusion: Asymptomatic CD colonization at hospital admission was detected in nearly 1 of 10 patients. The majority of colonized patients had one or more identifiable risk factors. These data could provide the basis for designing studies of targeted surveillance for *C difficile*.

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Clostridium difficile infection (CDI) is the leading infectious cause of health care-associated diarrhea. Asymptomatic colonization with *C difficile* (CD) is well recognized. In studies conducted in tertiary care hospitals in the late 1980s to early 1990s,[1-3] using stool or rectal swab cultures, its prevalence was found to range from 8% of patients at admission[3] to 20% of all patients hospitalized for more than 2 weeks.[1] However, unlike other health care-associated pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE), screening patients for asymptomatic colonization to prevent CD transmission has not been explored, and the role of asymptomatic CD carriers in transmission of CD in the health care setting has been identified as an area needing additional research.[4,5]

Significant changes in the epidemiology of CDI have occurred in the last 2 decades, with global rise in disease incidence associated with the emergence of hypervirulent strains.[6] In 2009, CD replaced MRSA as the most common etiology of health care-associated infection in community hospitals in the southeastern United States.[7] Rates of health care-associated CDI at our institution also increased steadily between 2004 and 2008, independent of changes in testing methodology. Despite the use of private rooms and contact precautions for patients with suspected or confirmed CDI, and continuation of contact precautions for the duration of hospitalization, the incidence of CDI at St. Mary's Hospital, Mayo Clinic, reached 22.5/10,000 patient-days in calendar year 2008 (compared with 7.5/10,000 patient-days in 2004 and 14/10,000 patient-days in 2006). This formed the basis of our investigation of the reservoir of asymptomatic CD carriers. The objectives of this study were (1) to determine the prevalence of hospitalized patients asymptomatically colonized with CD at the time of hospital admission, and, in light of the changing CD epidemiology, whether this constitutes a departure from historical tertiary care hospital rates; and (2) to identify risk factors for at-admission asymptomatic CD colonization in hospitalized patients and whether identification of those risk factors could lay the foundation for targeted CD surveillance.

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Conflicts of interest: None to report.

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http://dx.doi.org/10.1016/j.ajic.2012.09.023

METHODS

Study setting and participants

This study was performed at St. Mary's Hospital, a 1,249-bed tertiary care Mayo Clinic hospital in Rochester, MN, between March 1 and April 30, 2009. All patients admitted to the adult in-patient units (excluding psychiatry) on 20 pre-selected days (2-3 days/week from March 1 to April 30, 2009) were eligible for inclusion. Patients discharged within 24 hours of admission; those with known or suspected current CDI, diarrhea, or other symptoms of colitis; and those unable to provide consent (themselves or via their representatives) were excluded. Eligible patients (or their representatives) were contacted in person by study team members within 24 hours of admission for participation in the study. A verbal informed consent to participate and written Health Insurance Portability and Accountability Act (HIPAA) authorization were obtained. The study was approved by the Mayo Clinic Institutional Review Board.

Stool testing

The first stool sample available after admission was requested from each consenting patient; stool was collected by the patient's bedside nurse and transported to the clinical microbiology laboratory per usual clinical protocol. Stool was tested for the presence of toxigenic CD using a laboratory-developed, real-time polymerase chain reaction (PCR) assay that detects *tcdC* using a LightCycler (Roche Diagnostics, Indianapolis, IN), with a sensitivity of 86% and specificity of 97% compared with toxigenic culture.[8] Study samples were batched for testing; test results were not reported in the patient's medical record; and clinicians were not made aware of these test results.

Data collection

The following data were collected for each participant: patient age, gender, date and time of admission, and date and time of discharge were automatically retrieved from the electronic medical record; information on recent (within 3 months) hospitalization, residence in a long-term care facility, antibiotic use (any drug, dose, and duration), history of previous CDI, current symptoms or signs of colitis (diarrhea, abdominal pain, fever) was obtained through participant (or patient representative) interview; patient clinical characteristics including history of diabetes, chronic dialysis, frequent outpatient care (eg, more than weekly intravenous therapy or wound care for at least 2 weeks), current long-term indwelling device (such as urinary catheter, central venous catheter, or gastrostomy tube, present for at least 2 weeks), recent chemotherapy for cancer, use of corticosteroids, immunosuppressive therapy other than corticosteroids, proton pump inhibitors, and statins, were obtained through chart reviews. In addition, a composite variable "recent health care contact" was created to capture recent (within 3 months) contact with health care through any of the following: hospitalization, residence in a long-term care facility, chronic dialysis, or frequent outpatient care (as defined above).

Statistical analysis

The proportion of participants with detection of toxigenic CD in stool was calculated and stratified by duration between admission and sample collection. The association of demographic and clinical variables with asymptomatic CD colonization was assessed in univariate analysis using Student *t* test for continuous and Fisher exact test for categorical variables and in multivariable analysis using logistic regression. Age, recent antibiotic use, and all variables with $P < .1$ in univariate analysis were included in the multivariate logistic regression model. For independent risk factors for CD colonization (individually and in combination), the following were calculated: sensitivity and specificity in identification of patients colonized with toxigenic CD at admission and screening burden, ie, percentage of patients that would be assigned to a CD screening test based on presence of that risk factor.

Table 1
Comparison between patients in the final study sample and patients enrolled but not tested for *C difficile* colonization

Variable	Final sample (n = 320)	Enrolled but not tested (n = 409)*	*P* value
Age, yr, mean (SD)	64.0 (18.0)	59 (18)	<.001
Male sex	172 (54)	221 (54)	.99
Recent hospitalization	128 (40)	131 (32)	.02
Recent antibiotic use	195 (63)	208 (52)	.002
Recent residence in long-term care facility	30 (9)	23 (6)	.05

NOTE. All data are number (%) of patients unless otherwise stated.
*Represents patients who were enrolled but not tested for *C difficile* colonization because a stool specimen was not provided.

RESULTS

A total of 1,464 patients was admitted to the hospital on 20 prespecified study days between March 1 and April 30, 2009. Of these, 266 were either discharged or expired within 24 hours of admission; 270 were unable to provide informed consent (because of medical condition and unavailability of patient representative); 172 refused to participate; and 27 were excluded because of known or suspected current CDI, diarrhea, or symptoms of colitis. This resulted in 729 patients who provided consent to participate and were enrolled in the study. Of these, stool specimens were received from 320 patients (22% of all admissions), who constituted the final study sample. There was no difference in age or gender between patients who were enrolled in the study compared with those who were not. Among those who were enrolled, those in the final study sample were more likely to be older, to have been recently hospitalized, to have resided in a long-term care facility, and to have received antibiotics compared with those not included in the final study sample because of lack of stool specimens (Table 1).

All samples were received within 5 days of admission; 255 (80%) were received within 48 hours, and 293 (91%) were received within 72 hours of admission. Stool samples from 31 of 320 patients were positive, resulting in a CD colonization rate of 9.7%.

In univariate analysis, recent hospitalization, chronic dialysis, proton pump inhibitor use, and corticosteroid use were found associated with CD colonization (Table 2). There was no association of CD colonization with age, gender, residence in a long-term care facility, frequent outpatient care, presence of indwelling device, diabetes, history of CDI, recent use of antibiotics, immunosuppressive medications other than corticosteroids, chemotherapy for cancer, or statins. In multivariable analysis, independent predictors of CD colonization were recent hospitalization (odds ratio [OR], 2.45; 95% confidence interval [CI]: 1.02-5.84), chronic dialysis (OR, 8.12; 95% CI: 1.80-36.65), and corticosteroid use (OR, 3.09; 95% CI: 1.24-7.73). In a separate model using the composite variable "recent health care contact," after adjusting for age, proton pump inhibitor use, and corticosteroid use, recent health care contact was the only statistically significant predictor of asymptomatic CD colonization (OR, 3.36; 95% CI: 1.35-8.33).

Overall, one or more of the 3 independent risk factors (recent hospitalization, chronic dialysis, corticosteroid use) were present in 155 (48%) of study participants, and screening only those with one

Table 2
Characteristics of patients with asymptomatic *C difficile* colonization, ie, CD carriers, at admission compared with noncarriers

Variable	CD carriers No. (%) (n = 31)	Noncarriers No. (%) (n = 289)	*P* value*
Age >65 yr	20 (65)	154 (53)	.26
Male sex	18 (58)	154 (53)	.61
Recent hospitalization	20 (65)	108 (38)	.004
Residence in a long-term care facility	4 (13)	26 (9)	.51
Frequent outpatient care	3 (10)	13 (5)	.19
Chronic dialysis	4 (13)	5 (2)	.007
Indwelling device	6 (19)	25 (9)	.10
Diabetes	8 (26)	71 (25)	.88
History of CDI	2 (6)	10 (4)	.33
Recent antibiotic use	20 (69)	175 (63)	.51
Proton pump inhibitor use	18 (58)	111 (38)	.03
Corticosteroid use	10 (32)	44 (15)	.02
Other immunosuppressant use	3 (10)	14 (5)	.22
Chemotherapy for cancer	0 (0)	6 (2)	1.0
Statin use	13 (42)	107 (37)	.59

*P value based on χ^2 or Fisher exact test.

Table 3
Sensitivity, specificity, and screening burden of selected variables for predicting asymptomatic colonization with *C difficile* at admission

Risk factor criterion for admission screening	Sensitivity, % (95% CI)	Specificity, % (95% CI)	Screening burden, % (95% CI)
Recent hospitalization	65 (45-81)	63 (57-68)	40 (35-46)
Combination of recent hospitalization, chronic dialysis, and corticosteroid use*	74 (55-88)	54 (48-60)	48 (43-54)
Recent health care contact†	77 (59-90)	55 (49-61)	48 (42-53)

CI, confidence interval.
NOTE. Sensitivity: percentage of participants with *C difficile* in whom the risk factor was present. Specificity: percentage of participants without *C difficile* in whom the risk factor was absent. Screening burden: percentage of participants that would need to be screened based on presence of the risk factor(s).
*Criterion fulfilled if patient had any one of these risk factors.
†Defined as any of the following opportunities for health care contact: recent hospitalization, residence in long-term care facility, chronic dialysis, or frequent outpatient care.

or more risk factors would have identified 23 (74%; 95% CI: 55%-88%) CD carriers. The risk factor with the highest prevalence was recent hospitalization, and, if used alone for selecting patients, screening 128 (40%) patients would identify 20 (65%; 95% CI: 45%-81%) CD carriers. Finally, using the composite variable "recent health care contact," screening 153 (48%) patients would identify 24 (77%; 95% CI: 59%-90%) CD carriers (Table 3).

DISCUSSION

In this study, asymptomatic colonization with toxigenic CD was found in 9.7% participants at the time of admission to our tertiary care hospital; recent hospitalization, chronic dialysis, and corticosteroid use were risk factors for such colonization; and testing those with identified risk factors could increase the efficiency of screening for asymptomatic CD colonization.

The admission asymptomatic CD colonization rate in this study using stool PCR is similar to historical rates observed with stool or rectal swab culture.[2,3,9] The risk of transmission from asymptomatic reservoirs is the rationale behind recommendations for active surveillance for health care-associated pathogens such as MRSA and VRE,[10] but identification of asymptomatic CD carriers is not currently recommended.[4] Although the extent of contamination of health care workers and the environment from asymptomatically CD colonized individuals is less compared with patients with diarrhea,[11,12] these asymptomatic CD carriers could be an important source of CD transmission.[1,12] In one older study, nosocomial acquisition of a CD strain was preceded by introduction of that strain to the ward by an asymptomatic admission in 84% of cases.[1] In a recent study, Walker et al found that ward-based contact with symptomatic CDI cases did not account for most new CDI cases,[13] and it has been suggested that future investigations examine the possibility of transmission from asymptomatic carriers.[5]

A significant practical limitation to CD surveillance has been the labor-intensive nature and long turn-around times of anaerobic cultures. However, the previous lack of a rapid, sensitive, and specific test can now be overcome with use of real-time PCR as in our study. Another recent study using real-time PCR showed that perirectal swabs could be used instead of stool for detection of asymptomatic CD carriage, which could further simplify CD surveillance.[14]

Independent predictors for at-admission asymptomatic CD colonization in this study included recent hospitalization, chronic dialysis, and use of corticosteroids. Recent hospitalization was shown to be a risk factor for CD colonization in both an older US study of CD colonization detected within 72 hours of admission[3] and a recent, large, multicenter study in Canada by Loo et al that assessed health care-associated CD colonization developing after admission.[15] The most likely explanation for this finding is previous exposure to CD in the hospital environment,[3,15] and, despite the emergence of community-associated CDI,[16] this suggests that hospitals remain an important source of CD acquisition.

Patients with chronic kidney disease on dialysis have been found to be at greater risk for CDI,[17] and chronic kidney disease was also shown to be a risk factor for CD colonization in the study by Samore et al.[3] The present study provides additional evidence that chronic kidney disease requiring dialysis is a risk factor for asymptomatic CD colonization and may contribute to the burden of CD colonization pressure and, ultimately, CDI in dialysis units.

Whereas immunosuppressive conditions have been associated with development of CDI,[18] corticosteroids have not previously been shown to be a specific risk factor for CD colonization. In the study by Loo et al, there was no association between health care-associated CD colonization and use of glucocorticoids[15]; however, their study specifically looked at colonization developing during hospital stay, and individuals who were CD positive at admission were excluded from their risk factor analysis.

We propose that elucidation of risk factors for CD colonization could help identify asymptomatic individuals for targeted surveillance in selected hospital settings such as high endemicity despite the use of other control measures or epidemic situations. Potential infection prevention measures to prevent CD transmission from asymptomatically colonized patients include contact precautions, hand hygiene with soap and water, and environmental cleaning with a sporicidal agent. In our population, by targeting those with identified risk factors, we would need to screen approximately half of those patients with anticipated stays >24 hours, to identify three-fourths of those colonized with *C difficile*. This is in the range of previously published screening efficiency rates for MRSA.[19,20]

The most significant limitation of this study is the potential lack of representativeness of the study sample, given that approximately half of the admissions were enrolled, and less than half of those enrolled (22% of admissions) provided stool samples. We found that, among patients who gave consent for participation, those who provided stool samples were more likely to be older, to have been hospitalized, to have resided in a long-term care facility,

and to have received antibiotics in the preceding 3 months. Although we did not collect these data systematically, based on discussions between study personnel and staff nurses, the most common reason for not submitting a stool sample was no bowel movement during a short stay (eg, following elective surgery). Therefore, the study sample may be enriched in older and potentially sicker patients who have longer hospital stays. Twenty percent of the stools samples were received more than 2 days after admission: therefore, if initiation of contact precautions was to be based on such testing, it could be delayed for several days. This further underscores the challenges in using stool for CD colonization assessment, even in the setting of a research study. Another limitation is the lack of supporting stool culture data. Therefore, it is possible that the CD colonization prevalence was underestimated. However, we used a highly sensitive and specific PCR assay,[8] bearing in mind that in a real-world setting, surveillance for CD using culture would be quite cumbersome and could realistically only be performed using a molecular method.[14] Colonization assessment was performed at a single point in time, but our objective was to estimate the burden of asymptomatic CD carriers at admission because that constitutes an important checkpoint where risk factors can be assessed and infection prevention measures instituted.

In summary, our main findings were that nearly 1 in 10 study participants were asymptomatically colonized with CD at hospital admission and could be identified using PCR on formed stool. Risk factors for such colonization could be identified and, despite changes in CD epidemiology, appear similar to those identified nearly 2 decades ago. This is the first study to demonstrate the feasibility of performing CD surveillance on hospitalized patients at admission; inability to provide a stool sample was the biggest practical limitation. The role of asymptomatic carriers in transmitting CD should be studied further, and the utility of PCR-based targeted surveillance to detect asymptomatic carriers should be explored in areas of high endemicity or outbreak settings when other control measures have been exhausted.

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