Healthcare Quality Reporting Program

HOSPITAL-ACQUIRED INFECTIONS AND PREVENTION ADVISORY SUBCOMMITTEE

8:00-9:00am, 4/16/2012 at Healthcentric Advisors

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

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

Time	Topic/Notes
8:00am	**Welcome & Administrative Updates** *Leonard Mermel, DO, ScM* *Samara Viner-Brown, MS* - Today's objectives - Previous meeting's action items: • Distribute hand hygiene 5-day preview report (Margaret) • Ask Dr. Fine about discussing PCR testing with the hospital CEOs (Sam) • Confirm the date for Dr. Fine's HARI presentation (Rosa) • Draft advisory letter for the *Rules and Regulations* (Rosa/Len) • Comment on the advisory letter (Subcommittee)
8:15am	**Reporting Topics** *Leonard Mermel, DO, ScM* *Rosa Baier, MPH* - *C. Difficile* methodology update - MDR-GNB (ESBL & CPE-producing Gram negative bacilli) issues: • Microbiology lab director survey • Next steps - Rhode Island HAI Plan: • Review previous version • Update

8:55am **Open Forum & Action Items**
Rosa Baier, MPH

- Action items
- Next meeting: 5/21/12 at Healthcentric Advisors

Healthcare Quality Reports

HOSPITAL HAND HYGIENE

Data Report, March 2012

Clean hands are the most important strategy to prevent germs from spreading in hospital. As a result, how hospital healthcare workers clean their hands—their "hand hygiene"—is an important part of how the hospital controls infections. Hospitals' hand hygiene processes are reported on the Department of Health's (HEALTH's) Web site as part of the Department's hospital reporting work. You can learn more about these measures—including what each measure means, how it is calculated, and why this information is important—by reading the Technical Page. With questions about a hospital's performance, please contact the hospital directly by clicking on each hospital's name.

Hospital *(Alphabetical)*	Hand Hygiene & Glove Use Education Provided*	Hand Hygiene Measured[H]	Hand Hygiene Reported[ɘ]
		(Yes/No)	
Eleanor Slater Hospital	Yes	Yes	Yes
Kent County Memorial Hospital	Yes	Yes	Yes
Landmark Medical Center	Yes	Yes	Yes
Memorial Hospital	Yes	Yes	Yes
Miriam Hospital	Yes	Yes	Yes
Newport Hospital	Yes	Yes	Yes
Our Lady of Fatima Hospital	Yes	Yes	Yes
Rhode Island Hospital	Yes	Yes	Yes
Roger Williams Medical Center	Yes	Yes	Yes
South County Hospital	Yes	Yes	Yes
Westerly Hospital	Yes	No	No
Women & Infants' Hospital	Yes	Yes	Yes

* Hand hygiene and glove use educational program in place

H Hand hygiene compliance measured through direct observation, collected at least once every three months (quarterly)

ɘ Hand hygiene compliance measured through direct observation, collected at least once every three months (quarterly), with feedback provided to credentialed staff, the Chief Executive Officer, and Executive Leadership

Healthcare Quality Reports

HOSPITAL HAND HYGIENE

Technical Page

The hand hygiene compliance measures are reported on the Department of Health's (HEALTH's) Web site as part of the HCQP Program's Hospital-Acquired Infections work. This information provides additional details about the measures, including their data source, how they are calculated, and why each is important.

Measure Information

Topic	Why is this information important?
1. Hand hygiene & glove use education provided	Clean hands are the single most important strategy to prevent germs from spreading in hospitals. Making sure that staff know hand hygiene—how to clean their hands with an alcohol-based product or soap and water—and how to use gloves is important.
2. Hand hygiene measured	Going to different parts of the hospital (wards, clinics, etc.) to see if staff are actually cleaning their hands properly before and after caring for patients is important. This information helps hospitals know how often staff are cleaning their hands properly. They can then use this information to improve hand hygiene compliance, and help to prevent the spread of germs.
3. Hand hygiene reported	It is important for hospitals to use the information they collect about how staff are cleaning their hands to provide feedback. This feedback should include the staff who were observed and also the hospital administration. This tells the hospital if their staff are doing a good job or need to improve.

These measures are process measures. Process measures look at *how* hospitals work. The goal is for every hospital to have a 'Yes' for all three measures.

Definitions

Key Term/Phrase	Definition
Credentialed staff and licensed independent practitioners (LIPs)	▪ Healthcare workers engaged in direct patient contact, including: - Physician assistants (PAs) - Nurse practitioners (NPs) - Physicians (MDs and DOs) ▪ Includes clinicians who are hospital employees and also those who are not hospital employees.
Direct patient contact	▪ Any face-to-face interaction with patients.
Executive leadership	▪ High-level hospital administrative staff who run the hospital, including people such as the president and vice president, chief executive officer (CEO), chief financial officer (CFO), chief medical officer (CMO), chief nursing officer (CNO), chief operating officer (COO), and others.
Hand hygiene	▪ A general term that applies to cleaning hands with soap and water or using an antiseptic (e.g., alcohol) hand rub, gel, or foam (i.e., hand sanitizer).

Key Term/Phrase	Definition
Measuring hand hygiene	▪ The act of collecting data on hand hygiene compliance by collecting data, for example by observing staff.
Monitoring hand hygiene	▪ The act of using collected data to look at how a hospital's compliance rate changes over time (e.g., looking at trends). ▪ May be part of a program or quality improvement initiative to improve the hospital's hand hygiene compliance.
Physicians	▪ Includes both Medical Doctors (MDs) and Doctors of Osteopathy (DOs). ▪ Includes physicians who are hospital employees (e.g., hospitalists) and also those who are not hospital employees, but have direct patient contact with patients at the hospital.
Program to improve rates	▪ A team of staff, usually with different types of experience, who meet regularly to review data, identify improvement opportunities, and implement projects to improve the hospital's performance.

Data Source

The hand hygiene compliance measures are calculated based on information collected each year from hospitals in Rhode Island. Hospitals answer the following questions:

1. **Does your hospital have an educational program regarding the following?** *(Select all that apply.)*
   - Γ Principles of hand hygiene
   - Γ Proper glove use
2. **Does your hospital measure hand hygiene compliance on a regular basis?**
   - Γ No *(Stop)*
   - Γ Yes ↓
   - a. **How does your hospital measure hand hygiene compliance?**
     - Γ By measuring the volume of hand cleansing agent (e.g., hand sanitizer)
     - Γ Through direct observation
     - Γ Other *(please specify):* _____
   - b. **How often does your hospital collect hand hygiene compliance data?**
     - Γ Every quarter (3 months)
     - Γ Monthly
     - Γ Weekly
     - Γ Daily
     - Γ Other *(please specify):* _____
3. **Does your hospital have an ongoing program to improve hand hygiene compliance rates?**
   - Γ No
   - Γ Yes
4. **Does your hospital provide feedback regarding hand hygiene compliance to the following?** *(Select all that apply.)*
   - Γ Credentialed staff and licensed independent practitioners (LIPs)
   - Γ Chief Executive Officer (CEO)

- Γ Executive Leadership
- Γ None of the above

Measure Calculation

The measure scores (Y/N) are calculated based on the following definitions:

1. **Hand hygiene and glove use education provided**
   Yes: Q1: Both "Principles of hand hygiene" AND "Proper glove use" checked
2. **Hand hygiene compliance measured**
   Yes: Q2: Yes, AND
   Q2a: "By measuring compliance through direct observation," AND
   Q2b: At least quarterly
3. **Hand hygiene compliance reported**
   Yes: Measure 2: Yes, AND
   Q3: Yes, AND
   Q4: "Credentialed staff/LIPs" AND "CEO" AND "Executive Leadership" checked

RHODE ISLAND

HEALTHCARE-ASSOCIATED INFECTIONS PLAN

JANUARY 1,2010

Submitted by

The Rhode Island Department of Health

1. Develop or Enhance HAI program infrastructure

Table 1: State infrastructure planning for HAI surveillance, prevention and control.

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
Level I			1. Establish statewide HAI prevention leadership through the formation of multidisciplinary group or state HAI advisory council.	
	☒	☐	i. Collaborate with local and regional partners (e.g., state hospital associations, professional societies for infection control and healthcare epidemiology, academic organizations, laboratorians and networks of acute care hospitals and long-term care facilities).	Complete
	☒	☐	ii. Identify specific HAI prevention targets consistent with HHS priorities.	Q1 2010
			Other activities or descriptions (not required): • Rhode Island has an established HAI Subcommittee, comprised of the above stakeholder and provider groups. • The HAI Subcommittee will meet monthly between October and January to finalize the HAI Plan by 12/21/09 and then prioritize ongoing work based on the HHS priorities.	
			2. Establish an HAI surveillance prevention and control program.	
	☒	☐	i. Designate a state HAI Prevention Coordinator.	12/21/09
	☐	☒	iii. Develop dedicated, trained HAI staff with at least one FTE (or contracted equivalent) to oversee the four major HAI activity areas (Integration, Collaboration, and Capacity Building; Reporting, Detection, Response and Surveillance; Prevention; Evaluation, Oversight and Communication).	Q1 2010

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
			Other activities or descriptions (not required): • The Department of Health will identify both internal and external HAI subject matter experts (to ensure a range of clinical and epidemiological skill sets), comprising at least 1.0 FTE. • Rhode Island's contractor for the HAI Plan is Quality Partners of Rhode Island, the state's Quality Improvement Organization (QIO). This enables the state to align the HAI Plan work with the QIOs' HAI and NSHN expertise/focus. Two hospitals are working with Quality Partners to use NHSN (Our Lady of Fatima Hospital and Roger Williams Medical Center).	
	☐	☒	3. Integrate laboratory activities with HAI surveillance, prevention and control efforts. i. Improve laboratory capacity to confirm emerging resistance in HAI pathogens and perform typing where appropriate (e.g., outbreak investigation support, HL7 messaging of laboratory results).	Ongoing
			Other activities or descriptions (not required): • In response to this grant a representative from the state's Special Pathogens Laboratory has joined the HAI Subcommittee and will assist with coordination between the public reporting program and the state laboratories. The Special Pathogens Laboratory conducts regular testing and sends results to the CDC, as appropriate. • Additionally, we propose to accomplish capacity building by standardizing and overseeing hospital laboratory activities through the State Laboratory.	
Level II	☒	☐	4. Improve coordination among government agencies or organizations that share responsibility for assuring or overseeing HAI surveillance, prevention and control (e.g., State Survey Agencies, Communicable Disease Control, State Licensing Boards).	12/21/09

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
			Other activities or descriptions (not required): • The HAI Subcommittee includes Department of Health representatives who are involved in epidemiology, physician licensing, and other activities that help to ensure shared responsibility for HAI surveillance, prevention, and control.	
	☐	☐	5. Facilitate use of standards-based formats (e.g., Clinical Document Architecture, electronic messages) by healthcare facilities for purposes of electronic reporting of HAI data. i. Provide technical assistance or other incentives for implementations of standards-based reporting can help develop capacity for HAI surveillance and other types of public health surveillance, such as for conditions deemed reportable to state and local health agencies using electronic laboratory reporting (ELR). ii. Facilitate use of standards-based solutions for external reporting also can strengthen relationships between healthcare facilities and regional nodes of healthcare information, such as Regional Health Information Organizations (RHIOs) and Health Information Exchanges (HIEs).	n/a n/a
			Other activities or descriptions (not required): • While the Department of Health encourages the use of standards-based formats to ensure interoperability and consistency of HAI and other reporting efforts, this was not part of the scope of work proposed by the Department for this grant. • There is a state HIE in the early stages of implementation. It requires patients to opt-in, and will take time for sufficient patients to accrue in order to make it a useful tool for HAI.	

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates

Please note:

- Due to a state fiscal crisis, the state's 11-year-old public reporting program is being eliminated from the current fiscal year's budget, effective 12/31/09. While the HAI Subcommittee, which was established as part of the public reporting program, will continue under the CDC funding, this means that the programmatic oversight and infrastructure in existence when the grant was awarded will be eliminated. As a result, the HAI Subcommittee has updated the HAI Plan to reflect a stand-alone project limited to the CDC funding. Regardless, the state and its providers remain committed to transparency and reporting, and have a long-standing track record and culture of collecting and disseminating data about quality of care and patient satisfaction.
- The Department of Health applied for a CDC Epidemiology and Laboratory Capacity for Infectious Diseases (ELC) grant to implement a MDRO Collaborative, with focus topics to include c-diff and MRSA—but was notified in December 2009 that funding was *not* awarded. These funds would have enabled the Department to increase the FTE allocated to Rhode Island HAI efforts. In the absence of this funding, the HAI Plan cannot support and does not propose to expand NHSN use within Rhode Island. The HAI Subcommittee's prioritization and implementation of the HHS targets will reflect this limitation.
- Rhode Island has already published two HAI reports: (1) Surgical Care Infection Program (SCIP) Measures I, II, and III; and (2) Central Line-Associated Bloodstream Infections (CLABSI). These reports are updated quarterly. The next HAI report is anticipated to be employee influenza vaccination data, beginning with data from the 2008-2009 flu season.
- Rhode Island is the only state in the nation to have 100% of adult ICUs participating in the ICU Collaborative. The multi-year collaborative has achieved significant improvement on measures such as CLABSI, as well as lives saved and cost savings.

2. Surveillance, Detection, Reporting, and Response

Table 2: State planning for surveillance, detection, reporting, and response for HAIs

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
Level I			1. Improve HAI outbreak detection and investigation.	
	☒	☐	i. Work with partners including CSTE, CDC, state legislatures, and providers across the healthcare continuum to improve outbreak reporting to state health departments.	Ongoing
	☒	☐	ii. Establish protocols and provide training for health department staff to investigate outbreaks, clusters or unusual cases of HAIs.	Ongoing
	☒	☐	iii. Develop mechanisms to protect facility/provider/ patient identity when investigating incidents and potential outbreaks during the initial evaluation phase where possible to promote reporting of outbreaks.	Ongoing
	☒	☐	iv. Improve overall use of surveillance data to identify and prevent HAI outbreaks or transmission in HC settings (e.g., hepatitis B, hepatitis C, multi-drug resistant organisms [MDRO], and other reportable HAIs).	Ongoing
			Other activities or descriptions (not required): • Surveillance is currently done daily by hospital Infection Control Practitioners (ICPs), with results reported to the state's epidemiologists. The HAI Subcommittee will work with the epidemiologists to learn what is reported, at what thresholds, and what steps are followed, as well as to explore guidelines for non-reportable infections.	
	☐	☐	2. Enhance laboratory capacity for state and local detection and response to new and emerging HAI issues.	n/a

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
			Other activities or descriptions (not required): • Without additional staff and funding, enhanced laboratory capacity is not possible within the Department. The state is currently in a fiscal crisis, with hiring freezes and budget cuts.	
Level II			3. Improve communication of HAI outbreaks and infection control breaches.	
	☒	☐	i. Develop standard reporting criteria including, number, size and type of HAI outbreak for health departments and CDC.	Complete
	☒	☐	ii. Establish mechanisms or protocols for exchanging information about outbreaks or breaches among state and local governmental partners (e.g., State Survey agencies, Communicable Disease Control, state licensing boards).	Complete
			Other activities or descriptions (not required): • Guidelines for these activities exist and will be shared by the Department of Health with the HAI Subcommittee. As mentioned previously, surveillance is currently done daily in hospital Infection Control Practitioners (ICPs), with results reported to the state's epidemiologists.	
			4. Identify at least 2 priority prevention targets for surveillance in support of the HHS HAI Action Plan.	1/25/10 to prioritize among topics
	☒	☐	i. Central Line-Associated Bloodstream Infections (CLABSI)	
	☐	☐	ii. *Clostridium difficile* Infections (CDI)	
	☐	☐	iii. Catheter-associated Urinary Tract Infections (CAUTI)	
	☒	☐	iv. Methicillin-resistant Staphylococcus aureus (MRSA) Infections	

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
	☒ ☒	☐ ☐	v. Surgical Site Infections (SSI) [via Surgical Care Infection Program (SCIP) Measures I, II, and III – **not NHSN**] vi. Ventilator-associated Pneumonia (VAP) (via the ICU Collaborative)	
			Other activities or descriptions (not required): • Rhode Island has an established HAI Subcommittee that has begun prioritizing HAI reporting topics and will expand its existing work to identify at least two HHS priority topics from the above list. However, in light of the fact that Rhode Island's recent application for ELC funding to implement a MDRO Collaborative was denied, the HAI Plan cannot support and does not propose to expand NHSN use within Rhode Island. The HAI Subcommittee's prioritization, implementation of, and measurement of the HHS targets will reflect this limitation. • The HAI Subcommittee met monthly between October and December 2009 to finalize the HAI Plan and will begin to meet in January 2010 to finalize prioritization of ongoing work based on the HHS priorities. • As mentioned previously, the public reporting program has already published two HAI reports: (1) Surgical Care Infection Program (SCIP) Measures I, II, and III; and (2) Central Line-Associated Bloodstream Infections (CLABSI). These reports are updated quarterly. The next HAI report will be employee influenza vaccination data, beginning with data from the 2008-2009 flu season. Please note that none of these reports use NHSN reporting or data. • The ICU Collaborative participants (all adult ICUs) submit and monitor VAP through the Collaborative's reporting system, not NHSN.	
			5. Adopt national standards for data and technology to track HAIs (e.g., NHSN).	

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
	☐	☒	i. Develop metrics to measure progress towards national goals (align with targeted state goals). (See Appendix 1.)	Incremental, beginning Q1 2010
	☐	☒	ii. Establish baseline measurements for prevention targets.	(see note)
			Other activities or descriptions (not required): • Rhode Island's contractor for the HAI Plan is Quality Partners, the state's QIO, which is currently working with select hospitals on NHSN reporting. This enables the state to leverage existing NSHN training/ expertise for hospitals currently enrolled in NHSN or planning to implement it. • That said, the expansion of NHSN reporting and use of it to establish a baseline was contingent upon the Department's receipt of additional ELC funding to form a 12-month MDRO Collaborative and provide hospitals with technical assistance and support to register with and/or expand their use of NHSN. In light of the fact that Rhode Island's application was denied, the HAI Plan cannot support and does not propose to expand NHSN use within Rhode Island. The HAI Subcommittee's prioritization, implementation of, and measurement strategies for the HHS targets will reflect this limitation.	
	☐	☐	6. Develop state surveillance training competencies. i. Conduct local training for appropriate use of surveillance systems (e.g., NHSN) including facility and group enrollment, data collection, management, and analysis.	n/a

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
			Other activities or descriptions (not required): • Rhode Island's contractor for the HAI Plan is Quality Partners, the state's QIO, which is currently working with two hospitals on NHSN reporting (Our Lady of Fatima Hospital and Roger Williams Medical Center). Quality Partners' experience enables the State to leverage existing NSHN training/expertise. • Two additional hospitals, Rhode Island Hospital and Women and Infants' Hospital, have also begun using select NHSN modules.	
	☒	☐	7. Develop tailored reports of data analyses for state or region prepared by state personnel.	Quarterly
			Other activities or descriptions (not required): • Rhode Island's 11-year-old public reporting mandate (which will be unfunded beginning 1/1/10) uses a stakeholder-guided consensus process to develop and disseminate public reporting formats. The Department of Health will use the HAI Subcommittee to fulfill the above objective. • HAI reporting is already underway, with SCIP, CLABSI, and employee influenza vaccination measures published regularly.	
Level III			8. Validate data entered into HAI surveillance (e.g., through healthcare records review, parallel database comparison) to measure accuracy and reliability of HAI data collection.	
	☐	☐	i. Develop a validation plan.	n/a
	☐	☐	ii. Pilot test validation methods in a sample of healthcare facilities.	n/a
	☐	☐	iii. Modify validation plan and methods in accordance with findings from pilot project.	n/a

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
	☐	☐	iv. Implement validation plan and methods in all healthcare facilities participating in HAI surveillance.	n/a
	☐	☐	v. Analyze and report validation findings.	n/a
	☐	☐	vi. Use validation findings to provide operational guidance for healthcare facilities that targets any data shortcomings detected.	n/a
			Other activities or descriptions (not required): • These activities are not included under Part A funding.	
			9. Develop preparedness plans for improved response to HAI.	
	☒	☐	i. Define processes and tiered response criteria to handle increased reports of serious infection control breaches (e.g., syringe reuse), suspect cases/clusters, and outbreaks.	Complete
			Other activities or descriptions (not required): • Guidelines for these activities exist within the Department of Facilities Regulations at the Department of Health, and will be shared with the HAI Subcommittee.	
	☒	☐	10. Collaborate with professional licensing organizations to identify and investigate complaints related to provider infection control practice in non-hospital settings, and to set standards for continuing education and training.	Ongoing
			11. Adopt integration and interoperability standards for HAI information systems and data sources.	

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
	☐	☒	i. Improve overall use of surveillance data to identify and prevent HAI outbreaks or transmission in HC settings (e.g., hepatitis B, hepatitis C, multi-drug resistant organisms (MDRO), and other reportable HAIs) across the spectrum of inpatient and outpatient healthcare settings.	Ongoing
	☐	☒	ii. Promote definitional alignment and data element standardization needed to link HAI data across the nation.	Ongoing
			Other activities or descriptions (not required): • Surveillance is currently done daily by hospital Infection Control Practitioners (ICPs), with results reported to the state's epidemiologists. As discussed previously, the HAI Subcommittee will work with the epidemiologists to learn what is reported, at what thresholds, and what steps follow, as well as to explore guidelines for non-reportable infections. • Improved use of the surveillance data will result from the inclusion of Dr. Utalpa Bandy, state epidemiologist, and Cindy Vanner, from the state's Special Pathogens Laboratory, on the HAI Subcommittee. They will assist with coordination between the public reporting program and the state epidemiology and laboratory work.	
			12. Enhance electronic reporting and information technology for healthcare facilities to reduce reporting burden and increase timeliness, efficiency, comprehensiveness, and reliability of the data.	
	☒	☐	i. Report HAI data to the public.	Ongoing

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
			Other activities or descriptions (not required): • Rhode Island has a long-standing public reporting mandate and, as mentioned previously, has already published two HAI reports: (1) Surgical Care Infection Program (SCIP) Measures I, II, and III; and (2) Central Line-Associated Bloodstream Infections (CLABSI). These reports are updated quarterly. The next HAI report will be employee influenza vaccination data, beginning with data from the 2008-2009 flu season.	
	☒	☐	13. Make available risk-adjusted HAI data that enables state agencies to make comparisons between hospitals.	Ongoing
			Other activities or descriptions (not required): • Rhode Island has a long-standing public reporting mandate, although the public reporting program (as noted previously) will be eliminated from state funding on 12/31/09. The program reports risk-adjusted clinical quality measures and patient satisfaction to enable healthcare consumers, providers, and other stakeholders to make between-facility comparisons. • HAI reporting is already underway, with SCIP and CLABSI published regularly, and employee influenza vaccination reporting planned. Please note that none of these reports use NHSN reporting or data.	
	☐	☐	14. Enhance surveillance and detection of HAIs in non-hospital settings.	
			Other activities or descriptions (not required): • This activity is not included under Part A funding, although physician reporting of reportable HAIs is mandated.	

3. Prevention

Table 3: State planning for HAI prevention activities

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
Level I	☒	☐	1. Implement HICPAC recommendations. i. Develop strategies for implementation of HICPAC recommendations for at least 2 prevention targets specified by the state multidisciplinary group.	Q1 2010
			Other activities or descriptions (not required): • The HAI Subcommittee will prioritize the HHS prevention targets and identify measurement strategies for those targets selected for implementation (e.g., hand hygiene process measures for MRSA containment). • However, in light of the fact that Rhode Island's recent application for ELC funding to implement a MDRO Collaborative was denied, the HAI Plan cannot support and does not propose to expand NHSN use within Rhode Island. The HAI Subcommittee's prioritization, implementation of, and measurement strategies for the HHS targets will reflect this limitation.	
	☐	☐	2. Establish prevention working group under the state HAI advisory council to coordinate the state HAI collaborative. i. Assemble expertise to consult, advise, and coach inpatient healthcare facilities involved in HAI prevention collaborative.	n/a
			Other activities or descriptions (not required): • The Department of Health did not propose a HAI prevention collaborative as part of the grant application. This work is not funded. • Rhode Island HAI Subcommittee already exists and is comprised of the above stakeholder and provider groups.	

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
			3. Establish HAI collaboratives with at least 10 hospitals (i.e. this may require a multi-state or regional collaborative in low population density regions).	
	☐	☐	i. Identify staff trained in project coordination, infection control, and collaborative coordination.	n/a
	☐	☐	ii. Develop a communication strategy to facilitate peer-to-peer learning and sharing of best practices.	n/a
	☐	☐	iii. Establish and adhere to feedback of a clear and standardized outcome data to track progress.	n/a
			Other activities or descriptions (not required): • The Department of Health did not propose a HAI prevention collaborative as part of this grant application. This work is not funded. • The Department of Health will identify both internal and external HAI subject matter experts, to ensure a range of clinical and epidemiological skill sets, comprising at least 1.0 FTE.	
	☐	☐	4. Develop state HAI prevention training competencies. i. Consider establishing requirements for education and training of healthcare professionals in HAI prevention (e.g., certification requirements, public education campaigns and targeted provider education) or work with healthcare partners to establish best practices for training and certification.	n/a
			Other activities or descriptions (not required): • The HAI Subcommittee will review the state's education and training standards and consider any opportunities for alignment with national standards, but this work is not specifically funded under the CDC grant.	

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
Level II			5. Implement strategies for compliance to promote adherence to HICPAC recommendations.	
	☐	☐	i. Consider developing statutory or regulatory standards for healthcare infection control and prevention or work with healthcare partners to establish best practices to ensure adherence.	n/a
	☐	☐	ii. Coordinate/liaise with regulation and oversight activities such as inpatient or outpatient facility licensing/accrediting bodies and professional licensing organizations to prevent HAIs.	n/a
	☐	☐	iii. Improve regulatory oversight of hospitals, enhancing surveyor training and tools, and adding sources and uses of infection control data.	n/a
	☐	☐	iv. Consider expanding regulation and oversight activities to currently unregulated settings where healthcare is delivered or work with healthcare partners to establish best practices to ensure adherence.	n/a
			Other activities or descriptions (not required): • The HAI Subcommittee is comprised of Infection Control Practitioners (ICPs), hospital staff, Department staff, and other stakeholders with vested interests in limiting HAI in Rhode Island. These Subcommittee members will assist with establishing collaborative partnerships and policies and procedures that further reduce HAI in the state, although this work is not specifically funded by the CDC grant.	
	☐	☐	6. Enhance prevention infrastructure by increasing joint collaboratives with at least 20 hospitals (i.e., this may require a multi-state or regional collaborative in low population density regions)	
			Other activities or descriptions (not required): • The Department of Health did not propose a HAI prevention collaborative as part of the grant application. This work is not funded.	n/a

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
	☐	☐	7. Establish collaborative to prevent HAIs in nonhospital settings (e.g., long term care, dialysis)	n/a
			Other activities or descriptions (not required): • The Department of Health did not propose a HAI prevention collaborative as part of the grant application. This work is not funded.	

Please also describe any additional activities, not listed above, that your state plans to undertake. Please include target dates for any new activities.

- The Department of Health applied for a CDC Epidemiology and Laboratory Capacity for Infectious Diseases (ELC) grant to implement a 12-month MDRO Collaborative. If funded, this project would have aligned with the existing state HAI Plan and ongoing public reporting work, and would have provided a mechanism for the Department to expand the Plan to include the activities listed in Table 3. Unfortunately, this application for funding was denied.

4. Evaluation and Communications

Table 4: State HAI communication and evaluation planning

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
Level I			1. Conduct needs assessment and/or evaluation of the state HAI program to learn how to increase impact.	
	☐	☒	i. Establish evaluation activity to measure progress towards targets, and	Q1 2010
	☐	☒	ii. Establish systems for refining approaches based on data gathered.	Q2 2011
			Other activities or descriptions (not required): • The HAI Subcommittee will continually review the publicly reported data to observe trends and make recommendations to the Department and, possibly, to the hospitals. Please note that this funding does not establish a MDRO Collaborative to specifically implement, measure, or refine improvement strategies.	
	☐	☒	2. Develop and implement a communication plan about the state's HAI program and progress to meet public and private stakeholders' needs. i. Disseminate state priorities for HAI prevention to healthcare organizations, professional provider organizations, governmental agencies, non-profit public health organizations, and the public.	Q2 2010
			Other activities or descriptions (not required): • Rhode Island's established HAI Subcommittee is comprised of the above stakeholder and provider groups, and often outreaches to Infection Control Practitioners (ICPs) and others in the state with an interest in HAI surveillance and prevention. The communication plan will enable more formal dissemination of information.	

Planning Level	Underway	Planned	Items Planned for Implementation	Target Dates
Level II	☒	☐	3. Provide consumers access to useful healthcare quality measures.	Ongoing
			Other activities or descriptions (not required): • Rhode Island's public reporting program (which will be eliminated from funding on 12/31/09) publishes information on healthcare quality, including clinical outcomes and patient satisfaction, on the Department of Health's website. The HAI Subcommittee's work to date is included there. As a result of the funding Rhode Island received for Activity A, some level of public reporting will be continued for HAI.	
Level III	☒	☐	4. Identify priorities and provide input to partners to help guide patient safety initiatives and research aimed at reducing HAIs.	Ongoing
			Other activities or descriptions (not required): • Rhode Island's contractor for the HAI Plan is Quality Partners of Rhode Island, the state's Quality Improvement Organization (QIO), which is implementing Medicare's National Patient Safety Initiative (NPSI) with local nursing homes and hospitals. The NPSI work in the hospital setting involves improving MRSA rates. • However, in light of the fact that Rhode Island's recent application for ELC funding to implement a MDRO Collaborative was denied, the HAI Plan cannot support and does not propose to expand NHSN use within Rhode Island. The HAI Subcommittee's prioritization, implementation of, and measurement of the HHS targets will reflect this limitation.	

Appendix 1.

The HHS Action plan identifies metrics and 5-year national prevention targets. These metrics and prevention targets were developed by representatives from various federal agencies, the Healthcare Infection Control Practices Advisory Committee (HICPAC), professional and scientific organizations, researchers, and other stakeholders. The group of experts was charged with identifying potential targets and metrics for six categories of healthcare-associated infections:

- Central Line-associated Bloodstream Infections (CLABSI)
- Clostridium difficile Infections (CDI)
- Catheter-associated Urinary Tract Infections (CAUTI)
- Methicillin-resistant Staphylococcus aureus (MRSA) Infections
- Surgical Site Infections (SSI)
- Ventilator-associated Pneumonia (VAP)

Following the development of draft metrics as part of the HHS Action Plan in January 2009, HHS solicited comments from stakeholders for review.

Stakeholder feedback and revisions to the original draft Metrics

Comments on the initial draft metrics published as part of the HHS Action Plan in January 2009 were reviewed and incorporated into revised metrics. While comments ranged from high level strategic observations to technical measurement details, commenters encouraged established baselines, both at the national and local level, use of standardized definitions and methods, engagement with the National Quality Forum, raised concerns regarding the use of a national targets for payment or accreditation purposes and of the validity of proposed measures, and would like to have both a target rate and a percent reduction for all metrics. Furthermore, commenters emphasized the need for flexibility in the metrics, to accommodate advances in electronic reporting and information technology and for advances in prevention of HAIs, in particular ventilator-associated pneumonia.

To address comments received on the Action Plan Metrics and Targets, proposed metrics have been updated to include source of metric data, baselines, and which agency would coordinate the measure. To respond to the requests for percentage reduction in HAIs in addition to HAI rates, a new type of metric, the standardized infection ratio (SIR), is being proposed. Below is a detailed technical description of the SIR.

To address concerns regarding validity, HHS is providing funding, utilizing Recovery Act of 2009 funds, to CDC to support states in validating NHSN-related measures and to support reporting on HHS metrics through NHSN. Also, most of the reporting metrics outlined here have already been endorsed by NQF and for population-based national measures on MRSA and *C. difficile*, work to

develop hospital level measures will be conducted in the next year utilizing HHS support to CDC through funds available in the Recovery Act.

Finally, to address concerns regarding flexibility in accommodating new measures, reviewing progress on current measures, and incorporating new sources of measure data (e.g., electronic data, administrative data) or new measures, HHS and its constituent agencies will commit to an annual review and update of the HHS Action Plan Targets and Metrics.

Below is a table of the revised metrics described in the HHS Action plan. Please select items or add additional items for state planning efforts.

Metric Number and Label	Original HAI Elimination Metric	HAI Comparison Metric	Measurement System	National Baseline Established (State Baselines Established)	National 5-Year Prevention Target	Coordinator of Measurement System	Is the metric NQF endorsed?
1. CLABSI 1	CLABSIs per 1000 device days by ICU and other locations	CLABSI SIR	CDC NHSN Device-Associated Module	2006-2008 (Proposed 2009, in consultation with states)	Reduce the CLABSI SIR by at least 50% from baseline or to zero in ICU and other locations	CDC	Yes[*]
2. CLIP 1 (formerly CLABSI 4)	Central line bundle compliance	CLIP Adherence percentage	CDC NHSN CLIP in Device-Associated Module	2009 (Proposed 2009, in consultation with states)	100% adherence with central line bundle	CDC	Yes[†]
3a. C diff 1	Case rate per patient days; administrative/discharge data for ICD-9 CM coded *Clostridium difficile* Infections	Hospitalizations with *C. difficile* per 1000 patient discharges	Hospital discharge data	2008 (Proposed 2008, in consultation with states)	At least 30% reduction in hospitalizations with *C. difficile* per 1000 patient discharges	AHRQ	No
3b. C diff 2 (New)		*C. difficile* SIR	CDC NHSN MDRO/CDAD Module LabID[‡]	2009-2010	Reduce the facility-wide healthcare facility-onset *C. difficile* LabID event SIR by at least 30% from baseline or to zero	CDC	No

Metric Number and Label	Original HAI Elimination Metric	HAI Comparison Metric	Measurement System	National Baseline Established (State Baselines Established)	National 5-Year Prevention Target	Coordinator of Measurement System	Is the metric NQF endorsed?
4. CAUTI 2	# of symptomatic UTI per 1,000 urinary catheter days	CAUTI SIR	CDC NHSN Device-Associated Module	2009 for ICUs and other locations 2009 for other hospital units (Proposed 2009, in consultation with states)	Reduce the CAUTI SIR by at least 25% from baseline or to zero in ICU and other locations	CDC	Yes*
5a. MRSA 1	Incidence rate (number per 100,000 persons) of invasive MRSA infections	MRSA Incidence rate	CDC EIP/ABCs	2007-2008 (for non-EIP states, MRSA metric to be developed in collaboration with EIP states)	At least a 50% reduction in incidence of healthcare-associated invasive MRSA infections	CDC	No
5b. MRSA 2 (New)		MRSA bacteremia SIR	CDC NHSN MDRO/CDAD Module LabID‡	2009-2010	Reduce the facility-wide healthcare facility-onset MRSA bacteremia LabID event SIR by at least 25% from baseline or to zero	CDC	No
6. SSI 1	Deep incision and organ space infection rates using NHSN definitions (SCIP procedures)	SSI SIR	CDC NHSN Procedure-Associated Module	2006-2008 (Proposed 2009, in consultation with states)	Reduce the admission and readmission SSI§ SIR by at least 25% from baseline or to zero	CDC	Yes¶
7. SCIP 1 (formerly SSI 2)	Adherence to SCIP/NQF infection process measures	SCIP Adherence percentage	CMS SCIP	To be determined by CMS	At least 95% adherence to process measures to prevent surgical site infections	CMS	Yes

* NHSN SIR metric is derived from NQF-endorsed metric data
† NHSN does not collect information on daily review of line necessity, which is part of the NQF
‡ LabID, events reported through laboratory detection methods that produce proxy measures for infection surveillance
§ Inclusion of SSI events detected on admission and readmission reduces potential bias introduced by variability in post-discharge surveillance efforts
¶ The NQF-endorsed metric includes deep wound and organ space SSIs only which are included the target.

Understanding the Relationship between HAI Rate and SIR Comparison Metrics

The Original HAI Elimination Metrics listed above are very useful for performing evaluations. Several of these metrics are based on the science employed in the NHSN. For example, metric #1 (CLABSI 1) for CLABSI events measures the number of CLABSI events per 1000 device (central line) days by ICU and other locations. While national aggregate CLABSI data are published in the annual NHSN Reports these rates must be stratified by types of locations to be risk-adjusted. This scientifically sound risk-adjustment strategy creates a practical challenge to summarizing this information nationally, regionally or even for an individual healthcare facility. For instance, when comparing CLABSI rates, there may be quite a number of different types of locations for which a CLABSI rate could be reported. Given CLABSI rates among 15 different types of locations, one may observe many different combinations of patterns of temporal changes. This raises the need for a way to combine CLABSI rate data across location types.

A standardized infection ratio (SIR) is identical in concept to a standardized mortality ratio and can be used as an indirect standardization method for summarizing HAI experience across any number of stratified groups of data. To illustrate the method for calculating an SIR and understand how it could be used as an HAI comparison metric, the following example data are displayed below:

Risk Group Stratifier	Observed CLABSI Rates			NHSN CLABSI Rates for 2008 (Standard Population)		
Location Type	#CLABSI	#Central line-days	CLABSI rate*	#CLABSI	#Central line-days	CLABSI rate*
ICU	170	100,000	1.7	1200	600,000	2.0
WARD	58	58,000	1.0	600	400,000	1.5

$$\text{SIR} = \frac{\text{observed}}{\text{expected}} = \frac{170+58}{100000\times\left(\frac{2}{1000}\right)+58{,}000\times\left(\frac{1.5}{1000}\right)} = \frac{228}{200+87} = \frac{228}{287} = 0.79 \qquad 95\%\text{CI} = (0.628, 0.989)$$

*defined as the number of CLABSIs per 1000 central line-days

In the table above, there are two strata to illustrate risk-adjustment by location type for which national data exist from NHSN. The SIR calculation is based on dividing the total number of observed CLABSI events by an "expected" number using the CLABSI rates from the standard population. This "expected" number is calculated by multiplying the national CLABSI rate from the standard population by the observed number of central line-days for each stratum, which can also be understood as a prediction or projection. If the observed data represented a follow-up period such as 2009 one would state that an SIR of 0.79 implies that there was a 21% reduction in CLABSIs overall for the nation, region or facility.

The SIR concept and calculation is completely based on the underlying CLABSI rate data that exist across a potentially large group of strata. Thus, the SIR provides a single metric for performing comparisons rather than attempting to perform multiple comparisons across many strata, which makes the task cumbersome. Given the underlying CLABSI rate data, one retains the option to perform comparisons within a particular set of strata where observed rates may

differ significantly from the standard populations. These types of more detailed comparisons could be very useful and necessary for identifying areas for more focused prevention efforts.

The National 5-year prevention target for metric #1 could be implemented using the concept of an SIR equal to 0.25 as the goal. That is, an SIR value based on the observed CLABSI rate data at the 5-year mark could be calculated using NHSN CLABSI rate data stratified by location type as the baseline to assess whether the 75% reduction goal was met. There are statistical methods that allow for calculation of confidence intervals, hypothesis testing and graphical presentation using this HAI summary comparison metric called the SIR.

The SIR concept and calculation can be applied equitably to other HAI metrics list above. This is especially true for HAI metrics for which national data are available and reasonably precise using a measurement system such as the NHSN. The SIR calculation methods differ in the risk group stratification only. To better understand metric #6 (SSI 1) see the following example data and SIR calculation:

Risk Group Stratifiers		**Observed SSI Rates**			**NHSN SSI Rates for 2008 (Standard Population)**		
Procedure Code	**Risk Index Category**	**#SSI†**	**#procedures**	**SSI rate***	**#SSI†**	**#procedures**	**SSI rate***
CBGB	1	315	12,600	2.5	2100	70,000	3.0
CBGB	2,3	210	7000	3.0	1000	20,000	5.0
HPRO	1	111	7400	1.5	1020	60,000	1.7

$$\text{SIR} = \frac{\text{observed}}{\text{expected}} = \frac{315+210+111}{12600\times\left(\frac{3.0}{100}\right)+7000\times\left(\frac{5.0}{100}\right)+7400\left(\frac{1.7}{100}\right)} = \frac{636}{378+350+125.8} = \frac{636}{853.8} = 0.74 \qquad 95\%\text{CI} = (0.649, 0.851)$$

† SSI, surgical site infection

* defined as the number of deep incision or organ space SSIs per 100 procedures

This example uses SSI rate data stratified by procedure and risk index category. Nevertheless, an SIR can be calculated using the same calculation process as for CLABSI data except using different risk group stratifiers for these example data. The SIR for this set of observed data is 0.74 which indicates there's a 26% reduction in the number of SSI events based on the baseline NHSN SSI rates as representing the standard population. Once again, these data can reflect the national picture at the 5-year mark and the SIR can serve as metric that summarizes the SSI experience into a single comparison.

There are clear advantages to reporting and comparing a single number for prevention assessment. However, since the SIR calculations are based on standard HAI rates among individual risk groups there is the ability to perform more detailed comparisons within any individual risk group should the need arise. Furthermore, the process for determining the best risk-adjustment for any HAI rate data is flexible and always based on more detailed risk factor analyses that provide ample scientific rigor supporting any SIR calculations. The extent to which any HAI rate data can be risk-adjusted is obviously related to the detail and volume of data that exist in a given measurement system.

In addition to the simplicity of the SIR concept and the advantages listed above, it's important to note another benefit of using an SIR comparison metric for HAI data. If there was need at any level of aggregation (national, regional, facility-wide, etc.) to combine the SIR values across mutually exclusive data one could do so. The below table demonstrates how the example data from the previous two metric settings could be summarized.

	Observed HAIs			**Expected HAIs**		
HAI Metric	**#CLABSI**	**#SSI†**	**#Combined HAI**	**#CLABSI**	**#SSI†**	**#Combined HAI**
CLABSI 1	228			287		
SSI 1		636			853.8	
Combined HAI			228 + 636 = 864			287+853.8 = 1140.8

$$\text{SIR} = \frac{\text{observed}}{\text{expected}} = \frac{228+636}{287+853.8} = \frac{864}{1140.8} = 0.76 \qquad 95\%\text{CI} = (0.673, 0.849)$$

† SSI, surgical site infection

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ORIGINAL ARTICLE

Antimicrobial Stewardship at a Large Tertiary Care Academic Medical Center: Cost Analysis Before, During, and After a 7-Year Program

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BACKGROUND. An antimicrobial stewardship program was fully implemented at the University of Maryland Medical Center in July 2001 (beginning of fiscal year [FY] 2002). Essential to the program was an antimicrobial monitoring team (AMT) consisting of an infectious diseases–trained clinical pharmacist and a part-time infectious diseases physician that provided real-time monitoring of antimicrobial orders and active intervention and education when necessary. The program continued for 7 years and was terminated in order to use the resources to increase infectious diseases consults throughout the medical center as an alternative mode of stewardship.

DESIGN. A descriptive cost analysis before, during, and after the program.

PATIENTS/SETTING. A large tertiary care teaching medical center.

METHODS. Monitoring the utilization (dispensing) costs of the antimicrobial agents quarterly for each FY.

RESULTS. The utilization costs decreased from $44,181 per 1,000 patient-days at baseline prior to the full implementation of the program (FY 2001) to $23,933 (a 45.8% decrease) by the end of the program (FY 2008). There was a reduction of approximately $3 million within the first 3 years, much of which was the result of a decrease in the use of antifungal agents in the cancer center. After the program was discontinued at the end of FY 2008, antimicrobial costs increased from $23,933 to $31,653 per 1,000 patient-days, a 32.3% increase within 2 years that is equivalent to a $2 million increase for the medical center, mostly in the antibacterial category.

CONCLUSIONS. The antimicrobial stewardship program, using an antimicrobial monitoring team, was extremely cost effective over this 7-year period.

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Antimicrobial resistance is increasing throughout the United States. Furthermore, there are fewer new antimicrobials being developed to treat these resistant organisms.[1] This has led the Infectious Diseases Society of America, the Society for Health Care Epidemiology, and the Centers for Disease Control and Prevention to recommend that hospitals develop antimicrobial stewardship programs (ASPs) to help protect our existing armamentarium as long as possible.[2] Despite this recommendation, many medical centers have not established active programs. Such programs require resources during times when competition for finances is great and return of investment is uncertain.

The University of Maryland Medical Center (UMMC) developed an ASP using an antimicrobial monitoring team (AMT) in calendar year 2001. However, after 7 years the program was discontinued in favor of using the resources to provide additional infectious diseases physicians to enhance infectious diseases consultation throughout the medical center. The rationale for this was that the infectious diseases physicians, via consultations, would provide the necessary stewardship, making the AMT superfluous. This article documents the marked cost savings that resulted after the implementation of the ASP and the AMT in 2001 and the major cost impact that resulted after the program was discontinued.

METHODS

Background

The ASP was established at UMMC in 2001, in response to the perceived need for more appropriate use and the escalating costs of antimicrobial agents. It was continued through June 2008. At the time of the implementation of the ASP,

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UMMC had approximately 28,700 patient admissions per year; this has steadily increased, to 38,590 admissions in fiscal year (FY) 2010. The medical center has a very active cancer center, trauma center, and transplantation program. It has approximately 175 intensive care beds in the facility.

At the time of initiating the program, UMMC had a regulated formulary with restricted antimicrobials that required preauthorization for their use and an active pharmacy and therapeutics committee with an antimicrobial subcommittee. Despite this, annualized antimicrobial purchasing costs increased from $4.7 million in calendar year (CY) 1997 to over $8 million in CY 2000. Additionally, hospitals in Maryland were to be reimbursed for the disease entity treated (a drug-related group [DRG] system) instead of for the expenses incurred. This provided an additive monetary incentive for initiating the ASP.

Developing the ASP and the AMT

Leadership of the initiative was established within the infection control program and by working closely with the pharmacy department. The program was developed by the medical director for infection control and the infectious diseases clinical pharmacist and vetted at a number of meetings with key hospital personnel, including the director of pharmacy, the chief of infectious diseases, the vice president of quality for the medical center, and the chief medical officer. Essential and central to the ASP was the establishment of an AMT. This team consisted of (1) an infectious diseases physician with an initial dedicated effort to the program of 25% that subsequently increased to 50% and (2) a clinical pharmacist with infectious diseases training with a dedicated effort to the program of 80%. A data analyst with a dedicated effort of 5% and direction of the program was incorporated in the infection control program and required no additional resources.

Responsibilities of the AMT

The duties of the team were to provide an active computer-assisted real-time review of antimicrobial orders for the designated restricted antimicrobials and to provide active intervention when necessary. During their review, the team attempted to (1) identify ineffective or excessive antimicrobial coverage, (2) assure that the orders adhered to policies and guidelines, (3) discontinue unnecessary double coverage, (4) determine patients whose treatment could be converted safely from parenteral to oral therapy (IV-PO), and (5) suggest infectious diseases consults for difficult and complex cases. The team prioritized for review those patients receiving restricted antimicrobial agents and those areas of the medical center not served by specialized infectious diseases physicians such as were present in the trauma center.

Preauthorization Using the "BUGS Beeper"

Prior to the stewardship program, preauthorization for the use of certain antimicrobial agents was required, and this consent was provided by the infectious diseases consult service. To improve the process, a "BUGS beeper" program was developed. In this a beeper, activated by dialing "BUGS," was carried by the on-duty infectious diseases fellows on a rotational schedule. The fellow was supervised by the infectious diseases–trained faculty member assigned to the antimicrobial team. If preauthorization was not provided, the attending physician on the requesting service could directly call the attending physician on the antimicrobial team. If the conflict was still not resolved, a dose of the antimicrobial agent would be administered and an infectious diseases consult would be obtained in order to clarify the situation. Initially, an on-duty fellow carried the beeper until 10:00 p.m., but this was soon extended to 24 hours, 7 days a week. The program was initiated in late January 2001 and became fully implemented by July 2001 (beginning of FY 2002).

Development of Guidelines and Policies

To provide consistency for the physicians ordering the antimicrobials and for the antimicrobial team monitoring their use, guidelines and policies were developed where applicable. The AMT frequently provided leadership when formulating these guidelines, but attempts were made to have those most involved with their use participate in the development. When the policies and guidelines were written, they were approved through the normal channels, including the antimicrobial subcommittee of the pharmacy and therapeutics (P&T) committee, the parent P&T committee, and the medical executive committee, when appropriate.

Financial Goals

The financial goals for the antimicrobial program, which were based on those of other programs using an active interventional model at the time, were purposefully conservative: to save 10%–20% of the costs of antibiotics, based on an antimicrobial budget of $6 million per year over a 3-year period (a savings of $600,000–$1,200,000 over the 3-year period).[3]

Data Analysis

The actual costs for the antimicrobials were determined by the pharmacy service, and they represented the purchasing cost for the drug per unit. These costs were obtained by the pharmacy administration, independent of the antimicrobial team. The data program captured the utilization of antimicrobials, which was defined as those antimicrobials ordered by the provider who was caring for the patient and dispensed by the pharmacy. Any unused medication returned to the pharmacy was subtracted from this amount. Initially, these utilization data were captured using the Mega Source program. The data in this program were transferred using Monarche into Access, so that they could be categorized and manipulated into a usable database. On October 7, 2002 (second quarter of FY 2003), PharmNet was initiated. During this changeover, there were no data collected for the first 7 days

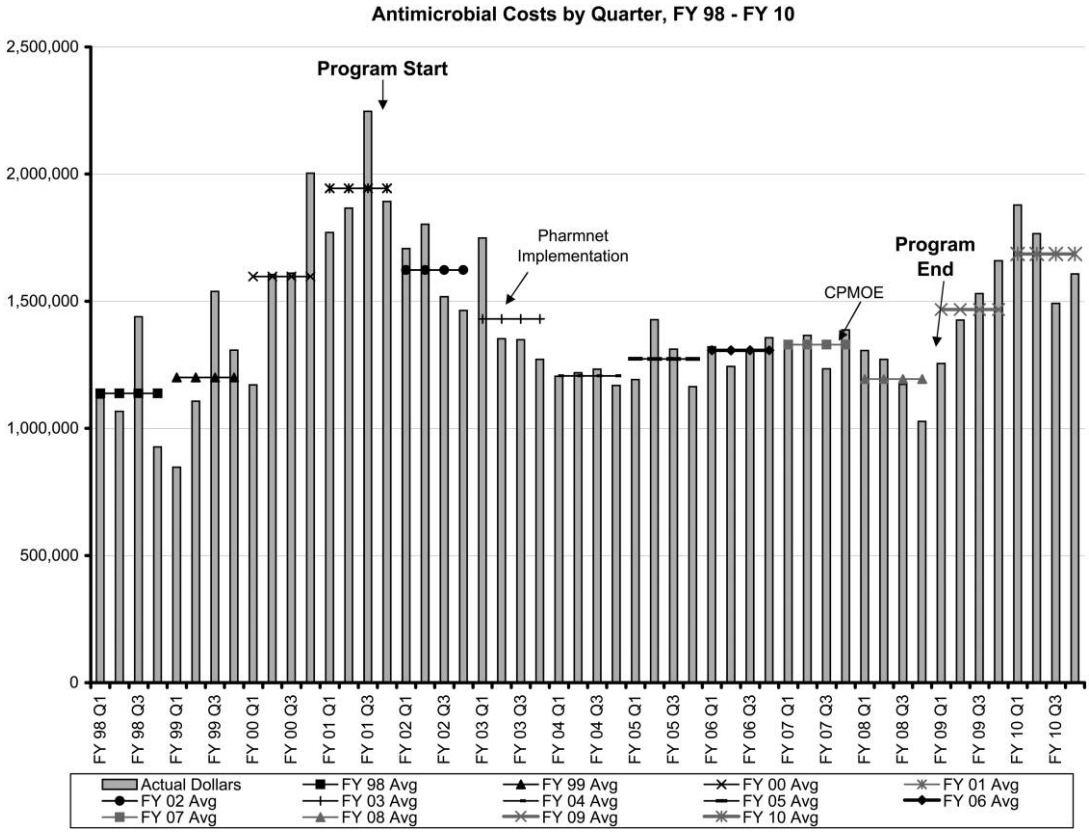

FIGURE 1. Quarterly costs of all antimicrobials, beginning with the first quarter of fiscal year 1998 (July 1997) and continuing through the 4th quarter of fiscal year (FY) 2010 (June 1, 2010). The solid horizontal lines represent the average cost for each fiscal year. The beginning and end of the antimicrobial stewardship program in the 3rd quarter of fiscal year 2001 and ending in the 4th quarter of fiscal year 2008, respectively, are indicated with arrows.

of that quarter. Instead, data for this period were estimated by extrapolating costs for the remaining portion of the quarter. Data from the PharmNet program were transferred into Access so that they could be categorized in a manner similar to the data from the Mega Source program.

Beginning in May 2004, PharmWatch (Cereplex; now owned by Premier), a decision-support program designed to assist in antimicrobial utilization, was used to evaluate for a 3-month period one-half of the patient population monitored by the antimicrobial team. Results of this evaluation have been reported previously.[4] The use of this program was subsequently expanded to include the entire hospital.

Defined Daily Doses (DDDs)

DDDs were determined according to dosages recommended by the World Health Organization (http://www.whocc.no/atc_ddd_index/). When no daily dosage was suggested by that organization, one was assigned that was thought to represent a typical daily dosage for adults with normal renal and hepatic functions. When a dosage amount was assigned, it was not changed throughout the evaluation period. The DDDs are expressed per 1,000 patient-days.

Quality Indicators

To monitor the safety of the stewardship program, we monitored selective quality indicators for the medical center including length of stay, readmissions within 30 days, and 30-day mortality. The DRG case mix index was monitored to ensure that changes in outcomes were not related to this index.

Statistical Analysis

The χ^2 test was used to compare the annual and cumulative reductions of antibiotic usage overall and then after introduction and after discontinuation of the AMT. To examine the trend in the prevalence of antimicrobial utilization over time, the results were compared using the χ^2 test for trend. For all analyses, the threshold for establishing statistical significance was set at $P < .05$. Statistical analyses were completed using the SPSS statistical package (ver 16).

RESULTS

Cost Savings after Implementation of the ASP

The utilization costs by quarter for the medical center from FY 1998 through FY 2010 are presented in Figure 1. (For example, the fiscal year for 2001 extends from July 1, 2000, through June 30, 2001.) The overall upward trend of costs that occurred from FY 1998 through the third quarter of FY 2001 (prior to the time of implementation of the ASP) is readily apparent. Similarly, the downward trend that occurred after the program was fully implemented (beginning in FY 2002) is marked, particularly in the first 3 years. Thereafter, a relatively stable period exists from FY 2004 until the first quarter of FY 2009, at which point the program was terminated. Following this termination, the costs for antimicrobials increase dramatically for the next 2 years.

The yearly costs before the stewardship program was implemented (FY 2001), for the 7 years of the program's existence (FY 2002–FY 2008), and for 2 years after it was terminated (FY 2009–FY 2010), including dollars per patient-days, are presented in Table 1. These costs are further separated into antimicrobial categories. The total expenditures for antimicrobial agents were reduced from $44,181 to $23,933 per 1,000 patient-days (45.8%; $P = .04$) over the duration of the program. In terms of costs for the hospital, a reduction of $2,949,705 occurred for the medical center within the first 3 years after implementation of the ASP.

By antimicrobial category, for FY 2001 (baseline), almost one-half ($3.7 million) of the entire budget of $7,774,588 went to pay for antifungal agents, with an additional $3.5 million (45%) paying for antibacterial agents. Together, these 2 categories were responsible for 93% of the antimicrobial costs. After the program began, the majority of the cost savings occurred in the antifungal category, which were reduced by $2,251,976 (60.7%) over the 3-year period, driven primarily by treatment guidelines for fungal infections in the medical center ($P = .003$). However, costs of antibacterial agents were also reduced by $513,044 (14.6%) over this 3-year period after the program was implemented ($P = .035$). Reductions are noted for the beta-lactam antibiotics as a group (10.2%), which include the carbapenems (primarily imipenem), the cephalosporins, and the penicillins (see Table 2). There was a slight reduction in the use of the antipseudomonal penicillins, primarily piperacillin/tazobactam, whereas use of the aminopenicillins (primarily ampicillin/sulbactam) increased. Reductions were also noted for the miscellaneous antimicrobial agents as a group, including vancomycin, quinipristin/dalfopristin, and metronidazole. The cost of the quinolones was reduced by 47% over the 3-year period. From FY 2004 to FY 2008, costs appeared to stabilize, decreasing by only $48,220 (1%); however, when patient-days are considered, this was a decrease of $3,785 per 1,000 patient-days, or 13.7%

Switch from Intravenous to Oral Delivery

An early intervention initiated by the stewardship program was the switch from intravenous to oral routes of delivery when the oral intake of other drugs was apparent and when the bioavailability of the antimicrobial agents permitted it. This was subsequently instituted as a policy. The reduction of costs resulting from this initiative was $179,285 in FY 2002 compared with baseline (FY 2001). The savings resulting from this switch were most apparent for fluconazole ($142,534) and linezolid ($19,597).

The increases in costs by antimicrobial category after the program was discontinued also is noted in Table 1, with the effects on specific antimicrobials presented in Table 2. There was an immediate increase in cost of $1 million during the first year after the program was discontinued and an additional increase of $873,184 during the second year, which represents an increase in cost of 41.2% for the 2-year period over the last year of the program (FY 2008; $P = .025$). After the discontinuation of the program, the increased costs primarily occurred in the antibacterial category, particularly the agents acting against gram-positive organisms, including vancomycin, linezolid, and daptomycin (see Table 2; $P = .002$). Also during

TABLE 1. Cost of Antimicrobials by Category, Before, During, and After the Antimicrobial Stewardship Program

	Before	During							After	
	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Antibacterials	3,503,878	3,017,828	3,189,081	2,990,834	3,117,084	3,283,178	3,498,911	3,183,232	4,020,487	4,751,641
Antifungals	3,710,465	2,926,270	2,011,050	1,458,489	1,605,573	1,513,837	1,343,056	1,154,256	1,268,795	1,268,498
Antimycobacterials	17,416	16,919	14,843	17,765	27,985	16,518	15,498	10,336	34,879	66,135
Antiparasitics	5,056	5,839	2,822	2,387	2,832	3,124	4,698	5,647	9,637	11,416
Antivirals	424,627	470,503	441,811	345,674	333,553	403,628	441,576	403,324	503,220	609,474
Total	7,774,588	6,490,231	5,667,893	4,824,883	5,094,800	5,227,490	5,315,848	4,776,663	5,869,764	6,742,948
Total per 1,000 patient-days	44,181	35,974	30,951	27,718	27,031	28,146	27,363	23,933	27,833	31,653
Savings (loss) from previous year		1,284,357	822,338	843,010	(269,917)	(132,690)	(88,358)	539,185	(1,093,101)	(873,184)

NOTE. Costs are in US dollars. FY, fiscal year.

TABLE 2. Utilization Costs for Selected Antibacterial and Antifungal Agents Before, During, and After the Antimicrobial Stewardship Program

	Before	During							After	
	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Antibacterials	3,503,878	3,017,828	3,189,081	2,990,834	3,177,084	3,283,178	3,498,911	3,183,132	4,020,487	4,751,641
Carbapenems	369,047	319,933	326,954	341,042	357,589	277,989	363,596	405,181	548,137	541,279
Imipenem	348,726	257,882	304,715	313,190	342,389	256,860	310,791	348,642	143,578	63
Doripenem	0	0	0	0	0	0	0	0	293,453	420,300
Meropenem	0	0	0	24,506	6,838	15,638	33,966	31,295	79,504	73,093
Ertapenem	0	0	0	3,347	8,362	5,491	18,839	25,245	32,203	47,823
Penicillins										
Piperacillin/ tazobactam	874,728	791,625	880,279	847,236	957,241	1,069,452	1,021,410	877,809	1,339,270	1,465,469
Ampicillin/ sulbactam	206,505	202,394	287,697	259,691	276,605	196,909	193,521	134,874	105,370	63,024
Cephalosporins										
Ceftriaxone	404,352	216,748	332,965	260,586	244,449	278,274	125,188	67,694	44,482	90,231
Cefepime	225,052	173,304	273,947	209,023	222,517	222,385	366,537	271,541	160,392	166,591
Total quinolones	336,773	299,349	203,674	179,896	168,783	177,561	141,323	92,831	47,410	47,348
Ciprofloxacin	155,902	83,542	32,560	27,026	35,442	55,203	79,106	62,319	21,342	17,147
Gatifloxacin	23,359	163,810	155,305	145,216	129,904	95,047	6	0	0	0
Moxifloxacin	0	0	14	56	545	16,183	60,836	30,251	25,852	29,484
Miscellaneous										
Vancomycin	177,830	160,211	136,395	111,177	132,576	149,188	188,117	193,424	249,130	469,830
Linezolid	164,396	136,922	220,484	287,461	258,030	332,132	427,656	343,725	499,845	643,968
Daptomycin	0	0	0	5,074	16,058	79,006	162,501	102,944	254,294	369,779
Tigecycline	0	0	0	0	0	0	0	187,305	274,554	199,766
Metronidazole	177,346	167,516	71,624	27,861	30,869	34,947	28,170	11,673	8,763	20,990
Quinupristin/ dalfopristin	102,858	49,912	12,724	4,158	12,782	7,679	0	8,607	4,321	10,307
Total antifungals	3,710,465	2,926,270	2,011,050	1,458,489	1,605,573	1,513,837	1,343,056	1,154,256	1,268,795	1,268,498
Amphotericin B	64,503	50,567	16,528	1,138	1,126	1,108	1,451	742	660	4,511
ABLC	1,591,090	1,977,355	1,139,801	440,191	464,585	276,213	241,977	157,147	151,587	152,960
LAMP	1,383,179	15,528	12,137	41,623	52,473	267,896	90,221	237,551	175,303	189,373
Fluconazole	604,611	461,486	369,196	361,525	342,970	337,820	251,431	51,127	54,829	31,959
Voriconazole	0	0	234,367	341,298	340,649	374,922	385,788	400,351	505,229	486,359
Caspofungin	23,949	137,780	124,073	222,690	359,473	184,608	172,443	23,956	28,162	26,958
Micofungin	0	0	0	0	0	26,155	160,841	253,678	289,640	284,304

NOTE. Costs are in US dollars. ABLC, amphotericin B lipid complex; FY, fiscal year; LAMP, liposomal amphotericin B.

this 2-year period, the costs of the antifungals as a class increased by approximately $100,000 (9.9%; $P = .34$).

Utilization Costs by Hospital Location

Cost savings after the program was implemented were observed in all 3 major areas of the medical center: the cancer center, the shock trauma center, and the main hospital (Table 3). However, the savings that occurred during the first 3 years of implementation were most apparent in the cancer center (~$2,000,000). Cost savings also occurred in the medical intensive care unit (MICU), the surgical ICU (SICU), and the transplantation service.

Discontinuation of the Program

After the program was discontinued, cost increases were most marked in the main portion of the medical center ($1,585,957), with very little added cost occurring in the cancer center. Costs in the shock trauma center also increased, but a new 12-bed ICU opened in this area at that time. Increases in costs after the ASP was terminated were also noted in the MICU and the SICU.

DDDs per 1,000 Patient-Days

Since 2004, we were able to obtain DDDs per 1,000 patient-days for all of the antimicrobial agents. These are indicated in Table 4 for selected antimicrobials and for the antimicrobial categories. Overall, there was a significant decrease in DDDs from FY 2004 through FY 2008, when the program was terminated. Total antimicrobial DDDs per 1,000 patient-days decreased by 439 (29%; $P = .014$), and for antibacterial agents they decreased by 323 (27.5%; $P = .03$). DDDs per 1,000 patient-days for antifungals and antivirals were also reduced, by

TABLE 3. Comparative Costs of Antimicrobials in Specific Locations

	Before	During							After	
	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Cancer center	3,003,319	2,432,623	1,661,372	966,490	982,074	1,237,998	1,067,555	1,036,283	1,109,035	1,097,686
Shock trauma	798,707	641,530	600,129	690,290	656,022	669,326	701,885[a]	552,297	672,938	921,395
Main hospital	3,972,563	3,416,078	3,427,937	3,167,467	3,454,957	3,317,712	3,546,094	3,186,464	4,063,116	4,772,421
Selected units										
SICU	791,406	341,268	265,699	202,674	207,206	197,553	253,504	183,470	309,148	267,560
MICU	506,960	395,089	187,329	188,550	241,250	245,562	503,242[b]	498,723	699,179	656,267
Transplant	985,471	872,275	594,148	647,068	499,521	505,801	490,991	417,755	393,896	540,069

NOTE. Costs are in US dollars. FY, fiscal year; ICU, intensive care unit; MICU, medical ICU; SICU, surgical ICU.
[a] Increase in number of ICU beds from 24 to 36 on January 1, 2007.
[b] Increase in number of MICU beds from 16 to 29 on April 19, 2006.

24% and 57%, respectively ($P = .001$). After the program was terminated, the overall DDDs per 1,000 patient-days for all antimicrobials increased minimally during the 2-year period (5.2%; $P = .014$). However, there was an increase in the uses of cefepime (14.3%), piperacillin/tazobactam (10.5%), and antibacterials against gram-positive organisms, including linezolid (21.2%), daptomycin (113%), and vancomycin (32.3%). Echinocandin usage also increased, by 121%.

Quality Indicators

Quality indicators, including length of stay, readmissions, and mortality, are noted in Table 5. There were no significant changes in these parameters before, during, or after the program. There were no significant changes in the DRG case mix index after the program ended, indicating that changes in antimicrobial use were not caused by a change in the severity of our cases.

DISCUSSION

ASPs have been recommended to prevent antimicrobial resistance, decrease disease from *Clostridium difficile* infections, and curb adverse reactions to antimicrobials.[5-8] Nevertheless, establishing stewardship programs requires resources. This report focuses on the cost analysis of such a program and demonstrates that the establishment of an ASP incorporating an AMT can be very cost effective in a large tertiary care teaching medical center.

This program resulted in a marked decrease in costs immediately after the program was initiated and a decrease in costs of 37% within the first 3 years. In terms of dollars, this was equivalent to a $3 million decrease in yearly costs over this period of time. Most of this decrease was related to the antifungal category of antimicrobials and was centered in the cancer center and facilitated by guidelines developed addressing this area of concern. Nevertheless, there were significant cost savings with other antimicrobial categories as well. This included antibacterial agents, for which costs decreased over $500,000. The IV-to-PO-switch therapy program resulted in a decrease of $180,000 within the first year of the program. Nor was the decrease in costs entirely centered within the cancer center. The shock trauma center, which has a team of infectious diseases physicians who see the majority of the trauma patients, also experienced reduced antimicrobial costs, particularly of antibacterial agents. The main hospital also experienced reduced costs, including in the MICU, the SICU, and the transplantation service.

Although the cost of antimicrobials appeared to remain stable from 2004 to 2008, an additional reduction of 13.7% occurred when patient-days are considered, in spite of drug price inflation.[9] Also noted during this period was a decrease in DDDs per 1,000 patient-days, from 1,512 to 1,073 (29%) for all antimicrobials.

The benefit of the antimicrobial program was apparent following its introduction, but the strength of this observation is enhanced by the rapid increase in antimicrobial costs that occurred after the program was terminated. Within 2 years these costs increased by 41.2%, or almost $2 million; however, this increase was not related to an increase in the use of antifungals (which were noted to decrease on initiation of the program) but instead primarily involved antibacterial agents. Costs increased with piperacillin/tazobactam, carbapenems, and many of the agents with activity against the gram-positive bacteria, including vancomcyin, daptomycin, and linezolid. External factors may have also partially contributed to this increase in cost. The guidelines for monitoring vancomycin, which called for an increase in its dosing, were published in January 2009, 6 months after our program was discontinued.[10] Also, there was an increase in the number of clinical culture isolates of vancomycin-resistant *Enterococcus* (but not bloodstream infections) in FY 2009 and FY 2010, after the program ended, which also could have contributed to an increase in the use of daptomycin and linezolid.

In 1999, Carling et al evaluated the cost of parenteral antimicrobials in 14 acute care hospitals and found that those 5 facilities that included a system for active prospective intervention that involved a clinical pharmacist and a staff-level infectious diseases–trained physician cost (per 1,000 patient-days) 3%–30% below the mean for all of the hospitals ana-

TABLE 4. Defined Daily Doses per 1,000 Patient-Days of Selected Antimicrobials

	During program					After program	
	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Total antibacterials	1,174	1,023	1,023	990	851	868	867
Quinolones	123	103	100	96	88	81	78
Moxifloxacin	1	1	6.9	41	36	32	32
Gatifloxacin	99	81	59	0	0	0	0
Ciprofloxacin	17	19	28	54	52	49	46
Cephalosporins	201	177	181	190	163	152	159
Cefepime	57	54	57	70	56	59	64
Penicillins							
Piperacillin/tazobactam	98	92	100	91	76	95	84
Carbapenems	25	24	19	26	28	30	30
Doripenem	0	0	0	0	0	14	21
Imipenem	23	23	17	20	22	8.3	0
Meropenem	2.5	0.7	1.6	3.1	2.8	5.4	3.9
Ertapenem	0.5	1.3	0.8	2.7	3.3	2.9	5.1
Miscellaneous							
Linezolid	16.0	12.5	16.5	20.2	15.6	19.6	18.9
Daptomycin	1.0	2.2	7.4	10.9	6.8	10.2	14.5
Vancomycin	85.1	92.6	107	106	99	98	131
Colistin	0.3	0	0	0.1	0.1	3.2	7.7
Tigecycline	0	0	0	0	8.7	13.2	9.2
Antifungals	150	129	129	123	120	139	142
Fluconazole	78	63	66	61	69	71	66
Voriconazole	28	22	27	24	25	31	29
Caspofungin	4.6	9.1	5.7	7.2	0.4	0.4	0.4
Micafungin	0	0	2.2	9.2	14	23	31
Total antivirals	142	99	125	116	63	79	81
Total antimicrobials	1,512	1,303	1,321	1,272	1,073	1,125	1,129

NOTE. FY, fiscal year.

lyzed, and all 5 had costs that were below the those of the 9 hospitals that used only passive measures.[3] Passive measures included measures such as automatic stop orders, antimicrobial order forms, limited formularies, measures to control contact between pharmaceutical representatives and prescribers, educational intervention (eg, institutional guidelines for antibiotic use), and restricted antibiotic susceptibility reporting by the microbiology laboratory. It was partially on the basis of this report that we established an active program with an AMT for active prospective antimicrobial monitoring and intervention.

Prior to initiating the program with the team, there was restriction of antimicrobials and a preauthorization process was in place. Although this process was made simpler using a "BUGS" beeper to call for preauthorization, the basic process that was in use prior to the initiation of the program remained in effect. The addition of the AMT, through real-time monitoring, assured that this preauthorization process was followed and that the information given at the time of the request was accurate. Furthermore, after the program was terminated, use of the "BUGS" beeper for authorization continued but the antimicrobial team was no longer present to assure that the information given to request the antimicrobials was accurate and that the release of the antimicrobials adhered to the policies of the medical center and were appropriate in the treatment situation. Thus, the major implementation in the program was the addition of the AMT.

Another component of the ASP, which enhanced the effectiveness of the AMT, was the use of a computer decision support system.[4] Indeed, this was developed to do what the AMT was already doing, but to make the team more efficient in their duties. This computer program organized and alerted the AMT when restricted drugs were ordered and indicated where the patient resided, other medications the patient was receiving, and microbiologic laboratory results. In addition to notifications of patients receiving "restricted" antimicrobials, some other alerts included notification if a patient was receiving double antimicrobial coverage or no antimicrobial coverage for an identified pathogen and identification of potential candidates for the switch from IV to oral therapy and patients who had received 5 days of antimicrobial therapy without the isolation of potential pathogens. In a carefully controlled blinded study, it was projected that this system saved the UMMC over $600,000, compared with the use of the antimicrobial team without the decision-support system if it were used in the major portion of the medical facility

TABLE 5. Hospital Quality Statistics Before, During, and After the Stewardship Program

	Before	During							After	
	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
Admissions	28,667	28,959	29,702	30,507	30,079	34,752	35,888	35,982	36,447	38,590
Patient-days	175,971	180,416	183,122	184,247	185,462	184,903	192,568	191,697	201,154	205,232
LOS	6.1	6.2	6.18	6.05	6.37	5.48	5.56	5.54	5.74	5.55
Unplanned readmissions	1,533	1,290	1,232	1,496	1,652	1,735	2,080	2,218	2,375	2,164
% of admissions	5.30	4.50	4.10	4.90	4.96	4.99	5.80	6.15	6.02	5.75
Mortality	867	901	908	876	898	1,019	970	983	948	981
% of admissions	3.0	3.1	3.1	2.9	2.9	2.6	2.8	2.7	2.7	2.5
DRG CMI	...	1.638	1.701	1.752	1.792	1.779	1.788	1.762	1.742	1.741

NOTE. DRG CMI, drug-related group case mix index; FY, fiscal year; LOS, length of stay.

for an entire year. When the stewardship program was terminated, the decision-support system was also not continued.

The stewardship program was discontinued because of some dissatisfaction over the preauthorization requirements as well as so that the funding for the program could be used to provide personnel for additional infectious diseases consultation throughout the medical center. The rationale for this change was that infectious diseases experts were the best trained individuals to make the necessary decisions for appropriate therapy in this difficult patient population and thereby could provide antimicrobial stewardship, therefore, rendering the AMT redundant. We cannot say for certain that this would not be an effective strategy, given more time. However, costs have continued to increase and the quality markers have remained stable, suggesting that more and more costly antimicrobials are being used, with no obvious increase in benefit.

In summary, the ASP with a preauthorization protocol using a "BUGS" beeper, an AMT to assure appropriate use, and computer decision-support assistance was an extremely cost-effective model for antimicrobial stewardship over a period of 7 years, and its discontinuation has proven to be very costly. On the basis of this information an ASP using an AMT has been restarted, but an automatic infectious diseases consult has replaced the preauthorization requirement for "restricted" antimicrobials.

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