



Major Article

Phased implementation of an antimicrobial stewardship program for a large community hospital system



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Background: Antimicrobial stewardship is recommended as a crucial mechanism to reduce the emergence of antimicrobial resistance. The purpose of this article was to describe implementation of antimicrobial management programs (AMPs) across a large health system of community hospitals.

Methods: The initiative was structured in 4 phases. Although each phase was implemented sequentially, facilities could progress at their own pace. Phase goals needed to be met before moving to the next phase. The 4 phases included preparatory, foundational, clinical care optimization, and refinement. A survey was administered prior to the initiative in 2010, and modified surveys were administered in 2015 and 2017.

Results: Stewardship activities improved in most areas of the AMP initiative in 2015, with substantial improvement by 2017. Important changes included an increase in established programs, from 82% in 2010 to 88% and 96% in 2015 and 2017, respectively. Physician Champions increased from 73% in 2010 to 94% in 2017. Advances were made in the use of evidence-based treatment recommendations, antibiogram development, prospective audit and feedback for antimicrobials, tracking of antibiotic usage metrics, and a cost reduction of 40% from baseline.

Conclusion: A well-designed, phased approach to implementing AMP can help community hospitals and hospital systems recognize substantial clinical and financial benefits.

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The increased prevalence of antimicrobial-resistant pathogens threatens patient safety through prolonged hospital stays, higher treatment costs, and higher mortality rates.^{1–6} Among the pressures contributing to the selection and spread of antimicrobial-resistant pathogens are the overuse and misuse of antimicrobials in the healthcare environment.^{7–10} Inappropriate antimicrobial use increases the risk of toxicity, increases adverse drug reactions and interactions, underlies unnecessary expenditures, and promotes the development of antibiotic-resistant organisms. It has been

estimated that 20%–50% of antibiotics prescribed in acute care facilities are unnecessary or inappropriate.^{11–14}

Antimicrobial stewardship has been recommended as a crucial mechanism for optimizing antimicrobial therapy to reduce the emergence of resistance and minimize the unintended consequences of antimicrobial use.^{15–17} Implementation of antibiotic stewardship programs is a key objective in the *National Plan for Combating Antibiotic-Resistant Bacteria*¹⁸ as well as a required standard from The Joint Commission, effective January 1, 2017.¹⁹ Other recognition of the importance of antimicrobial stewardship initiatives comes from the National Quality Forum (NQF),²⁰ the LeapFrog Group,²¹ and the Centers for Medicaid and Medicare Services—the latter of which proposes that antibiotic stewardship programs be considered as a requirement for participation.²² Although substantial progress has been made in the implementation of antimicrobial stewardship programs, there is still room for improvement: only approximately 39% of hospitals in the United States report having an antimicrobial stewardship program that meets all recommended elements.²³

The ability to implement a system-level change for antimicrobial stewardship is a challenge for health systems and for public

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agencies, such as individual state health departments and the Centers for Disease Control and Prevention (CDC). Guidelines from the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America, first released in 2007⁸ and revised in 2016,²⁴ specify the wide range of interventions that can comprise an antimicrobial stewardship program. These programs must be customized and implemented at the institutional level based on local factors, such as resistance patterns, facility size, infrastructure, and prescriber behaviors. While difficult for any institution, few reports have described how community hospitals adapt interventions and implementation strategies to best meet their needs and capabilities. Even fewer publications have provided guidance for a system-level change, and a broad system change is needed to have the most impact in reducing antimicrobial resistance. Here we describe the implementation of antimicrobial stewardship programs across a network of community hospitals. This implementation used a phased approach to allow facilities to focus on incremental efforts while building momentum toward a large mosaic of accomplishment in operational and financial outcomes over time.

METHODS

Setting

This initiative was developed and implemented within the Hospital Corporation of America (HCA) Healthcare system. This system currently comprises 178 acute care facilities across 20 U.S. states and the United Kingdom, as well as ambulatory surgery centers, free-standing emergency facilities, and physician practices. Acute care facilities are primarily large general community hospitals but also include academic health centers and large, tertiary-referral hospitals. Collectively, these facilities provide approximately 5% of major hospital services in the United States. Centralized corporate functions include enterprise financial operations, setting of organizational goals and clinical policies, formulary guidance, and measures for improvement. Other functions include provision of educational continuing education, dashboards with targeted metrics, and strategic coaching calls for sharing of best practices.

This HCA Antimicrobial Management Program (AMP) initiative was shared with all HCA-affiliated acute care facilities in the United States. The initiative was facilitated by a multidisciplinary team at the corporate level. This team consisted of clinical experts from pharmacy, infection prevention, laboratory, and information technology; an infectious disease physician; and representation by senior leadership. Preparatory work, conducted in 2009, included the development of a business case and proposal for senior leadership that focused on antibiotic overuse and waste and community concerns about multidrug-resistant organisms. The strategic decision was made to commit the resources to staff training and antimicrobial stewardship efforts to preemptively prepare for future resistance patterns.

Survey of Existing Antimicrobial Stewardship Efforts

A survey was designed to identify areas of opportunity and form the basis of action plans for the HCA AMP initiative. Survey questions included identification of antimicrobial stewardship leadership, training and time commitment for Physician and Pharmacy Champions, current actions to support optimal antibiotic use, pharmacy-driven interventions, laboratory capabilities, tracking and monitoring activities, and current educational programs.

A pre-implementation survey was distributed in 2010; a modified version of the survey was distributed in 2015 and 2017. Each follow-up survey featured revised questions that focused on gathering information about the implemented HCA AMP initiative

Table 1
Implementation phases and key tasks

Phase	Key tasks
Phase 1: Preparatory Work	- Establishing a multidisciplinary team - Identifying physician and pharmacist expertise
Phase 2: Foundational Work	- Formulary evaluation - Core measure and antimicrobial use processes - Dose optimization, including pharmacokinetic and pharmacodynamics dosing - Establishing intravenous-to-oral and renal dosing programs
Phase 3: Clinical Care Optimization	- Implementation of evidence-based guidelines for common infections - Microbiology standard practices - AMP metrics: spend, antibiotic use, antibiogram, and process measures
Phase 4: Stewardship Refinement	- Workflow efficiency - Focus on de-escalation and duration of therapy

components. The survey was completed at the facility level, with assistance from the corporate HCA AMP team. The survey was completed by all facilities that were part of the HCA network at the time of survey distribution.

Implementation Process

The HCA AMP initiative was structured in 4 phases (Table 1). Although each phase was implemented sequentially, facilities could progress at their own pace within each phase (Fig 1). Since the components for each phase built upon the previous, goals for each phases (i.e., the key tasks listed in Table 1) needed to be met by an individual facility within a specified timeframe before work could begin on the next phase.

Phase 1 consisted of preparatory work to ensure that hospital staff at each facility understood, embraced, and executed the principles of antimicrobial stewardship. Central to this phase was the construction of a facility-based multidisciplinary team focused on HCA AMP initiative implementation and the identification of physician and pharmacist subject matter experts. At each facility, this team helped drive the completion of a facility self-assessment and action plan. The team also ensured completion of relevant education and competencies by subject matter experts and other stakeholders who would be participating in the HCA AMP initiative. The chief executive officer of the facility served as an ad hoc member of the AMP team, with bidirectional communication to ensure alignment with facility goals and access to necessary resources.

Phase 2 consisted of foundational work that outlined how implementation of the HCA AMP initiative strategies would change the use of antimicrobials over time. Each facility evaluated its antimicrobial formulary and reviewed core measures and processes related to antimicrobial use. All facility pharmacists, including the AMP Pharmacy Champion, were asked to complete antimicrobial dose optimization training, which included topics such as weight-based dosing, pharmacokinetic and pharmacodynamic (PK/PD) approaches, renal adjustments, and intravenous-to-oral (IV-to-PO) conversions. The overall completion rate for these courses was higher than 80%. In addition, facilities that had not already implemented the previously listed strategies were asked to review and implement weight-based, PK/PD, and renal dosing in addition to protocol-driven IV-to-PO policies and procedures. Example policies, protocols, and resources to take to committees for discussion were provided to assist with implementation. Educational programs featuring reminders of basic infection prevention best practices were distributed for facilities to use as needed.

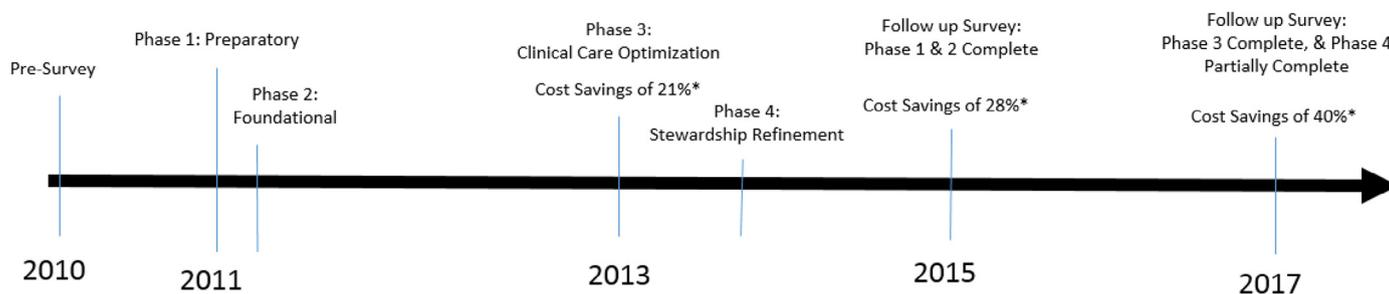


Fig 1. Timeline of AMP implementation across a large community health system. *Cost savings calculated on spend from 2010 prior to AMP phase implementation.

Phase 3 was the clinical care optimization stage. Facilities addressed more complex antimicrobial stewardship initiatives and/or involved more stakeholders. Objectives of this phase included implementation of evidence-based treatment guidelines for common infections, including antimicrobial criteria; microbiology standard practices; and tracking of hospital performance using common metrics.

Phase 4 was stewardship refinement. This phase focused on helping facilities refine their antimicrobial stewardship approach and workflow efficiency. Facilities focused on review of antimicrobial therapy during team rounds and assured that the local antibiogram was updated and accessible to clinicians. De-escalation and duration of therapy techniques were emphasized, and active treatment regimens were adjusted based on new information about patient condition.

The implementation of all 4 phases was supported by the corporate HCA AMP team and enterprise-wide resources. The corporate HCA AMP team conducted monthly coaching calls that allowed facilities to share local best practices and practical implementation guidance. Toolkits were created and accessible through the corporate intranet, and facility AMP teams could contact subject matter experts via email or phone. Enterprise-level informatics expertise and financial resources were committed to surveillance technologies to streamline stewardship workflows. This included the implementation of clinical pharmacist and infection prevention surveillance software and the development of clinical decision support within the electronic health record for antibiotic criteria of use and duration of therapy. The corporate HCA AMP team provided standardization, training, and maintenance for surveillance software.

Analysis

The survey of practices was distributed electronically via Survey Monkey (www.surveymonkey.com). Data were collected for each facility and compiled for facility-, division-, and enterprise-level results. Responses were compared for the pre-implementation survey (distributed in 2010), the mid-implementation survey (distributed in 2015), and the post-implementation survey (distributed in 2017).

Total antibiotic spend was collected from enterprise-level supply chain data. Yearly antibiotic cost per adjusted patient day was calculated from total spend and total number of patient days for all facilities in a given year.

RESULTS

Responses to the survey of antimicrobial stewardship efforts are presented in [Table 2](#). The pre-implementation survey distribution in 2010 revealed that many facilities had already begun implementation of some antimicrobial stewardship activities, including the establishment of a team dedicated to the implementation of the HCA

AMP initiative. The number of facilities that indicated participation in antimicrobial stewardship activities increased for most, but not all, HCA AMP initiative components in 2015, and there was an overall increase by 2017. The total number of facilities responding to the survey increased from 147 in 2010, to 153 in 2015, and to 157 in 2017; the survey was completed by all facilities that were part of the HCA network at the time of survey distribution.

Survey respondents were asked to estimate the number of hours per week that the AMP Physician Champion devoted to AMP-related activities. In 2010, 85% (61/72) of respondents indicated that the AMP Physician Champion spent less than 10 hours per week on AMP; 15% (11/72) indicated more than 10 hours per week. In 2015, 47% (21/44) of respondents indicated that the AMP Physician Champion spent less than 10 hours per week on AMP; 52% indicated more than 10 hours per week. The question was not included in the 2017 survey.

Total antibiotic cost per adjusted patient day was measured for all participating facilities. Using a baseline of 2010 cost (prior to the rollout), by 2015 there was a 28% reduction in total antibiotic spend, and by 2017 the total cost savings was 40% from baseline.

DISCUSSION

A phased rollout of antimicrobial stewardship interventions was successful in driving improvements in operational and financial outcomes in a large system of community hospitals. This phased approach allowed facilities to focus on incremental efforts toward more immediate goals, such as optimizing antibiotic selection, dose, and duration, as well as reducing adverse drug events, including secondary infection. As seen with the mid-implementation survey in 2015, most facilities increased their use of antimicrobial stewardship activities supported by the AMP initiative. In 2016, with the regulatory focus on antimicrobial stewardship, the HCA AMP initiative revamped the toolkits and elevated the coaching calls to include senior leadership distribution lists. The results confirm that Phases 1-2 of antimicrobial stewardship had been implemented by facilities in 2015, and Phases 3 and 4 were in progress with implementation by 2017 ([Fig 1](#)). These operational improvements helped drive down total antibiotic cost across the system and were sustainable throughout the phased implementation. These successes helped build momentum for the overall larger goals of improved patient outcomes, reduced morbidity and mortality, prevention or slowing of the emergence of antimicrobial resistance, and reduced healthcare expenditures by limiting antimicrobial waste and preventable patient complications.

The phased approach of this implementation was central to its success. Each phase was clearly laid out with checklists and step-by-step implementation suggestions. Facilities had access to tools that were developed and reviewed by subject matter experts. The corporate AMP team provided support and tools and also served as a model for the structure and function of the multidisciplinary

Table 2
Survey of antimicrobial stewardship activities in participating facilities, pre-implementation (2010), mid-implementation (2015), and post-implementation (2017)

Survey question	2010*	2015 [†]	2017 [‡]
	% Yes (n)	% Yes (n)	% Yes (n)
<i>HCA AMP team characteristics</i>			
AMP team established at facility	82% (120)	88% (134)	96% (151)
Facility has a Physician AMP Champion	73% (107)	83% (127)	94% (147)
AMP Physician Champion time contracted by the facility	25% (37)	41% (62)	76% (119)
AMP team representation by other physician team members:			
Intensivist	4% (6)	11% (17)	N/A
Hospitalist	11% (16)	27% (42)	N/A
Emergency Room Physician	2% (3)	11% (17)	N/A
Surgeon	0% (0)	5% (8)	N/A
Visible leadership support for HCA AMP	48% (71)	55% (84)	90% (142)
CMO aware of AMP team structure and goals	39% (58)	58% (89)	68% (107)
CMO is member of the AMP team	21% (31)	42% (64)	48% (76)
<i>Foundational Activities</i>			
Pharmacist-authorized automatic IV-to-PO policy in place	92% (135)	90% (138)	93% (146)
Pharmacist-authorized automatic renal dose adjustment policy in place	96% (141)	99% (151)	97% (152)
De-escalation incorporated into staffing assignments	80% (117)	84% (129)	99% (157)
Pharmacist-authorized PK/PD dose adjustment program in place	63% (92)	91% (139)	94% (147)
Facility antibiogram produced	78% (114)	96% (147)	97% (153)
AMP Pharmacy Lead is clinical pharmacist with PGY-2 training, SIDP training, or MAD-ID training	45% (66)	47% (72)	50% (78)
<i>Clinical Care Optimization Strategies</i>			
Evidence-based treatment recommendations for			
Pneumonia	90% (132)	N/A	N/A
Community-acquired pneumonia	N/A	85% (130)	90% (142)
Hospital-acquired pneumonia	N/A	78% (119)	86% (135)
Urinary tract infections	31% (45)	54% (81)	75% (118)
Skin and soft tissue infections	27% (39)	53% (81)	69% (108)
Surgical prophylaxis	N/A	80% (123)	87% (137)
Methicillin-resistant <i>Staphylococcus aureus</i>	56% (82)	45% (69)	50% (79)
<i>Clostridium difficile</i> infection	60% (88)	55% (84)	70% (110)
<i>Staphylococcus aureus</i> bacteremia	N/A	25% (38)	40% (63)
<i>Candida</i> infections	N/A	8% (12)	19% (30)
Formulary restriction and preauthorization	68% (100)	62% (95)	81% (127)
Implementation of drug use guidelines and/or criteria for use recommendations	56% (83)	59% (91)	80% (126)
Implementation of medication use evaluations	61% (89)	56% (85)	69% (109)
Pharmacist prospective audit and feedback for antimicrobials	58% (85)	78% (120)	83% (130)
Tracking of DDD or DOT per 1,000 patient days	54% (79)	67% (103)	100% (157)

AMP, Antimicrobial Management Program; CMO, chief medical officer; N/A, question not asked in survey; IV, intravenous; PO, oral; PK/PD, pharmacokinetic/pharmacodynamic; DDD, defined daily dose; DOT, days of therapy; PGY, postgraduate year; ID, infectious diseases; SIDP, Society of Infectious Diseases Pharmacists; MAD-ID, Making a Difference in Infectious Diseases.

*Total number of responses = 147.

[†]Total number of responses = 153.

[‡]Total number of responses = 157.

team that was recommended to lead implementation at the facilities. These factors gave facilities the flexibility to develop a stewardship program and implementation plan that was specific to their patient population and resources. Implementation progress was encouraged through accountability for each phase. Division-level pharmacy leaders promoted this accountability by obtaining regular updates from facilities as needed.

Despite these well-designed phases for implementation, there was still variation in the speed and extent of uptake by individual facilities. The program was designed to allow for this flexibility and be responsive to local priorities and resources. Division-level pharmacists and the corporate AMP team aided facilities in addressing barriers to implementation. Assistance included developing the business case to obtain a dedicated full-time pharmacist for AMP activities, policy development, workflow evaluation, creation of educational resources, and championing Making a Difference in Infectious Diseases and Society of Infectious Diseases Pharmacists training. Implementing and maintaining evidence-based treatment recommendations for *Candida*, *Staphylococcus aureus*, and *Clostridium difficile* infections remained an area of opportunity after implementation. This has been addressed with additional comprehensive initiatives, including education, coaching calls, treatment algorithms, and other toolkit resources. Formulary restriction and preauthorization was also difficult to sustain; clinical decision support at the time of provider order entry has been implemented to assist with this. Regulatory groups and their focus on antibiotic stewardship allowed Phase 4 to include specific expectations for implementation with targeted dates of completion. These expectations mirrored the recommendations from the CDC Core Elements and the NQF Playbook.^{20,25} Targeted goals were shared with all facilities in September 2016, and the 2017 survey was distributed in April 2017. This additional level of accountability with target dates of completion spread out over 2016 and 2017 permitted rapid adoption and support of Phase 4 objectives, as confirmed by the results of the 2017 survey.

At the time of this program, few existing models existed for the implementation of antimicrobial stewardship programs in community hospitals or across a large hospital system. Thus, the initiative described here was a new strategy that combined existing resources with best practices in implementation derived from experiences with previous deployments in this large hospital system. This initiative also benefited from the diversity of experiences encountered at various facilities. Feedback and best practices from individual facilities were reported to division-level pharmacists and the corporate AMP team, which helped inform refinements to the implementation program that were continuously shared with all facilities. A similar process could be applied to a group of hospitals working together in a region or state to implement stewardship programs. Although a facility or system considering a similar program may not have access to these sources of institutional knowledge, multiple tools are available from the CDC and the NQF that provide strategies and suggestions for the implementation of antimicrobial stewardship programs.^{20,26}

One limitation of this initiative was the lack of objective metrics for implementation. Both the pre-implementation and post-implementation surveys relied on the subjective measurement of whether a particular process or intervention had been implemented. Additional initiatives that have been implemented, such as the appropriate treatment of *S. aureus* bacteremia, require more specific objective metrics. Although we recognized this limitation during the implementation, we chose not to assign objective metrics at that time, because such a requirement would have complicated the already complex implementation process. Objective metrics for outcomes, processes, and antimicrobial consumption have since been developed for specific AMP initiatives after implementation to allow for comparison between facilities.

The clearly defined phases of implementation for an antimicrobial stewardship program allowed for a large degree of customization by individual facilities. As a result, facilities are now well poised to implement more specific interventions focused on disease states or aspects of antimicrobial stewardship, such as duration of therapy or de-escalation. Thus, the incremental gains from the phased

implementation not only built upon each other but also form the foundation for future efforts. As this implementation demonstrated, engagement of facility leadership and Physician Champions is critical to the success of antimicrobial stewardship programs, as are continued education and sharing of best practices. In total, a well-designed, phased approach to implementing antimicrobial stewardship programs can help community hospitals fully recognize sustainable clinical and financial benefits of these programs.

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