Contents lists available at ScienceDirect

American Journal of Infection Control

Major Article

Implementation of a nurse-driven antibiotic engagement tool in 3 hospitals

Elizabeth Monsees PhD, MBA, RN, CIC, FAPIC [a,*], Brian Lee PhD, MPH [b], Anne Wirtz PharmD, BCPPS [c], Jennifer Goldman MD, MSCR [d]

[a] Patient Care Services Research, Children's Mercy Hospital, Kansas City, MO
[b] Health Services and Outcomes Research, Children's Mercy Hospital, Kansas City, MO
[c] Department of Pharmacy, Children's Mercy Hospital, Kansas City, MO
[d] Division of Infectious Diseases, Children's Mercy Hospital, Kansas City, MO

Key Words:
Antibiotic stewardship
Nurses
Interprofessional communication
Duration
Leadership

Background: Nurses are key in implementing antibiotic stewardship; however, standardized processes are lacking.

Methods: This feasibility study tested implementation of a nurse-driven antibiotic engagement tool (AET) that addressed antibiotic indication, duration, discontinuation, and intravenous to oral conversion. An investigator-developed survey measured nurse satisfaction, confidence, and understanding of antibiotic plan of care among 4 clinical units. Mann-Whitney U was used to compare differences between time periods. Nonparametric summary distributions assessed AET use.

Results: Results from 121 surveys were available; 71 (36%) presurvey, 50 (24%) postsurvey. Thirteen registered nurses reported satisfaction or agreement with AET use: (1) ease (median: 4 [2.25, 4]); (2) time (median: 4 [3.5, 4.5]); (3) helped facilitate asking questions (median: 4 [3, 4]); (4) helped find antibiotic information (median: 4 [2.5, 4]); and (5) increased confidence in antibiotic discussions (median 4 [3, 4]). Planned duration of antibiotic therapy was unclear to nurses 13.9% of the time with nurses identifying duration discrepancies in 22.8% of submitted AETs.

Conclusions: The AET promoted interprofessional conversation. Use was higher in settings where leaders and nurse influencers were involved in stewardship promotion. Clarifying antibiotic duration is a prime area for future nursing antibiotic stewardship efforts.

Recommendations from the Centers for Disease Control and Prevention and the American Nurses Association identify staff nurses as critical players in the antibiotic stewardship movement, though their role is not established nor well-defined.[1] Nurses are the largest cadre in healthcare, with significant influence on care, and should play a key role in assuring that antibiotic stewardship processes are integrated into practice. Nurses are uniquely positioned to deploy stewardship strategies across the health care continuum and serve as a central hub for care integration which directly influence antimicrobial prescribing. Four nursing activities have previously been identified as crucial to improving use and optimization: (1) clarifying antibiotic indication and assuring the desired antibiotic duration is administered, (2) discontinuing the antibiotic at the desired end of therapy, (3) obtaining specimens for microbiology testing, and (4) identifying opportunities to convert from intravenous (IV) to oral (PO) therapy where appropriate.[1,2]

BACKGROUND

Despite calls to enlist nurses into the antibiotic stewardship activities, there is a knowledge gap of how to successfully integrate this process. Several studies revealed that nurses acknowledge their role in stewardship and are confident to perform practices supporting stewardship, yet education is sparse, and they feel dissatisfied when their participation is limited by a lack of involvement in antibiotic decisions.[3-7] Furthermore, organizational safety culture has been

shown to inhibit nurse participation despite nurses' strong desires to participate as frontline stewards.[8]

The primary aim of this study was to implement a nurse-driven antibiotic engagement tool (AET) that addresses 4 critical activities in antibiotic optimization: (1) clarifying antimicrobial indication, (2) examining duration, (3) discontinuing therapy, and (4) converting from IV to PO therapy.[3,9,10] The secondary aim was to evaluate the effectiveness the ADIOS AET on nurses' confidence, satisfaction, and understanding of antibiotic plans of care on 4 participating units to evaluate the feasibility of the implementation.

METHODS

Design and setting

Four clinical units from 3 not-for profit hospitals located in 1 central United States metropolitan area participated in this study. Hospital A is a 367-bed, free-standing pediatric academic medical center. Hospital B (226-bed) and Hospital C (451-bed) are adult, community hospitals. All hospitals have active antimicrobial stewardship programs and electronic medical record (EMR) systems, which contain medication administration records (MAR). All 3 hospitals have mandatory antimicrobial indications and durations translated as ordered discontinuation dates on the MAR.

The investigator-developed AET was designed by multispecialty nurses to overcome challenges associated with exchanging information between services, disciplines, and facilities. Two antimicrobial stewardship program pharmacists, an infectious diseases physician, a hospitalist, a nurse researcher, 4 frontline medical/surgical nurses, and 7 operational leaders collaborated to identify key components for assessing antibiotic use and incorporated those details into the AET. Key information evaluated included 5 basic principles for an antibiotic assessment where each letter formed the successive parts of the acronym "ADIOS" (Fig 1): (A) presence of an **a**ntimicrobial, (D) planned (ie, prescriber desired stop date) and ordered (ie, discontinuation date on MAR) **d**uration, (I) **i**ndication, (O) transition from intravenous to **o**ral, and (S) **s**ummary of any additional nursing observations (eg, sluggish line). Multiple iterations of the AET were evaluated by nurses represented on the interdisciplinary group to assure content was winnowed to the 5 essential elements and an acceptable length. Corresponding education was developed and presented on the reverse side of the ADIOS AET to help guide the user through the assessment (Fig 2). The general format of the AET was modeled after the Kamishibai cards (K-cards), used in Lean methodology to aid in practice audits.[11] This approach has been used in infection control to prevent central line-associated bloodstream infections.[11] After the K-card prototype was prepared, 2 pharmacists and 2 infection preventionists reviewed the AET and educational content with stakeholders in their respective facilities for consensus. Modifications were incorporated into a final AET for adult and pediatric sites.

AET collection

Based on the recommendations of the interdisciplinary group, a pre-post intervention design was selected and focused on communication of antibiotic information (ADIOS) during care activities, in particular patient care transitions. Care transitions were operationally defined as: (1) a transfer of a patient's care between services, (2) a patient admission, and (3) a patient discharge. The AET was trialed on each unit for 6 weeks. Nurses who participated in the interdisciplinary group recommended providing the ADIOS AET and inviting nurses to complete it for each patient who was receiving an antimicrobial and record the type of transition. Paper copies of the AET were available on the nursing units as an available resource; use and

Fig 1. ADIOS antibiotic engagement tool.

submission were per nurse discretion. For this study, AET use was defined as a nurse's report of using any of the 5 elements on the ADIOS AET. Paper copies of the ADIOS AET were collected at Hospital A and B, if submitted voluntarily by the nurse completing the form. Paper copies were collected and analyzed by reviewers at hospital A

ADIOS Antibiotic Engagement Tool Education

Nurses should ensure patients receive the **right antimicrobial** for the **right indication** & **right duration** to prevent harm.

Harm from antimicrobials includes antibiotic resistance, antibiotic side effects, C. difficile infections, & increased cost

What is an Antimicrobial?

- Antimicrobials = antibiotics, antifungals, antivirals
- **Antibiotics** treat bacteria
- **Antifungals** treat fungi
- **Antivirals** treat viruses
- **Where to find this?** Order on MAR

What is the planned Duration?

- Being aware of the planned duration is important to prevent patients from **missing necessary doses** or **receiving unnecessary doses**
- Length of treatment is often selected from guidelines or chosen specifically for a patient
- **Common Durations (ranges <u>may vary per patient</u> −** consider discussing with MD/pharmacist)
- **Where to find this?** Progress notes, MAR stop date

What are Indications for Antimicrobials?

- Considering the indication is **useful when selecting treatment** and reassessing once cultures result
- Including indications **helps communicate complete treatment plans** with patients/families
- **Prophylaxis** = prevent infection
- **Treatment** = treat active infection
- **Non-Infectious** = used for other indications besides infection
- **Where to find this?** Progress notes, order on MAR

Why is it important to transition to oral therapy?

- IV to PO transitions minimize **line entries,** complications & reduce cost
- RNs can **evaluate if patients are improving** or tolerating PO to help determine treatment while collaborating with MDs/Pharmacists on the route
- IV antibiotics are required for endocarditis, meningitis, CLABSI, or other serious infections
- For patients able to take oral medications, Pharmacists can help identify potential formulary options

Suggestions for future education?

Fig 2. ADIOS antibiotic engagement tool education.

and B. Hospital C elected not to use paper copies, rather the AET was laminated on the nurses' bedside charting station to serve as a conversation tool; therefore, data collection and analyses were not included for this site. All sites underwent a review and approval by either an Institutional Review Board or an internal quality improvement council and were approved to participate in this study.

Survey design

To evaluate the effectiveness the ADIOS AET on nurses' confidence, satisfaction, and understanding of antibiotic plans of care, the team developed an anonymous survey using the web-based Research Electronic Data Capture application to collect data from nurses a month prior ("pre-survey") and a month after ("post-survey") they were exposed to the intervention.[12] Pre- and postsurvey responses were not matched. Survey data were collected only from nurses who reported to be direct care registered nurses or licensed practical nurses and were collected from all 3 hospital sites.

The presurvey contained 20 questions that focused on nursing confidence and communication regarding stewardship practices. The instrument was modeled from 2 recent stewardship studies describing nursing practices that impact stewardship processes and antibiotic prescribing.[3,9] Nurses were asked 8 questions on their confidence performing a number of nursing practices (eg, assessing for an adverse drug reaction) and 7 questions regarding antibiotic stewardship communication and understanding of antibiotic plans of care. All confidence and communication questions were scored using a 5- point Likert-scale to measure perceived confidence or agreement. Higher scores indicated more confidence or better communication. Five demographic questions were included to evaluate experience and education.

The post-survey had 35 questions, including the same 15 confidence and antibiotic plan questions and the 5 demographic questions from the pre-survey. Nurses were also asked if they used the AET at least once, and if so, 13 additional questions addressed whether the AET improved nurses' understanding of the antibiotic plan of care, general use (eg, time to use and frequency), and satisfaction with the tool. Data were collected on the nurses' opinions of communication openness among teams, which is defined as the freedom to ask questions or speak up when in the presence of those with more authority, and were modified questions from the Agency for Healthcare Research and Quality Hospital Survey on Patient Safety Culture. Two of the 13 questions assessed when the nurses used the tool, either during shift-to-shift handoffs or patient transfer. Nurses were encouraged to elaborate on the ADIOS AET or antibiotic stewardship practices in 2 corresponding free text comment fields.

Each site coordinator was provided talking points about the survey to market the study to colleagues. The recruitment e-mails included the informed consent process and online survey link. Each survey remained open for 1 month, and 2 reminder emails were sent.

Analysis

The pre-and post-survey summary distributions of the 8 general stewardship questions and 7 confidence questions were calculated and the Mann-Whitney U test was used to compare differences between time periods. The proportion of ADIOS AET use was calculated for several demographic features (eg, time since graduation, time worked at hospital, highest degree, and shift), and distributions were compared using Pearson's chi-square test. Non-parametric summary distributions of the satisfaction with the ADIOS AET, as well as frequency of AET use, was assessed during antibiotic use, handoffs, and patient transfers and is reported for nurses who used the AET. Free-text comments were reviewed to inform future study. All analyses were completed using SPSS, version 25.0.

RESULTS

Completed AETs

Seventy-nine AETs were completed and voluntarily returned (Table 1). Hospital B demonstrated the greatest frequency with tool

Table 1
Completed AET responses

	AET responses (N = 79)
Unit	
Hospital A Unit 1	4 (5.1%)
Hospital A Unit 2	14 (17.7%)
Hospital B	61 (77.2%)
Hospital C	0 (0%)
Transition type	
Shift-to-shift	52 (75.4%)
Patient transfer	12 (17.4%)
Other	5 (7.2%)
Planned stop date	
Yes	50 (63.3%)
No	18 (22.8%)
Couldn't find in MAR	11 (13.9%)
Documented Indication	
Yes	73 (97.3%)
No	2 (2.7%)
Consistently eating	
Yes	59 (76.6%)
No	14 (18.2%)
I don't know	4 (5.2%)
Able to take meds	
Yes	69 (95.8%)
No	3 (4.2%)

AET, antibiotic engagement tool; MAR, medication administration records.

Table 2
Respondent demographics

	Presurvey (N = 71)	Postsurvey (N = 50)	P value
Hospital			.756
Hospital A	51 (71.8%)	33 (66%)	
Hospital B	12 (16.9%)	11 (22.0%)	
Hospital C	8 (11.3%)	6 (12.0%)	
Time since graduating from nursing school			.989
Less than 1 year ago	3 (4.3%)	2 (4.0%)	
1-5 years ago	26 (37.1%)	20 (40.0%)	
6-10 years ago	16 (22.9%)	10 (20.0%)	
11-15 years	7 (10.0%)	6 (12.0%)	
More than 15 years ago	18 (25.7%)	12 (24.0%)	
I have worked at this hospital			.934
Less than 5 years	37 (53.6%)	24 (48.0%)	
5-10 years	15 (21.7%)	13 (26.0%)	
11-15 years	5 (7.2%)	4 (8.0%)	
More than 15 years	12 (17.4%)	9 (18.0%)	
Highest degree			.601
RN diploma	0 (0.0%)	1 (2.0%)	
RN assoc.	11 (15.7%)	6 (12.0%)	
RN BSN	46 (65.7%)	36 (72.0%)	
Master's	12 (17.1%)	7 (14.0%)	
Other	1 (1.4%)	(0.0%)	
Shift worked			.252
Nights	29 (41.4%)	26 (52.0%)	
Days	41 (58.6%)	24 (48.0%)	

use (77.2%). An overwhelming majority of nurses (97.3%) knew why the patient was actively receiving an antibiotic. Planned duration of antibiotic therapy was unclear to nurses 13.9% of the time with nurses identifying duration discrepancies in 22.8% of submitted AETs. Nurses commented that they were unclear about the duration when multiple antibiotics were ordered.

Survey respondents

A total of 197 (114 from Hospital A, 22 from Hospital B, and 61 from Hospital C) and 209 (123 from Hospital A, 25 from Hospital B, and 61 from Hospital C) nurses were invited to participate during the pre- and postsurvey, respectively. The pre-post differences in the number of eligible subjects resulted from normal nurse turnover and staffing variations. A total of 121 participants (71 presurvey, 50 postsurvey) completed the survey. Of these, 2 did not select registered nurses or licensed practical nurses and were removed from the analysis. The overall response rate for the presurvey was 36% (71 nurses), whereas the post-survey had a 24% response rate (50 nurses). The response rate varied during the presurvey and postsurvey; however, the participant distributions by hospital did not change (Table 2). The majority of nurses in the presurvey (n = 37) and postsurvey (n = 24) had been working at the hospital for less than 5 years. Approximately 85% of respondents had a baccalaureate or master's degree in nursing.

Understanding and confidence

Pre-survey results demonstrated nurses strongly agreed in understanding the importance of assuring that cultures were obtained before antibiotics are initiated (median: 5 [interquartile range (IQR): 4, 5]) (Table 3). However, nurses tended to report lower confidence identifying wrong antibiotics dosing (presurvey median: 3.5 [IQR: 2, 4]). The distribution increased in the following postsurvey confidence and agreement responses: (1) they are knowledgeable about antibiotic stewardship (median: 4 [IQR: 4, 4]), (2) satisfied with the exchange of information with pharmacists (median: 4 [IQR: 4, 5]), and (3) have a good understanding of where to find antibiotic information within the patient's medical record (median: 4 [IQR: 4, 4]).

Differences in the distributions between time periods were not considered statistically significant.

Reported AET use

In the post-survey, 13 of 50 nurses (26%) reported using the AET (Table 3). Nurse unit and educational level were significantly related to AET use. Among those 13 nurses who reported using the tool, they: (1) were satisfied with the ease of tool use (median: 4 [IQR: 2.25, 4]), (2) were satisfied with the amount of time it took to use the tool (median: 4 [IQR: 3.5, 4.5]), (3) agreed the tool helped them to ask questions when something did not seem right (median: 4 [IQR: 3, 4]), (4) agreed that the tool helped them to develop a better understanding of where to find antibiotic information in the medical record (median: 4 [IQR: 2.5, 4]), and (5) were more confident to be involved in antibiotic discussions (median 4 [IQR: 3, 4]) (Table 4). Nurses reported using the AET more frequently for nurse-to-nurse handoffs (30%) rather than when transferring patients (7.7%).

DISCUSSION

This multisite study engaged direct care nurses in the deployment of an antibiotic assessment tool to address 4 points of antibiotic optimization during care transitions with the primary aim being to test the implementation followed by examining nurse confidence, satisfaction, and understanding of antibiotic plans to evaluate the feasibility of the implementation. Three noteworthy findings were identified through the course of the study. First, nurses identified discrepancies in antibiotic stop dates. Second, nurses found the ADIOS AET to help ask questions and improve confidence to be involved in antibiotic discussions. Finally, AET use varied by hospital unit. Anecdotally, the study team observed that units who used the AET more frequently had a higher level of leadership involvement.

Although antibiotic duration has been identified as an opportunity for nurses to steward by confirming the intended duration is actually occurring, determining intended antibiotic duration can be challenging.[13,14] As Merrill et al. has identified, rarely will nurses, even those

Table 3
Nurse Antibiotic Stewardship (AS) understanding and performance confidence

	Presurvey		Postsurvey		
	Responses	Median [IQR]	Responses	Median [IQR]	*P* value
General Understanding of AS Questions (1="Strongly Disagree"; 2="Disagree"; 3="Neutral"; 4="Agree"; 5="Strongly Agree")					
I am knowledgeable about antibiotic stewardship.	69	4 [3, 4]	50	4 [4, 4]	.154
When I talk with other nurses, I am generally satisfied with the exchange of antibiotic information.	67	4 [3, 4]	49	4 [3, 4]	.953
When I talk with providers, I am generally satisfied with the exchange of antibiotic information.	69	4 [3, 4]	50	4 [3, 4]	.854
When I talk with pharmacists, I am generally satisfied with the exchange of antibiotic information.	70	4 [4, 4]	50	4 [4, 5]	.257
In general, I feel like I have a good understanding of where to find antibiotic information within a patient's medical record.	70	4 [3, 4]	49	4 [4, 4]	.29
In general, I feel like I have a good understanding of the antibiotic plan of care.	70	4 [3, 4]	50	4 [3, 4]	.991
I would like more information about antibiotic stewardship including how it may impact the clinical care I provide.	69	4 [3, 4]	49	4 [3, 4]	.217
Nurse Confidence with ASP activities (1="Not Confident"; 5="Very Confident")					
Assuring that cultures (ie, urine, blood, etc.) are obtained before antibiotics are initiated	68	5 [4, 5]	50	5 [4, 5]	.655
Evaluating the need for continued antibiotic use to see if the treatment is still necessary	69	4 [3, 4]	50	4 [3, 4]	.668
Assessing for a history of an adverse drug reaction	69	4 [4, 5]	50	4 [4, 5]	.562
Identifying a wrong antibiotic dose	70	3.5 [2, 4]	50	3 [2, 4]	.277
Notifying the provider/pharmacist of a wrong antibiotic dose	70	4 [3, 5]	50	4 [2.75, 4]	.651
Assessing for potential adverse events associated with antibiotic use	70	4 [3, 5]	50	4 [3.75, 5]	.566
Collaborating with providers/pharmacists about transitioning antibiotic route from IV to PO	70	4 [3, 4.25]	49	4 [3, 5]	.305
Educating patients and/or families about the importance of taking antibiotics correctly to reduce bacterial resistance and expected side effects	70	4 [4, 5]	50	4 [4, 5]	.503

IQR, interquartile range.

with baccalaureate (BSN) degrees or higher, question the antibiotic choice, dose, route, or duration.[13] In fact, in this study, 30% of BSN-prepared nurses reported that they have given an antibiotic they thought was inappropriate. Within the present study, over a third of

Table 4
Antibiotic Engagement Tool (AET) Usage by experience and education

	Did not use AET (N = 37)	Used AET (N = 13)	*P* value
Hospital*			.006
Hospital A Unit 1	8 (22.9%)	1 (8.3%)	
Hospital A Unit 2	19 (54.3%)	2 (16.7%)	
Hospital B	4 (11.4%)	7 (58.3%)	
Hospital C	4 (11.4%)	2 (16.7%)	
Time since graduating from nursing school			.686
Less than 1 year ago	1 (2.7%)	1 (7.7%)	
1-5 years ago	16 (43.2%)	4 (30.8%)	
6-10 years ago	6 (16.2%)	4 (30.8%)	
11-15 years	5 (13.5%)	1 (7.7%)	
More than 15 years ago	9 (24.3%)	3 (23.1%)	
I have worked at this hospital			.626
Less than 5 years	17 (45.9%)	7 (53.8%)	
5-10 years	9 (24.3%)	4 (30.8%)	
11-15 years	4 (10.8%)	0 (0%)	
More than 15 years	7 (18.9%)	2 (15.4%)	
Highest degree			.007
RN Diploma	1 (2.7%)	0 (0%)	
RN Assoc.	1 (2.7%)	5 (38.5%)	
RN BSN	30 (81.1%)	6 (46.2%)	
Master's	5 (13.5%)	2 (15.4%)	
Shift worked			.424
Nights	18 (48.6%)	8 (61.5%)	
Days	19 (51.4%)	5 (38.5%)	

AET, antibiotic engagement tool.
*One respondent did not indicate hospital unit.

the nurses reported either not knowing the antibiotic duration or identified a discrepancy between the ordered discontinuation date and the desired stop date. A concerning finding, especially when applied to the context of care transitions. Informed antibiotic communication may be a future area where nurses can meaningfully intervene.

These transitions in care are a ubiquitous problem for all patients because antibiotic information is often unavailable or difficult to locate, leaving nurses uncertain of the therapeutic plan and reluctant to intervene on appropriate use.[15] This AET demonstrated some utility in assessing antibiotic use; however, future modifications should increase operability when the duration is unclear or unknown to promote action and decision-making among the clinical team, similar to findings reported from Ha and colleagues.[16] Several nurses added the diagnoses to the AET or in the comment fields, which may suggest specific patient information may be useful in future editions. Nurses also expressed more confusion in cases of polypharmacy; therefore, when several antibiotics are ordered, clarity around the antibiotic plan and duration are essential.

Nurses in this study reported the ADIOS AET helped guide questions about antibiotic therapy, and it improved their confidence to be involved in discussions about therapeutic plans. The goal for including communication questions from the Agency for Healthcare Research and Quality was to help ascertain whether the ADIOS AET stimulated nurses to question when something did not seem right and whether the AET promoted collaboration with those with more authority.[3,8,9] Nurses may be reluctant to engage in conversations about antibiotic plans of care, especially if they perceive a knowledge, status, or power differential between nurses and prescribers or pharmacists. Questioning antibiotic orders can be perceived as challenging; therefore, it was important that the ADIOS AET was viewed as a conversational tool, rather than as a mechanism to police prescriber behavior which could fracture interprofessional relationships.[9,17]

Table 5
Antibiotic Engagement Tool (AET) Impressions among nurses who reported use

Level of agreement (1="Strongly Disagree"; 2="Disagree"; 3="Neutral"; 4="Agree"; 5="Strongly Agree") − median [IQR]	Nurses (N = 13)Median [IQR*]
Satisfied with the ease of using the ADIOS	4[2.25,4]
The amount of time it took for me to use the ADIOS tool was reasonable	4 [3.5, 4.5]
The ADIOS tool improved my understanding why the patient was receiving antibiotic therapy	3 [3, 4]
The ADIOS tool was useful for conveying antibiotic information between nurses	3.5 [2.25, 4]
The ADIOS tool was useful for conveying antibiotic information to providers/pharmacists	3 [3, 4]
The ADIOS tool was useful for conveying antibiotic information during the transfer of patients	3 [2.5, 4]
The ADIOS tool helped me to collaborate with providers/pharmacists on the antibiotic plan of care	3 [3, 4]
The ADIOS tool helped me to ask questions about antibiotic therapy when something didn't seem right	4 [3, 4]
The ADIOS tool helped me to develop a better understanding of where to find antibiotic information within a patient's medical record	4 [2.5, 4]
When using ADIOS, I felt confident to be involved in antibiotic discussions	4 [3, 4]

	Tool use	Frequency (percent)
Frequency of ADIOS tool use for when a patient was on an antibiotic		
	0	0 (0%)
	1-5	5 (38.5%)
	6-10	4 (30.8%)
	11-15	0 (0%)
	16-20	3 (23.1%)
	>21 times	1 (7.7%)
Frequency of ADIOS tool use for nurse-to-nurse or shift-to-shift handoffs		
	0	7 (53.8%)
	1-5	2 (15.4%)
	6-10	3 (23.1%)
	11-15	0 (0%)
	16-20	0 (0%)
	>21 times	1 (7.7%)
Frequency of ADIOS tool use when transferring patients		
	0	12 (92.3%)
	1-5	0 (0%)
	6-10	0 (0%)
	11-15	0 (0%)
	16-20	0 (0%)
	>21 times	1 (7.7%)

AET, antibiotic engagement tool.

Abbas and colleagues reported a similar finding in a recent publication where 67.3% and 69.8% of the 159 nurse respondents identified scope of practice and physician pushback respectively, as barriers to nursing stewardship participation.[7] To minimize prescriber interruptions with AET use, facilities recommended nurses route questions about antibiotic therapies to unit pharmacists, as the prescribers and pharmacists leverage established communication structures when determining therapeutic choices. While the AET was not designed to mitigate all communication challenges between teams, it does offer a cursory, yet standard, overview of key antibiotic details of which each member of the care team should have knowledge.

Findings from this study reiterate that nurse leaders are crucial to establishing unit-based and organizational patient safety priorities and setting the strategic direction, so clinical teams can operationalize those objectives.[18] Hospital B provided evidence to this effect. Approximately half of the nurses participated in the pre and post survey, and the majority of completed AET submissions were credited to Hospital B, a smaller community hospital. Without an Institutional Review Board, hospital leaders elected to engage in this project as a quality improvement initiative. The nurse leader and infection preventionist frequently rounded and encouraged staff to participate. An area for further exploration is messaging the critical importance and necessary leveraging of resources to promote the involvement of nurses at every organizational level in order to create a systematic, engaged workforce.[19]

A strength of this study was the intentional collaboration with nurses from multiple hospitals to ensure the approach was meaningful and relevant to the participating sites. Direct care and operational leaders were involved in each aspect of the study design, survey development, AET design and implementation. However, this study has several limitations to acknowledge.

As a feasibility study, the interest was regarding usage and satisfaction; therefore, survey responses were not matched. Future studies should include matched pre-post measures, which would strengthen the assessment of changes following the implementation of the AET. The overall response rates, both pre- and post-implementation were relatively low. Additionally, given the voluntary nature, nurses potentially used the tool without writing their experience or may have opted to use the tool and not submit the AET for analyses. This study was initiated during the summer when viral respiratory agents are lowest and nurse staffing shortages are minimized; however, this is often the time of year most conducive for nurses to take family leave. The survey and use of the AET was voluntary, coupled with the variable response rates, thus it may not represent all and could reflect those with a stewardship interest.

CONCLUSIONS

The recent focus on direct care nurses in improving antibiotic use is promising, and they certainly have a key role in assuring the progression of the antibiotic stewardship process, particularly in practice settings where infectious disease experts are lacking. Through a highly collaborative work process, this study identified that antibiotic duration is an area where nurses can intervene during care transitions and, when provided, tools may foster productive, engaged conversations between clinical teams. Additionally, operational and direct care nurse leaders are essential to the design and use of innovative nurse-driven tools to help convey the essential components of

an antibiotic assessment. To further commitments that stewardship is a shared enterprise, future research should continue to focus on the development of communication approaches that empower a full complement of professionals that are willing and welcomed to speak up about antibiotic use.

Acknowledgments

References

1. American Nurses Association & Centers for Disease Control & Prevention. Redefining the antibiotic stewardship team: recommendations from the American Nurses Association/Centers for Disease Control and Prevention workgroup on the role of registered nurses in hospital antibiotic stewardship practices. Available at: https://www.cdc.gov/antibiotic-use/healthcare/pdfs/ANA-CDC-whitepaper.pdf. Published 2017. Accessed March 31, 2020.
2. Centers for Disease Control and Prevention. Core elements of hospital antibiotic stewardship programs. Available at: https://www.cdc.gov/getsmart/healthcare/implementation/core-elements.html. Revised 2019. Accessed March 31, 2020.
3. Monsees E, Popejoy L, Jackson MA, Lee B, Goldman J. Integrating staff nurses in antibiotic stewardship: opportunities and barriers. *Am J Infect Control*. 2018;46:737−742.
4. Greendyke WG, Carter EJ, Salsgiver E, et al. Exploring the role of the bedside nurse in antimicrobial stewardship: Survey results from five acute-care hospitals. *Infect Control Hosp Epidemiol*. 2018;29:360−362.
5. Cadavid CD, Sakamoto SD, Terashita DM, Schwartz B. Bedside registered nurse roles in antimicrobial stewardship: a survey of acute-care hospitals in Los Angeles County. *Infect Control Hosp Epidemiol*. 2017;38:1263−1265.
6. Carter EJ, Greendyke WG, Furuya EY, et al. Exploring the nurses' role in antibiotic stewardship: a multisite qualitative study of nurses and infection preventionists. *Am J Infect Control*. 2018;46:492−497.
7. Abbas S, Lee K, Pakyz A, et al. Knowledge, attitudes, and practices of bedside nursing staff regarding antibiotic stewardship: a cross-sectional study. *Am J Infect Control*. 2019;47:230−233.
8. Monsees E, Popejoy L, Goldman J, Jackson MA, Lee BR. Barriers to pediatric staff nurse participation in antimicrobial stewardship programs (ASP) linked to organizational culture. *Open Forum Infect Dis*. 2018;5(Suppl 1):S27−S28.
9. Monsees E, Goldman J, Vogelsmeier A, Popejoy L. Nurses as antimicrobial stewards: recognition, confidence, and organizational factors across nine hospitals. *Am J Infect Control*. 2020;48:239−245.
10. Monsees E, Jackson MA, Popejoy L, Lee B, Goldman J. Perceptions among pediatric staff nurses on their role and confidence in performing antimicrobial stewardship activities. *Paper presented at: Infectious Disease Week 2017*. San Diego, CA; 2017. October.
11. Shea GE, Smith W, Knobloch MJ, Safdar N. K cards: a visual method to sustain evidence-based practice. *Am J Infect Control*. 2018;46:S87.
12. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)−A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomedl Inform*. 2009;42:377−381.
13. Merrill K, Hanson SF, Sumner S, Vento T, Veillette J, Webb B. Antimicrobial stewardship: staff nurse knowledge and attitudes. *Am J Infect Control*. 2019;47:1219−1224.
14. Norton LE, Lee BR, Harte L, et al. Improving guideline-based streptococcal pharyngitis testing: a quality improvement initiative. *Pediatrics*. 2018;142:e20172033.
15. Kwan JL, Lo L, Sampson M, Shojania KG. Medication reconciliation during transitions of care as a patient safety strategy: a systematic review. *Ann Intern Med*. 2013;158(5 Pt 2):397−403.
16. Ha DR, Forte MB, Olans RD, et al. A multidisciplinary approach to incorporate bedside nurses into antimicrobial stewardship and infection prevention. *Jt Comm J Qual Patient Saf*. 2019;45:600−605.
17. Kapadia SN, Abramson EL, Carter EJ, et al. The expanding role of antimicrobial stewardship programs in hospitals in the United States: lessons learned from a multisite qualitative study. *Jt Comm J Qual Patient Saf*. 2018;44:68−74.
18. Manning ML, Giannuzzi D. Keeping patients safe: antibiotic resistance and the role of nurse executives in antibiotic stewardship. *J Nurs Adm*. 2015;45:67−69.
19. Manning ML, Pfeiffer J, Larson EL. Combating antibiotic resistance: the role of nursing in antibiotic stewardship. *Am J Infect Control*. 2016;44:1454−1457.