ORIGINAL RESEARCH

Impact of Antimicrobial Stewardship on Physician Practice in a Geriatric Facility

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ABSTRACT

Background: There is a paucity of literature describing the implementation of antimicrobial stewardship programs (ASPs) in long-term care (LTC) facilities. The current study evaluated the impact of an ASP that was implemented across a geriatric facility, which included an inpatient specialty hospital and an LTC facility. The program included prospective audits with feedback, multidisciplinary education, information technology interventions, and guideline development.

Objective: To investigate the impact of the ASP on physicians' prescribing practices in this geriatric facility.

Methods: Utilization data for antibiotics commonly used to treat urinary tract infections were retrieved for the period September 1, 2011, to August 31, 2013. The study examined whether there were significant changes in overall antibiotic use, ciprofloxacin use, and physician prescribing behaviour after program implementation in September 2012.

Results: There was no significant change in the total number of antibiotic prescriptions for urinary tract infections in the hospital or the LTC facility after ASP implementation. Significant reductions were seen in the average days of therapy initially prescribed and the actual days of therapy after ASP implementation in the LTC facility but not the hospital. Across both facilities, significant reductions were seen in the number of ciprofloxacin prescriptions.

Conclusions: The current study showed that an ASP can affect physicians' antibiotic prescribing behaviour and antibiotic usage in an LTC environment.

Keywords: antibiotics, long-term care, urinary tract infection, practice modification, antimicrobial stewardship

Can J Hosp Pharm. 2016;69(6):460-5

RÉSUMÉ

Contexte : Il n'existe que très peu de documentation qui porte sur la mise en œuvre de programmes de gérance des antimicrobiens dans les établissements de soins de longue durée. La présente étude a évalué l'effet d'un programme de gérance des antimicrobiens mis en œuvre dans l'ensemble d'un centre gériatrique, qui comprenait un hôpital spécialisé et un établissement de soins de longue durée. Le programme comprenait des audits prospectifs accompagnés de rétroaction, des séances de formation multidisciplinaire, des interventions s'appuyant sur les technologies de l'information et l'élaboration de lignes directrices.

Objectif : Évaluer les effets du programme de gérance des antimicrobiens sur les habitudes de prescription des médecins travaillant dans ce centre gériatrique.

Méthodes : L'étude s'appuie sur les données d'utilisation des antibiotiques les plus employés pour traiter les infections urinaires recueillies entre le 1er septembre 2011 et le 31 août 2013. L'étude a examiné si des changements significatifs à l'utilisation des antimicrobiens et de la ciprofloxacine ainsi qu'aux habitudes de prescription des médecins ont résulté de la mise en œuvre du programme en septembre 2012.

Résultats : Aucun changement significatif n'a été noté dans le nombre total de prescriptions d'antibiotiques destinés à traiter les infections urinaires à l'hôpital et dans l'établissement de soins de longue durée. D'importantes réductions ont été observées dans la moyenne des jours de traitement initialement prescrits et le nombre réel de jours de traitement après la mise en œuvre du programme à l'établissement de soins de longue durée, mais pas à l'hôpital. Aux deux établissements, des réductions significatives du nombre de prescriptions de ciprofloxacine ont été observées.

Conclusions : La présente étude a montré qu'un programme de gérance des antimicrobiens peut avoir un effet sur les habitudes de prescription d'antibiotiques des médecins et sur l'utilisation des antibiotiques dans un établissement de soins de longue durée.

Mots clés : antibiotiques, soins de longue durée, infection urinaire, changement dans la pratique, gérance des antimicrobiens

INTRODUCTION

Antibiotics are often overprescribed in long-term care (LTC) facilities.[1] Studies have shown that 47% to 79% of LTC residents are exposed to at least one antibiotic course over a 12-month period.[2] Urinary tract infections (UTIs) account for 20% to 60% of systemic antibiotic courses in the LTC setting,[3,4] with about one-third of antibiotics prescribed for the treatment of asymptomatic bacteriuria.[5] For elderly patients in LTC facilities, diagnostic difficulty arises when the UTI presentation is atypical.[6]

Antimicrobial stewardship programs (ASPs) are being implemented in response to rising antibiotic resistance rates. Through various interventions, ASPs serve to optimize antibiotic use by ensuring appropriate diagnosis and drug selection, as well as appropriate dosing, route, and duration of antibiotic therapy. ASPs aim to achieve the best patient outcomes and to minimize unnecessary exposure to antibiotics, thereby reducing or stabilizing levels of antibiotic resistance. Since 2014, Accreditation Canada has included ASPs as a Required Organizational Practice for organizations that provide complex continuing care services.[7]

Despite a plethora of guidelines for developing an ASP in an acute care setting,[8] there remains a paucity of literature describing ASP implementation in LTC facilities.[9,10] Successful Canadian ASPs include programs implemented at large acute care teaching hospitals, such as Mount Sinai Hospital,[11] the University Health Network,[12] and Sunnybrook Health Sciences Centre.[13] In 2012, an ASP was implemented at Baycrest Health Sciences, a geriatric facility in Toronto, Ontario, that includes both an inpatient specialty hospital and an LTC facility. This ASP was modelled on successful strategies that have been reported in the literature, with consideration of the local culture and support resources available. The ASP included development of guidelines, multidisciplinary educational interventions, information technology interventions, and prospective audits with feedback, and focused on 4 major areas of learning: correct diagnosis of UTIs, appropriate choice of antibiotic, appropriate duration of therapy, and modification of therapy on the basis of culture and sensitivity results. The purpose of the current study was to evaluate the effectiveness of the ASP.

METHODS

Study Setting

The ASP was implemented at an academic geriatric health care facility that included both an LTC facility and a specialty hospital. These were the 2 units of observation involved in both the intervention and the evaluation study.

The LTC facility has 472 beds, and the average age of residents is 88 years. Patient services do not include IV therapy, long-term ventilation therapy, or dialysis. The hospital is a 255-bed specialty hospital, and the average age of patients is 83 years. The hospital houses a range of care services, including complex continuing care units, which serve medically complex patients (e.g., patients with chronic tracheostomy who are not receiving ventilation). The hospital also has rehabilitation, palliative care, psychiatry, and behavioural neurology units.

At the time of ASP implementation, there were 21 attending family physicians on staff (mostly part-time). The ASP team consisted of 1 part-time pharmacist and 2 part-time family medicine physicians.

Antimicrobial Stewardship Program Description

The institutional ASP was initiated in September 2012. Four complementary intervention strategies (Table 1) were employed to promote awareness of best-practice ASP policies and to effect behaviour change among health care providers. The interventions targeted all medical and nursing staff, pharmacists, patients, and their families.

Outcome Measures

Three research questions were identified to determine whether the ASP was effective: (1) Were there differences in over-

Table 1. Antimicrobial Stewardship Strategies Implemented

Category	Intervention	Desired or Expected Outcome
ASP guidelines and policies	Adoption of treatment algorithms by institution's Medical Advisory Committee	Geriatricians and subspecialists become aware of ASP goals
Audit and feedback	ASP supportive feedback to physicians and clinical pharmacists (e.g., follow up on laboratory results, IV-to-PO step-down, dosing recommendations)	Increased awareness of the most appropriate treatment options
Information technology tools	Change to default stop dates for some antibiotics	Encouragement of use of shorter treatment duration
	Simplified access to guidelines on computers	Increased visibility of guidelines
Education	Presentations during medical rounds, posters, newsletter articles, hand-outs	Open dialogue about ASP-related issues with families and professionals
	Directed to physicians, nurses, pharmacists, patients, and families	Increased visibility of ASP across the organization

ASP = antimicrobial stewardship program, IV-to-PO = intravenous to oral.

all antibiotic use before and after ASP implementation? (2) Were there differences in physician prescribing behaviour, in terms of either initial duration of therapy or later modification of duration? (3) Were there differences in ciprofloxacin use? Ciprofloxacin was chosen for investigation because it is commonly used in the treatment of UTIs and because fluoroquinolones are associated with high resistance rates.

Overall Antibiotic Use

As an index of overall antibiotic use, the UTI rate was calculated. Selection of any UTI antibiotic (Box 1) was used as a proxy for identification of UTI cases. The UTI rate was calculated as the number of UTI cases in a given month divided by the unit occupancy for that month:

$$\text{UTI rate} = \frac{\text{Count of UTI cases}_j}{\text{Occupancy}_j}$$

where j = month.

Physician Prescribing Behaviour

Two metrics were retrieved from patient records as indices of physician prescribing behaviour: prescribed days of therapy (PDOT) and actual days of therapy (ADOT). PDOT refers to the duration of treatment indicated on the physician's medical (written) orders. ADOT refers to the actual number of days that an antibiotic drug (regardless of dose) was dispensed. These two days-of-therapy (DOT) metrics were calculated independent of the dosage or specific antibiotic that a given patient received.

The PDOT and ADOT values were adjusted to control for differences in patient days and the number of UTI cases in a given month. The adjusted PDOT and ADOT variables for a given month were calculated by first determining, for each patient, the DOT for the individual patient divided by total patient days for that patient, then summing these values across all patients and dividing by the number of UTI cases:

$$\text{PDOT} = \frac{\Sigma\,[(\text{PDOT}_{ij})/\text{total patient days}_{ij}]}{\text{Count of UTI cases}_j}$$

$$\text{ADOT} = \frac{\Sigma\,[(\text{ADOT}_{ij})/\text{total patient days}_{ij}]}{\text{Count of UTI cases}_j}$$

where i = individual patient and j = month.

Ciprofloxacin Use

Ciprofloxacin use was determined from the count of ciprofloxacin prescriptions. Two measures of ciprofloxacin use were considered. The ciprofloxacin rate represented the number of ciprofloxacin prescriptions in a given month per unit occupancy for that month, and the ciprofloxacin proportion represented the number of ciprofloxacin prescriptions in a given month per UTI case:

$$\text{Ciprofloxacin rate} = \frac{\text{Count of ciprofloxacin prescriptions}_j}{\text{Occupancy}_j}$$

Box 1. Antibacterial Agents Used for Treatment of Urinary Tract Infection at Study Institution

Amikacin
Amoxicillin
Amoxicillin–clavulanic acid
Ampicillin
Ceftriaxone
Ciprofloxacin
Gentamicin
Levofloxacin
Meropenem
Nitrofurantoin
Norfloxacin
Piperacillin and tazobactam
Tobramycin
Trimethoprim (TMP)
Trimethoprim–sulfamethoxazole (TMP-SMX)

$$\text{Ciprofloxacin proportion} = \frac{\text{Count of ciprofloxacin prescriptions}_j}{\text{Count of UTI cases}_j}$$

where j = month.

Data Retrieval

Data on antibiotic drug use were retrieved from hospital and LTC facility records for individual patients for the period September 1, 2011, to August 31, 2013. Individual patient records were extracted if the patient had received a prescription for a medication most commonly associated with UTI. Antibacterial agents that the institution used for UTI treatment were identified (Box 1).

Additional data collected included monthly patient days (defined as the number of days a given patient spent at the institution) as well as monthly occupancy data for the hospital and LTC facility (defined as the total number of patient days across all patients at the institution).

Data Analysis

It would have been prohibitively difficult to match patient identification across the pre- and post-implementation periods. Therefore, data extracted for the 2 periods were treated as independent observations. Independent-sample t-tests were performed for each of the outcome measures (i.e., the variables UTI rate, PDOT, ADOT, ciprofloxacin rate, and ciprofloxacin proportion), comparing the pre-intervention period (September 2011 to August 2012) and the post-intervention period (September 2012 to August 2013) separately for the hospital and the LTC facility. All hypothesis tests were performed at an α level of 0.05.

RESULTS

Data were extracted from 2638 patient records that met the study criteria. Independent-sample t-test results and summary statistics are reported in Table 2.

Table 2. Results of Independent-Sample *t*-Tests of Outcome Measures

Variable	Mean ± SD		t(22)	*p* Value	(95% CI)	Cohen *d*
	Before	After				
Hospital						
UTI rate	0.055 ± 0.009	0.050 ± 0.017	1.014	0.322	(–0.006 to 0.017)	0.432
PDOT	0.606 ± 0.088	0.643 ± 0.280	–0.446	0.660	(–0.213 to 0.138)	–0.190
ADOT	0.442 ± 0.080	0.446 ± 0.198	–0.077	0.939	(–0.133 to 0.123)	–0.033
Ciprofloxacin rate*	0.014 ± 0.004	0.010 ± 0.002	3.790	0.016	(0.001 to 0.007)	1.805
Ciprofloxacin proportion	0.250 ± 0.068	0.213 ± 0.052	1.514	0.144	(–0.014 to 0.089)	0.646
Long-term care facility						
UTI rate	0.048 ± 0.012	0.043 ± 0.007	1.255	0.223	(–0.003 to 0.013)	0.535
PDOT	0.271 ± 0.036	0.236 ± 0.038	2.293	0.032	(0.003 to 0.066)	0.978
ADOT	0.245 ± 0.034	0.207 ± 0.030	2.902	0.008	(0.011 to 0.065)	1.237
Ciprofloxacin rate	0.014 ± 0.005	0.006 ± 0.004	3.790	0.001	(0.003 to 0.012)	1.616
Ciprofloxacin proportion	0.288 ± 0.097	0.148 ± 0.082	3.809	0.001	(0.064 to 0.216)	1.624

ADOT = actual days of therapy, CI = confidence interval, PDOT = prescribed days of therapy, SD = standard deviation, UTI = urinary tract infection.
*Test of unequal variances, where df = 17.643.

Hospital

Overall Antibiotic Use: There was no significant difference in the rate of UTI cases (the indicator of antibiotic use) before and after implementation of the ASP.

Physician Prescribing Behaviour: There was no significant change in PDOT or ADOT after implementation of the ASP.

Ciprofloxacin Use: The independent-sample *t*-test indicated that there was a significant decrease in the rate of ciprofloxacin prescriptions after implementation of the ASP. However, there was no significant change in terms of the ciprofloxacin proportion (i.e., prescriptions per UTI case).

LTC Facility

Overall Antibiotic Use: There was no significant difference in the rate of UTI cases before and after implementation of the ASP.

Physician Prescribing Behaviour: There were significant decreases in both PDOT and ADOT following implementation of the ASP.

Ciprofloxacin Use: Both ciprofloxacin rate and ciprofloxacin proportion were significantly lower following implementation of the ASP.

DISCUSSION

The current study has shown that physician prescribing behaviour in an LTC environment can be influenced by implementation of an ASP. Although no reduction in the number of antibiotic prescriptions for UTIs was observed in either the hospital or the LTC facility, there were significant reductions in both PDOT and ADOT after ASP implementation in the LTC facility (but not the hospital). In addition, significant reductions were seen in the number of ciprofloxacin prescriptions in both facilities.

The few previous studies that examined ASPs in LTC environments showed that ASP interventions can reduce total antibiotic consumption.[14-16] The current study had similar overall results but suggests the existence of significant barriers to change. For example, the ASP at the study institution involved a small team, functioned at the program level rather than as part of the clinical team, used an external pharmacy for prescriptions generated in the LTC facility (which resulted in a lack of control over the formulary), and did not have on-site infectious disease services.

UTI Cases

The current study showed no change in the number of UTI cases after implementation of the ASP. These negative results could be attributable to several factors. The existing literature supports the notion that diagnosis of UTI in elderly patients is difficult.[6,17,18] Physicians often initiate empiric treatment of suspected UTI, attributing certain symptoms such as increased agitation and change in urine quality to a UTI, as well as initiating treatment for positive urine culture results in the absence of symptoms.

The measure used as an index of the number of UTI cases (i.e., number of antibiotic prescriptions for UTI) could be a poor indicator of UTI diagnosis. Chart reviews were not conducted to confirm diagnoses, nor was there any analysis of information about orders for urine culture.

The ASP attempted to combat these clinical barriers through the development of diagnostic guidelines. However, it is well recognized that there is considerable resistance to guidelines among front-line general practitioners.[19-21] Reinforce-

ment of education was also difficult because no ASP committee member was embedded in the clinical teams.

PDOT and ADOT

Despite the absence of detectable change in the number of UTI cases, further analyses were conducted to examine specific measures of physician prescribing behaviour, including PDOT, an index of the decision to treat and the intended duration of treatment. This study used 2 DOT variables, as opposed to defined daily dose (the assumed average maintenance dose per day for a drug used for its main indication in adults[22]), as outcome measures because they more accurately reflect antibiotic usage in a geriatric population, where renal dosing is often required.

There was a significant decrease in both PDOT and ADOT in the LTC facility but not the hospital. The decreases in the LTC facility can most likely be attributed to multiple aspects of the ASP, including implementation of short default stop dates for select antibiotics used for uncomplicated UTIs and audit with feedback for all UTI antibiotic prescriptions. The lack of any effect on DOT variables in the hospital may reflect the greater patient complexity and physicians' ability to treat severe infections on site, where longer durations of antibiotic treatment are recommended.[23-25] However, no subanalyses were performed on the use of parenteral antibiotics, which made any direct measure of disease severity difficult.

Ciprofloxacin Cases

Another key focus of the ASP initiative was to reduce the use of ciprofloxacin, and significant reductions in ciprofloxacin use were observed at both sites. Change in the use of ciprofloxacin in particular may have resulted from widespread dissemination of institution-specific antibiograms. The antibiograms showed high ciprofloxacin resistance, which may have motivated staff to change empiric antibiotic selection.

Study Limitations

This observational study had a number of limitations. Chart reviews were not conducted because of resource constraints. The antibiotics assessed were assumed to be used exclusively for UTI treatment, but some patients may have had other types of infection. Urine culture results, as an indicator of suspected UTIs, were not analyzed. The study population was not stratified by disease severity. Finally, the study duration may have been insufficient to allow for behaviour change.

Implications

Based upon the process and findings of this evaluation study, it is recommended that future evaluations be conducted 2–3 years after program implementation, to allow sufficient education regarding the diagnosis of UTI and asymptomatic bacteriuria.

CONCLUSION

The current study showed that an ASP initiative in an LTC environment can affect physicians' antibiotic prescribing behaviour and antibiotic usage. The findings indicate initial success in a nursing home environment, but more work must be done to recognize and overcome barriers to identification and appropriate management of UTIs.

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Competing interests: None declared.

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Funding: None received.

Acknowledgements: The authors would like to acknowledge the following groups and individuals for their support: the institution's Antimicrobial Stewardship Steering Committee and Dr Andrew Morris for study conception; Dr Malcolm Binns for data analysis; and Dexter Garcia and Jonathan Light for data acquisition.