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Primary care

Effect of a multifaceted intervention on number of antimicrobial prescriptions for suspected urinary tract infections in residents of nursing homes: cluster randomised controlled trial

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Abstract

Objective To assess whether a multifaceted intervention can reduce the number of prescriptions for antimicrobials for suspected urinary tract infections in residents of nursing homes.
Design Cluster randomised controlled trial.
Setting 24 nursing homes in Ontario, Canada, and Idaho, United States.
Participants 12 nursing homes allocated to a multifaceted intervention and 12 allocated to usual care. Outcomes were measured in 4217 residents.
Interventions Diagnostic and treatment algorithm for urinary tract infections implemented at the nursing home level using a multifaceted approach—small group interactive sessions for nurses, videotapes, written material, outreach visits, and one on one interviews with physicians.
Main outcome measures Number of antimicrobials prescribed for suspected urinary tract infections, total use of antimicrobials, admissions to hospital, and deaths.
Results Fewer courses of antimicrobials for suspected urinary tract infections per 1000 resident days were prescribed in the intervention nursing homes than in the usual care homes (1.17 *v* 1.59 courses; weighted mean difference −0.49, 95% confidence intervals −0.93 to −0.06). Antimicrobials for suspected urinary tract infection represented 28.4% of all courses of drugs prescribed in the intervention nursing homes compared with 38.6% prescribed in the usual care homes (weighted mean difference −9.6%, −16.9% to −2.4%). The difference in total antimicrobial use per 1000 resident days between intervention and usual care groups was not significantly different (3.52 *v* 3.93; weighted mean difference −0.37, −1.17 to 0.44). No significant difference was found in admissions to hospital or mortality between the study arms.
Conclusion A multifaceted intervention using algorithms can reduce the number of antimicrobial prescriptions for suspected urinary tract infections in residents of nursing homes.

Introduction

Antimicrobial use for suspected urinary tract infections among residents of nursing homes is common and often inappropriate.[1–4] One third of prescriptions for presumed urinary tract infection among such residents are for asymptomatic bacteriuria, or the presence of bacteria in the urine in the absence of urinary symptoms.[1 4] Although treatment of asymptomatic bacteriuria in children and pregnant women is recommended, four randomised controlled trials showed no benefit from doing so in institutionalised elderly people.[5–8] Unnecessary use of antimicrobials in elderly people can lead to adverse consequences, including the development of multidrug antimicrobial resistance,[9–12] drug related adverse effects,[4] harmful drug interactions,[13] and excessive costs.[14]

To optimise antimicrobial use for suspected urinary tract infection in residents of nursing homes, we developed algorithms on the basis of evidence from randomised trials,[5–8] observational studies assessing relations between symptoms, bacteriuria, and confirmed urinary tract infection,[15 16] a qualitative study assessing antimicrobial prescribing for urinary tract infection in this setting,[17] and the results of a consensus conference on antimicrobial prescribing in long term care (figs 1 and 2).[18] The main recommendations of the algorithms are that in the absence of a minimum set of symptoms or signs of urinary tract infection, urine should not be cultured and antimicrobials should not be prescribed.

Changing prescribing patterns is difficult and the best intervention for achieving it is unclear.[19] We hypothesised that introduction and adoption of the algorithms in a nursing home using a multifaceted intervention (education, written material, real time reminders, and outreach visits) targeted to nurses and physicians would safely reduce antimicrobial use for suspected urinary tract infection. We carried out a cluster randomised controlled trial to test the effectiveness of this intervention on reducing rates of antimicrobial prescriptions in residents of nursing homes.

Methods

To help ensure comparability of the intervention and usual care nursing homes for rates of antimicrobial prescriptions at baseline, we paired nursing homes within each province or state by size (number of occupied beds) and by proportion of residents with indwelling catheters. One member of each pair was randomised to the intervention and the other to usual care. A statistician independent of the study team used a random numbers table to assign the intervention to nursing homes (odd or even) corresponding to the number selected. We measured outcomes over 12 months. The nursing homes served as the unit of allocation, intervention, and analysis.

A research coordinator contacted nursing homes in southern Ontario and Idaho about the study. Only eligible for our study were free standing, community based nursing homes with 100 or more residents and no stated policy for diagnosis or

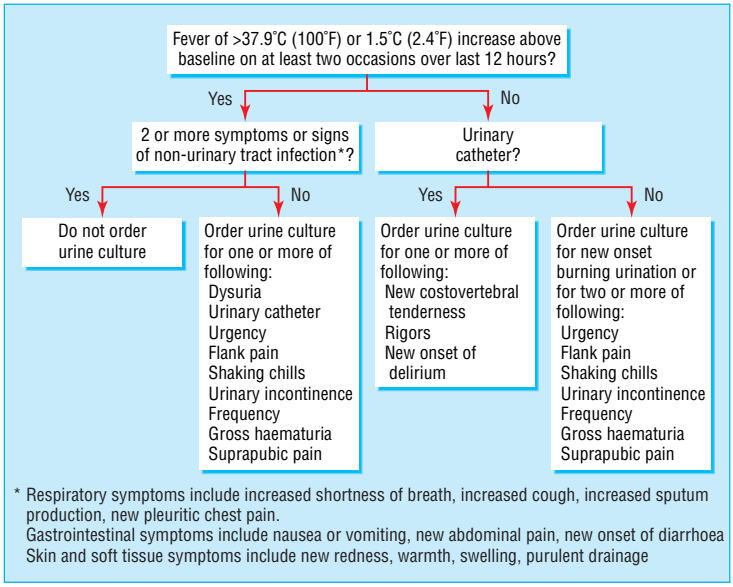


Fig 1 Diagnostic algorithm for ordering urine cultures for nursing home residents in intervention arm

treatment of urinary tract infections. To reduce the potential for selection bias, all residents in study nursing homes were eligible for participation. We contacted a total of 56 nursing homes, 36 in the Hamilton region, Ontario and 20 in the Boise region, Idaho. Eligible nursing homes had to agree to refrain from introducing new management strategies for antimicrobial use or clinical pathways for urinary tract infection during the 12 months of the study. To enhance representativeness of nursing homes in the community, we excluded nursing homes directly associated with tertiary care centres. Of the 56 homes approached, 24 were randomised, of which 16 were from Ontario and eight from Idaho. Nursing homes were enrolled from September 2001 to February 2002, with the last follow-up in March 2003. Participating and non-participating homes were of similar bed size (mean (SD) 183 (64.7) beds *v* 168 (73.4) beds, P = 0.40).

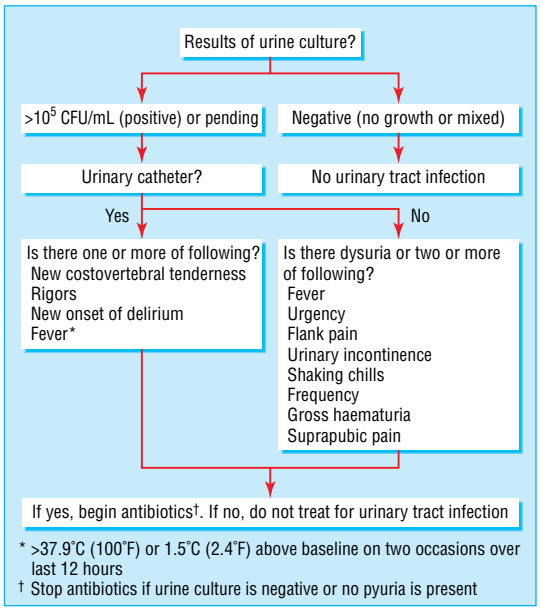


Fig 2 Treatment algorithm for prescribing antimicrobials to nursing home residents in intervention arm

Intervention nursing homes

We introduced the nurses and physicians of the intervention nursing homes to the diagnostic and therapeutic algorithms. Before data collection, one of two study investigators presented six case scenarios lasting a total of 30 minutes to small groups of between 10 and 15 registered nurses or registered nursing assistants. Participation was active, and nurses were asked to decide whether to order antibiotics and urine cultures and to justify their answers using the algorithms. We videotaped a reconstruction of the small group sessions and distributed the video to the nursing homes for viewing by existing and new staff over the course of the study. We sent the algorithms, along with written explanatory material, to all the physicians who cared for the nursing home residents. One of three investigators met once individually with the physicians who cared for 80% or more of residents in each nursing home. The algorithms were explained to them using the six case scenarios, printed on pocket cards and distributed to the physicians and nursing staff at the start of the study, and mounted as large posters at all nursing stations. The physicians and nurses were asked to use the algorithms when assessing residents for fever or suspected urinary tract infection. We asked the nurses to complete a one page log of presenting symptoms and signs for every resident in whom urinary tract infection was suspected, as a reminder to use the algorithms. One member of staff in each nursing home was assigned the role of reminding nurses to use the algorithms. The intervention homes were allowed a four week training period before data collection. We visited the nursing homes every three months to address any questions that the staff had and to carry out audits of the records to check that antimicrobial prescriptions for suspected urinary tract infection had not been missed.

Usual care nursing homes

Nurses and physicians in the usual care nursing homes were notified about the study and were informed about how data were going to be collected. No other interventions were applied to these homes.

Outcomes

The main outcome was the number of prescriptions for antimicrobials. We considered all antimicrobials given for one particu-

lar indication to be one course and antimicrobials prescribed for a second indication during the same period or prescribed after one week for the same indication to be separate courses. Other outcomes included number of urine cultures ordered, admissions to hospital, and deaths. Each facility's infection control practitioner used standardised data collection forms to collect data on antimicrobials prescribed and urine cultures sent.

Although allocation was concealed, given the nature of the intervention the nursing home staff could not be blinded to the intervention. Pharmacies affiliated with the study (the source of confirmation of antimicrobial prescriptions) were, however, blinded. To verify accuracy of data recorded at the nursing home, we carried out onsite audits of the charts records of the nursing home residents and obtained records from the pharmacies of antimicrobials prescribed.

Statistical methods

The unit of analysis was the nursing home. We used paired *t* tests, weighted by size of nursing home (number of beds) to analyse the following within pair differences in matched pairs of nursing homes: rates of antimicrobials prescribed for suspected urinary tract infections, proportions of antimicrobials prescribed for urinary tract infections, total rates of antimicrobials prescribed, urine cultures obtained, admissions to hospital, and mortality. To assess the effect of the intervention over time, we used linear regression to model the difference in antimicrobial rates for suspected urinary tract infection between the study homes by study month. Analyses were carried out using SAS version 8.2.

Sample size calculation

We determined that we would need 142 prescriptions for antimicrobials for suspected urinary tract infection (71 in each arm) to have 80% power to detect a 20% reduction in prescriptions at an α of 0.05, assuming a 30% baseline rate of prescriptions. To adjust for the effect of within cluster dependency, we calculated the intracluster correlation coefficient (variance for urinary antimicrobial prescriptions between homes divided by the sum of variance between and within the homes) and found this to be 0.04 using data from an Ontario long term care facility study.[4] The variance inflation factor was 11,[20] such that we required 1562 prescriptions for suspected urinary tract infection. Since these represent about 30% of all antimicrobial prescriptions,[12] we increased the sample size to 5206 prescriptions to assess whether a reduction in prescriptions for antimicrobials for suspected urinary tract infection could also reduce overall use of antimicrobials. On the basis of prescribing rates from a large cohort study,[6] we estimated that we would need to follow 20 (10 pairs) nursing homes for 12 months. Since we did not account for matching in the sample size calculation, which would improve efficiency, these figures were conservative. We recruited another four homes to maintain the target sample size in case of withdrawals from the study.

Table 1 Characteristics of 24 study nursing homes at randomisation. Values are median numbers (ranges)

Characteristic	Intervention home (n=2156)	Usual care home (n=2061)
Occupied beds per nursing home	160 (101-367)	155 (97-350)
Residents with indwelling urinary catheters	4 (0-17)	2 (1-12)
Staff per 100 residents:		
Physicians	7 (1-17)	8 (1-36)
Registered nurses	14 (6-42)	12 (8-28)
Nursing assistants	29 (14-89)	28 (13-59)

Results

The characteristics of the pairs of intervention and usual care nursing homes were similar at baseline (table 1). Two nursing homes dropped out of the study (fig 3), each citing insufficient nurses as the reason. One of these homes had over 26 nurses per 100 residents, the median number of nurses in all study nursing homes. The nursing home in the intervention arm dropped out of the study after randomisation but before beginning data collection. The home in the usual care arm dropped out after collecting data for eight weeks. These nursing homes and their paired homes were withdrawn from the study. The analysis is based on follow-up data from 10 pairs of nursing homes.

Complete follow-up data were available for all nursing homes except one. This nursing home reported that after a change in ownership some records for antibiotics were missing for the second half of the study period. Despite repeated efforts we could not obtain the missing data. We based our analyses of antimicrobial prescribing on the first six months of data collected from this home, using the same period in the corresponding usual care home as a comparator.

Antimicrobial use

During the study 4906 courses of antimicrobials were prescribed, 2337 in the intervention homes and 2569 in the usual care homes. Of the 4906 antimicrobial courses, 1655 (664 in the intervention arm, 991 in the usual care arm) were for sus-

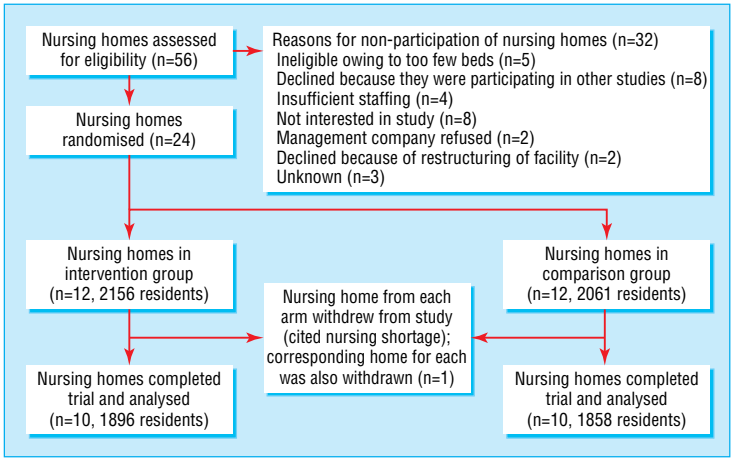


Fig 3 Flow chart of clinical trial

Table 2 Rates of antimicrobial courses for suspected urinary infection (per 1000 resident days) and number of occupied beds in 10 intervention and 10 usual care study nursing homes

	Intervention home courses per 1000 resident days		Usual care home courses per 1000 resident days	
Nursing home pair	Antimicrobial rate	No of occupied beds	Antimicrobial rate	No of occupied beds
1	0.85	148	1.49	148
2	1.05	233	1.99	238
3	1.00	248	0.63	252
4	0.77	170	1.06	172
5	0.70	367	1.93	350
6	1.59	149	1.14	131
7	0.79	171	0.69	162
8	0.51	198	1.29	210
9	2.10	108	2.68	97
10	2.27	101	2.95	107

pected urinary tract infection. Table 2 shows the rates of antimicrobials prescribed for urinary indications for the 10 pairs of nursing homes.

The rate of antimicrobial use for suspected urinary tract infections was significantly lower in the intervention arm than in the usual care arm (1.17 courses of antimicrobials per 1000 resident days prescribed *v* 1.59; weighted mean difference −0.49, 95% confidence interval −0.93 to −0.06). The monthly rates of antimicrobials for suspected urinary tract infection were consistently lower in the intervention homes over the 12 months of the study. The difference was, however, reduced over time (fig 4). The weighted linear regression analysis showed a tendency towards a reduced effect over time, although this was not significant (regression coefficient −0.017, −0.056 to 0.02).

The proportion of total antimicrobials prescribed for suspected urinary tract infection in the intervention arm was significantly lower than in the usual care arm: 28% of antimicrobial courses compared with 39% of courses (weighted mean difference −9.6%, −16.9% to −2.4%). Proportions of antimicrobials for respiratory, skin and soft tissue, or other infections did not differ between the study arms. The rate of defined daily dosages of antimicrobials prescribed (equivalent to the standard amount of antibiotic in a typical prescription[21]) for suspected urinary tract infections was 6.9 per 1000 resident days in the intervention arm compared with 10.9 in the usual care arm (weighted mean difference −3.85, −7.37 to −0.34).

Total antimicrobial use between the intervention and usual care groups was not significantly different (3.52 courses of antimicrobials per 1000 resident days compared with 3.93, respectively; weighted mean difference −0.37, −1.17 to 0.44).

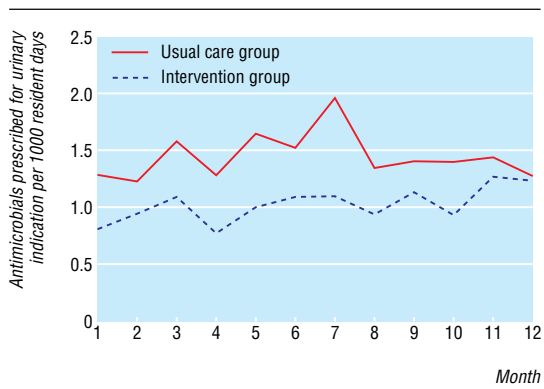


Fig 4 Monthly rates of antimicrobial prescriptions for urinary indications in intervention and usual care nursing homes

Urine cultures obtained

Overall, 1402 cultures were sent from the intervention homes compared with 1737 from the usual care homes. The rate of urine cultures sent was lower in the intervention homes (2.03 urine cultures per 1000 resident days compared with 2.48). This difference was not, however, significant (weighted mean difference −0.51, −1.38 to 0.35).

Adverse events

We found no significant difference in overall admissions to hospital or mortality between the two study arms. The rate of all cause admissions to hospital was 0.98 per 1000 resident days in the intervention homes compared with 0.81 (weighted mean difference 0.17, −0.14 to 0.48). The rate of admission to hospital for sepsis of suspected urinary origin or of unknown origin was 0.026 per 1000 resident days in the intervention arm compared with 0.018 in the usual care arm (weighted mean difference 0.008, −0.025 to 0.039). Mortality was 1.11 per 1000 resident days in the intervention arm compared with 1.09 (weighted mean difference 0.07, −0.22 to 0.36).

Discussion

Clinical algorithms targeted to physicians and nurses and implemented using multiple interventions reduced the rate of antimicrobials prescribed for urinary indications in a large group of nursing home residents. Results of other trials of interventions for optimising antimicrobial use for urinary tract infection have shown only modest benefit.[22,23] These studies were, however, geared to physicians in general practice and not to the nursing home setting. Our findings of a 31% reduction in antimicrobial use for urinary indications support recommendations that without a minimum set of urinary symptoms or signs, urine should not be cultured and antimicrobials should not be prescribed for residents of nursing homes.[18] Although antimicrobial use for suspected urinary tract infection was reduced, the intervention did not significantly reduce overall antimicrobial use. This finding is not unexpected because the intervention was limited to urinary indications. An alternative explanation that was not borne out by the data is that physicians changed the indication, shifting from a urinary to a non-urinary indication to bypass the algorithms and use antimicrobials. This would have resulted in increased use for non-urinary indications, which was not seen in our data. Physicians and nurses who were interviewed at the end of the study about barriers to sustainability did not identify relabelling as an issue.

The rate of culturing urine was not significantly different between the study groups. The purpose of the diagnostic

What is already known on this topic

Antimicrobial use among residents of nursing homes is common and often inappropriate

Little is known about interventions to optimise antimicrobial use in this setting

What this study adds

A multifaceted intervention using diagnostic and therapeutic algorithms resulted in fewer antimicrobial prescriptions for urinary indications in nursing home residents

Implementing large scale intervention studies to improve antimicrobial use in long term care facilities is feasible

algorithm was to reduce the number of inappropriate urine cultures, leading to fewer prescriptions for antimicrobials. This is based on previous data indicating that positive urine cultures for asymptomatic bacteriuria often serve as a trigger for inappropriate prescribing of antimicrobials.[4 17] Where a significant difference was shown, it is possible that the therapeutic algorithm was the more important of these two components of the intervention. Alternatively, the reduction in number of urine cultures ordered may have helped reduce urinary antimicrobial use even if a significant reduction in culture rate could not be shown.

Limitations of the study

One limitation of our study is that it may not be generalisable to nursing homes with fewer than 100 residents. Our study was underpowered to assess important differences in admissions to hospital and death between study arms. Another limitation is that differences between the study arms in antimicrobials courses for urinary indications were reduced during the final months of the study, although the trend was not statistically significant. This may have been due to fatigue of the healthcare provider with the intervention.

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Competing interests: None declared.

Ethical approval: This study was approved by the McMaster University ethics committee and the medical advisory committees or resident councils of the nursing homes.

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