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A nurse led education and direct access service for the management of urinary tract infections in children: prospective controlled trial

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Abstract

Objectives To determine whether a nurse led education and direct access service improves the care of children with urinary tract infections.
Design Prospective cluster randomised trial.
Setting General practitioners in the catchment area of a UK paediatric nephrology department.
Participants 88 general practices (346 general practitioners, 107 000 children).
Main outcome measures Rate and quality of diagnosis of urinary tract infection, use of prophylactic antibiotics, convenience for families, and the number of infants with vesicoureteric reflux in whom renal scarring may have been prevented.
Results The study practices diagnosed twice as many urinary tract infections as the control practices (6.42 *v* 3.45/1000 children/year; ratio 1.86, 95% confidence interval 1.42 to 2.44); nearly four times more in infants (age <1 year) and six times more in children without specific symptoms. Diagnoses were made more robustly by study practices than by control practices; 99% *v* 89% of referred patients had their urine cultured and 79% *v* 60% had bacteriologically proved urinary tract infections ($P<0.001$ for both). Overall, 294 of 312 (94%) children aged under 4 years were prescribed antibiotic prophylaxis by study doctors compared with 61 of 147 (41%) by control doctors ($P<0.001$). Study families visited hospital half as much as the control families. Twice as many renal scars were identified in patients attending the study practices. Twelve study infants but no control infants had reflux without scarring.
Conclusion A nurse led intervention improved the management of urinary tract infections in children, was valued by doctors and parents, and may have prevented some renal scarring.

Introduction

General practitioners in the United Kingdom manage urinary tract infections in children variably, and evidence suggests that their practice does little to prevent renal scars.[1–3] Rigorous hospital based primary care in Sweden has reduced scarring and rates for end stage renal failure in children.[4] We aimed to determine whether the management of urinary tract infections in children in the United Kingdom could be improved with a different healthcare model.

We had already piloted a model allowing general practices direct access to imaging for children with a bacteriologically proved urinary tract infection. This made practices the focus for management, improved diagnostic standards, reduced delays in treatment, and minimised hospital visits. The present study extended this protocol to further general practices, coordinated by a nurse practitioner.

Methods

We invited all general practices, excluding the pilot practices, in our catchment area to participate. Allocation to study or control practices was by stratified randomisation according to health district, whether the practice had a trainee doctor, and whether the practice population of children exceeded 1000. Patients referred by control practices were identified from referral letters and requests for imaging, and data were collected as soon as the paired study practice had been enrolled.

Control practices were not asked to change their management. Paediatricians followed their standard practice, assessing cases and explaining the imaging investigations when indicated, assisted by information sheets. Children with a probable or certain urinary tract infection underwent ultrasonography and scanning with dimercaptosuccinic acid; infants (age <1 year) also underwent cystography.[5] Infants without scars or vesicoureteric reflux were considered at negligible risk of future scarring, as were unscarred children aged over 4 years. Children aged 1-4 years were considered still at risk of scarring with future urinary tract infections.[6]

A nurse practitioner and a part time clerk facilitated the study service. Study doctors were educated about the study at a seminar held at their practice. New management guidelines covered clinical awareness; collection, storage, and culture of urine samples; phase contrast microscopy; antibiotic treatment; information for parents; and management of children according to their imaging results and age (see bmj.com). Doctors ordered imaging investigations and bacteriology through the nurse practitioner. She sought clarification about equivocal referrals; organ-

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Three extra tables appear on bmj.com

Table 1 Referral rates of infants and children with suspected urinary tract infections from study and control practices, according to clinical category (excluding 22 first seen by deputising doctor or casualty officer)

Clinical category	No of children referred per 1000 children/year		Study:control practices (95% CI)	P value
	Study practices	Control practices		
All children	6.42	3.45	1.86 (1.42 to 2.44)	<0.001
Infants aged <1 year	0.92	0.24	3.84 (1.94 to 9.32)	<0.001
Children and infants with non-specific symptoms only and no urethral symptoms*	1.49	0.24	6.10 (3.47 to 11.76)	<0.001

*From 841 children and infants whose presenting symptoms were described with sufficient accuracy.

Table 2 Proportion of study and control children given antibiotic prophylaxis while awaiting imaging investigations for suspected urinary tract infection

Age group	No (%) of children given prophylaxis		Study:control practices (95% CI)	P value
	Study practices	Control practices		
<1 year	82/85 (97)	12/22 (55)	2.09 (1.37 to 4.29)	<0.001
1-2 years	55/55 (100)	20/34 (59)	2.11 (1.51 to 3.53)	<0.001
2-3 years	84/90 (93)	18/51 (35)	2.37 (1.66 to 3.88)	<0.001
3-4 years	73/82 (89)	11/40 (28)	2.89 (1.81 to 5.82)	<0.001
>4 years	82/278 (29)	13/143 (9)	4.46 (2.45 to 9.17)	<0.001

ised imaging investigations; reviewed results with a paediatric nephrologist, radiologist, and medical physicist as necessary; and informed the doctor and family of normal results. Only children with abnormal results saw a paediatric nephrologist. Direct access was refused if study practices could not provide clinical details or failed to collect a urine sample. Practices were offered a phase contrast microscope and training in its use.

Simultaneously, a community paediatrician independently introduced a form of direct access for four control practices which involved no training element or any specific quality requirement for referrals. We analysed these with the control practices and separately.

For each practice we calculated the annual referral rate per 1000 children. We analysed similarly the proportions of referred children in a practice who had particular attributes, such as treatment without delay. Conditional logistic regression was used for comparisons within practices—for example, between patients with urethral and systemic symptoms. Geometric means for waiting times for imaging for each practice were computed and compared for study and control practices.

Results

Our catchment area comprised 104 general practices; 16 declined to participate. The remaining 88 (85%) were randomised equally into study and control practices. A nurse practitioner enrolled practices over four months. Subsequent contact included frequent telephone guidance and 36 seminars. Referrals were monitored for a mean of 20 months, totalling 180 000 children years. Seven practices analysed urine by microscopy.

Referral patterns

The quality of diagnosis was poor for 22 patients (2%) seen by deputising or casualty doctors; only six (27%) had a bacteriologically proved urinary tract infection compared with 635 of 884 (72%) seen by general practices. The general practitioners referred 884 children overall (5.1/1000 annually).Compared with the control practices the study practices referred twice as many children, nearly four times as many infants, and six times more patients without urethral symptoms, and they did so consistently throughout the study period (table). Children without urethral symptoms were predominantly younger; 48 of 84 (57%) were infants but only 28 of 404 (7%) were children aged over 4 years (odds ratio 12.4, 95% confidence interval 5.8 to 26.2, $P<0.001$). Referral rates were unrelated to practice size or trainee status of the doctors. Both groups had identical age and sex profiles. Male and female infants were referred equally, but among children aged over 1 year females outnumbered males fourfold.

Urine collection

Urine pad (study 75 of 85; 88%, control 19 of 22; 86%) or clean catch was mostly used to collect urine from infants; only four sterile adhesive collection bags were used. More study parents than control parents also used pads for infants aged 1 or 2 years (81% *v* 49%: ratio 1.67, 1.13 to 3.03; $P=0.001$) and potties for infants aged 2 or 3 years (26.4% *v* 10.5%: 2.51, 1.08 to 11.03; $P<0.02$), and 95% prepared them appropriately compared with 43% of control parents (2.24, 1.11 to 8.00; $P<0.001$). Among children aged under 4 years awaiting investigations, more in the study group (294 of 312) than in the control group (61 of 147) were given prophylactic antibiotics (table 2).

Standards of microbiology

More children referred from study practices than from control practices had bacteriologically proved urinary tract infections (see table A on bmj.com). More were unequivocal, with $>10^5$/ml *Escherichia coli*, *Proteus* spp, or *Klebsiella* spp (study 79%, controls 60%: 1.31, 1.16 to 1.54; $P<0.001$), and only five study children compared with 31 control children had no urine cultured (1% *v* 11%: 0.09, 0.01 to 0.25; $P<0.001$). Fewer study practices than control practices referred children whose colony counts excluded infection (7% *v* 17%: 0.41, 0.21 to 0.72; $P=0.008$). Equivocal cases were referred equally (study 14%, controls 12%: 1.12, 0.69 to 1.80; $P=0.62$).

Treatment delays

Study practices started a smaller proportion of children on antibiotic treatment immediately (48% *v* 68%: 0.70, 0.59 to 0.83. P < 0.001), waiting instead for the culture result. However, because they diagnosed more children, they treated more without delay (300 *v* 186). Immediate treatment was less common among children without urethral symptoms (without 48%, with 70%: 3.40, 2.21 to 5.23; P < 0.001) in both groups (test for interaction P = 0.26). Study practices used nitrite sticks less often (study 18%, controls 41%: 0.44, 0.26 to 0.68; P < 0.001), but they were more likely to treat immediately when they did (with sticks 69%, without 43%: 3.07, 1.75 to 5.37; P < 0.001). Few study practices assessed urine by microscopy (study 4%, controls 3%: 1.36, 0.27 to 11.70; P = 0.78).

Renal imaging

Of 644 children with unequivocal, uncomplicated urinary tract infections, 598 underwent ultrasonography and scanning with dimercaptosuccinic acid, 12 underwent scanning with dimercaptosuccinic acid only, and 15 underwent ultrasonography only (see table A on bmj.com); 3% of families in each arm refused all investigations (study 14, controls five). Nine children were not scanned because of previous normal imaging at age over 4 years. Three study children were initially assessed by a paediatric nephrologist. Most children whose urine was not tested or was equivocal were imaged. Many study children and most controls whose bacteriological evidence excluded a urinary tract infection were still imaged (study 60%, controls 90%: 0.67, 0.44 to 0.90; P < 0.03).

Similar numbers of study and control children were imaged within the target of four months after referral (study 26%, controls 21%: 1.24, 0.72 to 2.35; P = 0.51). For the rest, study children were delayed for a geometric mean of 26 days and control children for a geometric mean of 68 days (0.38, 0.31 to 0.49; P < 0.001). Study families attended hospital a mean of 1.3 times compared with 2.6 for control families.

Renal scars were identified in 10 study children (five multiple) and five control children (two multiple). Four study children had other parenchymal abnormalities, and one control child had nephrocalcinosis. Cystograms showed vesicoureteric reflux in 19 of 86 (22%) study children and 2 of 19 (11%) control children (see table B on bmj.com). Twelve study infants and no control infants had reflux without scarring.

Direct access alone

The control practices with simple direct access had similar standards to the other control practices but poorer standards than the study practices (see table C on bmj.com).

Discussion

A nurse led direct access service improved the management of children with urinary tract infections, was preferred by general practices and families alike, and saved time for paediatric clinics. The diagnosis rate doubled overall and quadrupled in infants and in children without urethral symptoms. The study children had the same age and sex profiles as the control children and as some previous cohorts.[7 8] These data imply that general practices without this service misdiagnose three quarters of infants with urinary tract infections and half overall. The standards of deputising doctors seemed lower.

Study practices advocated parent friendly urine collection and produced higher standards of bacteriological confirmation. We encouraged study practices to treat infants on clinical suspicion until culture results were confirmed because prompt treatment may prevent scarring.[4] We discouraged nitrite stick testing because this misses about half the cases, and we discouraged looking for white cells, which is unhelpful.[5 9] Control practices may have lowered their diagnosis rates by discarding urine samples that were negative by stick testing.[1]

Although the study practices treated more children without delay than the control practices, this represented a smaller proportion of their cases. The reasons are complex. Firstly, not all study practices may have accepted that an infant with a suspected urinary tract infection justified "blind" treatment with antibiotics. Secondly, more study patients than control patients had non-specific symptoms. Thirdly, discouraging the use of nitrite sticks reduced the opportunities for confident instant diagnoses; it may have been better to encourage their use and to ensure that negative samples were cultured. We saw 12 study infants, but no control infants with vesicoureteric reflux who remained unscarred, which is likely to reflect effective prevention.[10]

The success of our model was not through providing the direct access per se because it was ineffective when introduced alone by a community paediatrician. Education was vital. Informal, practical teaching during the nurse practitioner's case feedback seemed more effective than previous formal teaching.

Our model has several advantages: general practices retain clinical control, families are managed by their own doctor, fewer hospital visits are needed,

What is already known on this topic

It is often difficult to diagnose urinary tract infections in children, especially infants aged under 1 year

General practices may fail to make a bacteriological diagnosis, miss the diagnosis, or start treatment after a delay

Renal scarring, which can occur rapidly in children aged under 4 years, may be prevented by early treatment

What this study adds

A nurse led education model improves the rate and bacteriological quality of diagnoses of urinary tract infections made by doctors in children

The model combines continuing education, the ordering of imaging investigations by the general practitioner, and their management of patients with normal results

The rate of diagnosis increased fourfold among infants, who are at greatest risk of scarring

and parents need less time off work to attend consultations. This model is now being run as a clinical service.

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Competing interests: None declared.

Ethical approval: This study was approved by the Newcastle joint ethics committee and steered by a multidisciplinary group.

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Proactive asthma care in childhood: general practice based randomised controlled trial

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Abstract

Objectives To assess the feasibility and effectiveness of a general practice based, proactive system of asthma care in children.
Design Randomised controlled trial with cluster sampling by general practice.
Setting General practices in the northern region of the Australian Capital Territory.
Participants 174 children with moderate to severe asthma who attended 24 general practitioners.
Intervention System of structured asthma care (the 3+ visit plan), with participating families reminded to attend the general practitioner.
Main outcome measures Process measures: rates for asthma consultations with general practitioner, written asthma plans, completion of the 3+ visit plan; clinical measures: rates for emergency department visits for asthma, days absent from school, symptom-free days, symptoms over the past year, activity limitation over the past year, and asthma drug use over the past year; spirometric lung function measures before and after cold air challenge.
Results Intervention group children had significantly more asthma related consultations (odds ratio for three or more asthma related consultations 3.8 (95% confidence interval 1.9 to 7.6; P = 0.0001), written asthma plans (2.2 (1.2 to 4.1); P = 0.01), and completed 3+ visit plans (24.2 (5.7 to 103.2); P = 0.0001) than control children and a mean reduction in measurements of forced expiratory volume in one second after cold air challenge of 2.6% (1.7 to 3.5); P = 0.0001) less than control children. The number needed to treat (benefit) for one additional written asthma action plan was 5 (3 to 41) children. Intervention group children had lower emergency department attendance rates for asthma (odds ratio 0.4 (0.2 to 1.04); P = 0.06) and less speech limiting wheeze (0.2 (0.1 to 0.4); P = 0.0001) than control children and were more likely to use a spacer (2.8 (1.6 to 4.7); P = 0.0001). No differences occurred in number of days absent from school or symptom-free day scores.
Conclusions Proactive care with active recall for children with moderate to severe asthma is feasible in general practice and seems to be beneficial.

Introduction

Proactive care (regular review), in conjunction with written asthma action plans and training in self management, improves outcomes for adults with asthma.[1] No similar evidence base exists for children with asthma. Given the high prevalence of asthma in children,[2] evaluating proactive asthma care in this population is important. Guidelines endorsing proactive asthma care have been promoted in Australia in the National Asthma Council's six step plan.[3] This has been adapted for the fee for service environment of Australian general practice with the introduction of the 3+ visit plan (3+ plan, see box).[4]

The 3+ plan does not normally demand an active recall system, which would increase attendance for proactive general practice consultations.[5] We aimed to evaluate the feasibility and effectiveness of the 3+ plan combined with active recall in the proactive management of children with moderate to severe asthma.

Methods

Recruitment

Primary schoolchildren in the Australian Capital Territory received a health survey between February and April 2000. Children were eligible for recruitment if the survey indicated that they had moderate to severe asthma, defined by National Asthma Council criteria,[3]