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Diagnostic accuracy on the management of acute paediatric urinary tract infection in a general paediatric unit

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ABSTRACT

Objective: To ascertain diagnostic accuracy of paediatric urinary tract infection (UTI) in a general paediatric unit of a district hospital. **Methods:** Retrospective case note review and comparing to the final computerised database of Human in-Patient Enquiry (HIPE) at Portiuncula Hospital, Galway, Ireland. All children from 0-16 years of age with the diagnosis of UTI were enrolled within the 3 year study period. The information was first retrieved from HIPE system to capture list of patients. Case notes revision was followed to extract data under standardized pro-forma for demography, accuracy of diagnosis, treatment instituted and investigation ordered. Patients' data was reviewed according to updated definition. **Results:** There were 85 cases treated for UTI during the 3 year period, and only 45 cases were considered as genuine UTI according to diagnostic criteria. Out of 45 cases, 16 cases were considered as suspected UTI cases. *Escherichia coli* was noted to be the commonest organism. Cephradine has been used as the first line treatment as per local guideline; however, different antibiotic regimes were based on physician's preferences. The sensitivity of the current method of UTI diagnosis remained at 64% when comparing final diagnosis in the HIPE system. **Conclusions:** UTI can be difficult to accurately diagnosis in certain clinical cases. Decisions made should be individualized and tailored according to clinical suspicion and presentation of the patients. Improvement to ensure accurate diagnosis is vital to ensure correct data capture in the HIPE system thus giving valuable information and resource for future care.

1. Introduction

Urinary tract infection (UTI) is a common infection after respiratory tract infection. Paediatric UTI is associated with the presence of vesicoureteric reflux (VUR), hypertension and other congenital anomalies[1]. Factors predispose children to UTI include congenital and functional abnormalities, and even environmental factors. Long term sequalae of UTI as a result of coexistence of VUR is renal scarring leading to renal insufficiency. Accurate diagnosis is important to ensure adequate therapy and proper follow up is done to prevent future complication[2]. The goal of management should be focusing on accurate diagnosis, followed by identifying risks factors and high risk patients[3]. The management of UTI varies among the physicians due to different understanding and evolving nature of the research findings. Despite the availability of updated evidence, differences of management can be seen between the district and regional hospitals, and between the managing medical or surgical team. Knowledge on UTI should be regularly updated to ensure a universal approach to diagnosis and management of this condition in children.

UTI is defined as the presence of abnormal urinalysis result that suggest infection (pyuria and bacteriuria) and a positive culture at least 50000 colony-forming units per mL of uropathogen cultured from a urine specimen obtained by catheterization and suprapubic aspiration[4]. Lower counts as 10^2 cfu may be significant especially in boys and specimen obtained by suprapubic aspiration or catheterization[6]. Complicated UTI (includes pyelonephritis) is defined as UTI which was complicated by virulent organism, the finding of abnormal urinary tract, systemic involvement,

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impaired host defence and renal function. Uncomplicated UTI is determined by growth of common uropathogen in a child with normal urinary tract and responded to antibiotic within 48 hours of treatment. Suspected UTI cases is coined to patients with symptom consistent with UTI but urine growth was either contaminated with multiple organism or sterile as a result from partial treatment by antibiotics[7]. Low count UTI are those with low count bacteriuria $<10^5$ CFU but have persistent urinary symptoms which may account for early phase of UTI[8-10]. Urethral syndrome or urethritis is an inflammation or irritation of urethra with usually evidence of pyuria on dipstick and negative urine culture[11]. Contamination sample referred to the presence of multiple organisms in urine culture which does not represent of infection. Asymptomatic bacteriuria are group of asymptomatic patients with bacterial colony count $>10^5$ CFU without the presence of pyuria on urinalysis[12,13].

The purpose of study is to review the accuracy of diagnosis made either by medical or surgical teams when compared to the final Human in-Patient Enquiry (HIPE) data capture and to investigate overall method of investigations and management of UTI at a district general hospital.

2. Material and methods

A retrospective review of case notes was conducted at Portiuncula Hospital, a district general hospital located in the West of Ireland. Approval to conduct the study has been granted from the Paediatric Department and the National University of Ireland, Galway. The study population included all children from 0-16 years, who were admitted under either medical or surgical team, with primary or secondary diagnosis of UTI, which has been keyed in HIPE system. Standardized pro-forma was designed to extract demographic details and clinical information in the studied population. It covered diagnostic precision and evaluation of management following the diagnosis. Patients with known renal or urological abnormalities were excluded. Patients' case notes were carefully examined using diagnosis criteria and classification to achieve the objective of the study. We used operational definition based on the finding and classified into UTI and non UTI group. Under UTI group, we sub classified into true UTI and suspected cases of UTI. Suspected cases of UTI were examined to ascertain the accuracy of diagnosis based on clinical criteria despite mixed or low count growth of microorganisms. For non-UTI group, we further divided into urethral syndrome, asymptomatic bacteriuria and contamination group accordingly (Table 1).

Data were stored using Microsoft Excel and further statistical test were performed to view descriptive data and statistical analysis. All P value below 0.05 were considered as significant. Sensitivity, specificity, positive predictive value and negative predictive value for UTI were calculated based on the current practice method of urine collection.

3. Results

3.1. Study demography and diagnosis

During the 3 year study period, 85 patients (Table 2) were identified through HIPE system as positive for UTI. The age group of subject ranged from 0-16 year of age at the time where the study was commenced. Fifty nine (69.4%) of those participants were male. Fifty four (73.5%) of the recruited participants were age below five. Majority of the cases (77, 90.6%) were from medical patients who were admitted for further investigation and management of UTI. The confirmed cases of UTI were 45 (52.9%) only (Figure 1). Out of this, 29 (34.1%) were true UTI cases and 16 (18.8%) were 'suspected' UTI cases. These included cases whereby patients have been commenced on antibiotic prior to presentation to the hospital, or those who perhaps have had early UTI with a positive low count bacterial growth. Also 68 (80.0%) of the patients only stayed in the hospital less than 4 days in the hospital as a result of successful antibiotic therapy and majority were discharged without any major complication.

Table 1
Criteria for diagnosis UTI.

	Diagnosis	Criteria
UTI	Symptomatic	a. Clean catch needs ≥ 2 samples with pure growth of single organism $>10^5$ with positive urinalysis for infection b. SPA/Catheter sample needs only growth of organism which count may be $<10^5$ (50 000 CFU/mL) c. Symptom of UTI or more non specific in younger age group
	Possible/Suspected	a. Based on single clean catch per urethra with growth of single organism $>10^5$
		b. Young children who are empirically started on antibiotic to treat other condition ie URTI, but showed either mixed or sterile growth on urine culture (Masked by antibiotic coverage)
		c. Low count bacterial count (10^4-10^5 CFU) on urine culture with persistent UTI symptom (Lower Count UTI)
Non UTI	Asymptomatic bacteriuria	a. Clean catch needs ≥ 2 samples with pure growth of single organism $>10^5$ without significant pus cell b. No symptom of UTI
	Urethral syndrome	Persistent pyuria without any growth or count $<10^5$ of organism on urine culture
	Contamination	a. Multiple organism seen on urine culture b. Epithelial cells on urine microscopy c. Varying organism between sample d. Identified organisms like streptococcus or corynebacterium on urine culture are regarded as contaminants

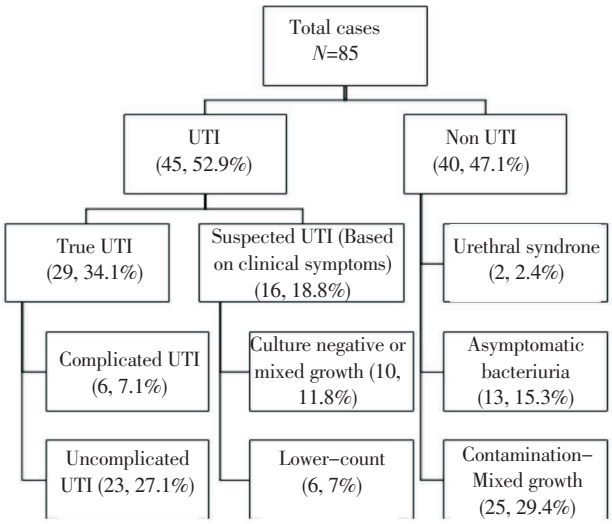

Figure 1. Classification of UTI and Non UTI depending on definition.

Table 2
Demographic and baseline characteristic.

Variable	No. of cases [*n* (%)]
Age at time of study (year)	
<1	11 (12.9)
1-5.0	43 (50.6)
5.1-10	16 (18.9)
>10	15 (17.6)
Sex	
Male	59 (69.4)
Female	26 (30.6)
Length of stay (day)	
1-3	68 (80.0)
4-5	8 (9.4)
>5	9 (10.6)
Admission	
Medical	77 (90.6)
Surgical	8 (9.4)

3.2. Investigations

Mid stream urine (MSU) was the most common method of urine collection with 64 (75.3%), with urine bags in 13 (15.3%), clean catch in 7 (8.2%) and catheter sample in 1 (1.1%) of the cases. We also noted despite MSU as a reliable method of sampling, there were contaminated samples in 17 (26.5%) out of 64 in MSU group, 2 (28.6%) out of 7 from clean catch group and 6 (46.2%) out of 13 from urine bag group. Overall, we found that overall the sensitivity of urine collection in this study 64% and specificity was 5% using the method of collection employed in this study (Table 3). The commonest uropathogen identified was *Escherichia coli* (41), followed by *Coliform species* (15), *Pseudomonas aureginosa* (2), *Proteus mirabilis* (1) and *Streptococcus species* (4).

Table 3
Specificity, sensitivity, positive predictive value and negative predictive value of UTI diagnosis based on revision of overall UTI criteria and urine collection method.

UTI	Specificity (%)	Sensitivity (%)	PPV (%)	NPV (%)
UTI diagnosis (Clinical criteria & urine collection method *i.e.* clean catch *etc*)	5	64	43	11

PPV: Positive predicted value, NPV: Negative predicted value.

3.3 Management

There were 37 (43.5%) patients who received first line antibiotic according to our hospital protocol. Three were commenced on Co-amoxiclav (Augmentin), and the remaining seven with variety of other antibiotics. Thirty eight (44.7%) of the patients were not on antibiotics due to uncertainty of the UTI diagnosis. A total of 47 (55.3%) patients received antibiotics and out of those only 2 from non-UTI group. Prophylaxis antibiotics were commenced on all complicated UTI patients (7.1%) and 10 (11.7%) out of 23 uncomplicated UTI cases.

All complicated UTI cases completed ultrasound, DMSA and MCUG investigations. In suspected UTI cases investigations were performed to support and aid the uncertainty of UTI diagnosis. In non-UTI cases, none of the cases had imaging. The co-morbid risk in this studied population were constipation (10.5%), recurrent UTI (16.5%) and accidental finding of kidney anomalies (5.9%).

4. Discussion

UTI can be difficult to diagnose. It involves a combination of clinical, laboratory and radiological investigations to accurately diagnose the condition. Wide range of practices are seen among physicians despite established standard local policy and guidelines. The universally agreed definition is symptom of UTI together with the presence of single pathogenic microorganism $>10^5$ CFU/mL in the urine in one or two consecutive urine samples[14]. However, a revised definition by the American Academy of Pediatrics stressed on positive urinalysis and the finding of 50 000 CFU/mL of organism if investigated via catheterization or suprapubic aspiration[4]. We classified the pool of cases as UTI and non-UTI depending on the agreed definition. Interpretation of urine result can be challenging and must be carefully executed. Clear cut cases are labelled as true UTI and fit the established definition. 'Suspected' or 'Possible' UTI cases refer to cases of children with high clinical suspicion of UTI but patients were started with antibiotic therapy for other reason prior to hospitalization. Hence, the urine may become sterile or produce a culture of mixed or multiple organisms, due to partial response to empirical antibiotic treatment. This small group of patients were categorised as UTI due to the presence of clinical symptoms or high index of suspicion for UTI. Serial urine examination are required in these cases[15].

There were 45 UTI cases and 40 non-UTI cases which were captured as UTI in HIPE data. These data exercise is important for hospital policy, disease prevalence and channelling of hospital fund towards effective treatment and management. A study on HIPE system reported that coding accuracy for any primary diagnoses was 59%[16], compared to 53% in our study. The sensitivity using the current modality of diagnosis criteria and method of investigation was 64%. The reason in low sensitivity mainly is unstandardized urine

collection method in children including unreliable urine bag collection. The accuracy of HIPE diagnosis depends on the final clinical decision or reporting made by the managing physicians. There are various factors which could influence clinicians' decision process. UTI diagnosis could be masked by number of urine sample collection, delayed availability of the culture result, and repeat urine study, differences of management and diagnosis between medical and surgical disciplines. Most of UTI cases in surgical patients were in the adolescent and, hence, aggressive investigations were not warranted in this age group. Urine bag has been remained a favourable option of urine collection method especially in the emergency department. Clean catch, though time consuming, was a preferred mode of urine collection in the paediatric ward.

The majority of UTI cases identified were from uncomplicated UTI group(23/45). Small number (16/45) of patients was diagnosed as UTI despite unfulfilling the standard criteria. Clinical symptoms with findings of mixed growth or low count are in the urine culture. Unclear results were as a result of partial response to antibiotic commenced in the community. This explained reduction in the urinary pathogen load in the culture but did not eradicate the urinary symptoms. Asymptomatic bacteriuria (13/40) cases have been a coincidental finding when the patients were admitted for other medical conditions (*i.e.* viral illness) and urine culture was ordered as part of infection screen[12]. Attempts should be carefully made to ensure that urinary sampling was performed when indicated with correct method of sampling to avoid spurious result.

The term about lower counts of UTI, urethral syndrome, asymptomatic bacteriuria and masked infection can be confusing. Persistent symptoms are probably due to incomplete clearance of uropathogen by partially sensitive antibiotic, inadequate growth of uropathogen in the bladder, high output urinary outflow and slow growth of uropathogen[9]. The revised practice guideline in 2011 have caused considerable paradigm shift depending on quality of evidence and strength of recommendation especially in infants and small children with unexplained fever. Older children are excluded due to co-morbidities such as dysfunctional elimination. Development of the algorithm for diagnosis and management for children has simplified diagnostic criteria. Aggressive urinary investigation according to gold standard suprapubic aspiration and catheterization is mandatory to confirm the underlying UTI. However, majority of hospitals still adopted a less invasive approach to diagnosis. Urinalysis availability somehow differs in different hospital settings. There is fundamental lack of resources for investigations leading to treatment-based on clinical suspicion when culture is inconclusive. We included cases of lower count and masked infection due to high index clinical suspicion. This also can be a weakness of the study due to inability to fulfil criteria defined in the American Academy of Pediatrics guidelines. Over diagnosis of UTI has been a common problem which has led to aggressive antibiotic therapy and unnecessary imaging. Although low counts and mixed growth can represent contamination, with the presence of clinical symptoms, it is vital to be aggressive in treatment rather than under treating the condition medically.

Cephradine has been the first line antibiotics in our hospital setting and has been used in 37 patients. Other antibiotics were indicated when the urine culture showed intermediate sensitivities to cephradine. In complicated UTI, broad spectrum antibiotics were preferred parenterally. Cephradine is a first generation cephalosporin that covered treatment for skin, urinary tract and respiratory tract infection. It is cheaper and covered most of the uropathogen in our setting. Antibiotic therapy for UTI should depend on the identification of dominant uropathogen, antimicrobial sensitivity, symptom severity, community resistance, drug toxicity and cost effectiveness[26]. The use of broad spectrum antibiotic is discouraged to prevent emergence of bacterial resistant. We also noted most of our patients received 10 days of antibiotics cover. However, the practice can change in view of urinary findings, persistent systemic symptoms and other high risk factors.

HIPE is a system that maintains an accurate national database based on hospital discharge activity. This requires to meet policy makers, clinical team and researcher requirements through various development of support in data collection, audit, data quality and reporting. This is important for hospital references, census and allocation of resources. Data capturing was usually done following patients discharge by the managing team. In our study, data capture were influenced by many factors; delayed confirmatory result availability, delayed in revision of the patients' diagnosis and violated pathway of UTI management. The sensitivity of 64% for diagnosis using current method can be seen as low for a general paediatric unit. Our suggestion about regular educational approach is a must for future improvement. This is because the policy for children covers different age group and presentation with many cofounders. The educational partnership between surgical and medical disciplines is vital to ensure correct diagnosis and usage of investigational tools. The hospital will have to look at how the data is captured again because at this current model, there still lack of data accuracy in the HIPE system. Final revision of data has to be carefully revised to avoid repeated over-diagnose label as shown in our study.

Majority of UTI cases reviewed in our study did not meet the criteria of the clinical definition. This can lead to inappropriate investigation and treatment which potentially unwarranted. Discrepancy of HIPE figure was related to incomplete ascertainment and documentation which point out the study weaknesses. Clinicians should be aware that accurate diagnosis is required to capture HIPE data in suspected UTI cases. There were also inappropriate variation

of antibiotic prescribing in the community and the hospital leading to unfavourable outcome such as emergence of resistance to cephradine and difficulty in yielding microorganism in the urine culture. With available evidence of the management of UTI, it is essential that management is done according to universally agreed and international recognized practice. In borderline cases, it should be guided by clinical instinct supported with clinical presentation and laboratory findings. Evaluation of management of paediatric UTI should be in parallel with the needs of intervention to avoid future renal sequelae.

Conflict of interest statement

The authors report no conflict of interest.

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