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Short Communication

Successful antibiotic stewardship in hospitalised children in a developing nation

Fatima Mustafa[a,*], L.A. Koekemoer[a], Robin J. Green[a], Astrid C. Turner[b], Piet Becker[c], Gertruida van Biljon[a]

[a] Department of Paediaitrics and Child Health, University of Pretoria and Steve Biko Academic Hospital, Pretoria, South Africa
[b] School of Health Systems and Public Health, University of Pretoria, Pretoria, South Africa
[c] Deans Office, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa

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ABSTRACT

Objectives: Increasing antimicrobial resistance has become a looming threat to paediatric health and, therefore, health facilities are obliged to practice antimicrobial stewardship. This study was undertaken to review stewardship adherence in the Department of Pediatrics at the Central Hospital, Pretoria, South Africa.

Methods: Antibiotic prescriptions of children admitted to hospital were reviewed for consistency with the national essential medicines list from January 2017 to January 2019. Medical records of children were reviewed to obtain the primary diagnosis, requested laboratory investigations and antibiotic prescription practices. The management was adjudicated as consistent with policy by a score system.

Results: This study reveals that management was in agreement with standard guidelines in 69.3% of cases, with a range of 33–77%. From the start of the study in January 2017 to the final date in January 2019 there was a significant increase in the number of patients with respiratory tract infections who were treated correctly, increasing from 41% to 73% at study end.

Conclusions: This study is the first to report the success of antibiotic stewardship in children admitted to a tertiary hospital in South Africa. However, it is critical that antibiotic stewardship be continued and antibiotic prescriptions be aligned with guidelines.

1. Introduction

Antimicrobial resistance is an important threat to adult and paediatric health across the globe. Antimicrobial resistance will inevitability undermine a century of progress made since antibiotics were first discovered and the contribution that antibiotics have made to improve the health and survival of children in the developing world. The incremental resistance has been reported in both community-acquired and hospital care settings [1–3].

The burden of common infectious diseases has undoubtedly been reduced through the use of antibiotics in paediatric patients and forms an integral part of many medical interventions. Therapeutic guidelines for empirical treatment depend on the information available with regard to microbial aetiology and therapeutic susceptibility [1,3]. However, South Africa, in fact most of sub-Saharan Africa, lacks diagnostic capacity and antimicrobial resistance surveillance [4–9].

The inefficiency of current antibiotics against common pathogens has led high-income countries to resort to more expensive broader spectrum antibiotics, whereas in low-income or developing countries the increasing antibiotic resistance has led to an increase in morbidity and mortality [10–12].

A large-scale study collected data from 71 countries, including South Africa, to define trends in antibiotic use, between the years 2000 and 2010, and concluded that there was a 36% increase in antibiotic use across these countries. Brazil, Russia, India, China and South Africa accounted for 76% of this increase [13]. Antibiotic use varied considerably with season in most countries [13].

To counter the increasing antibiotic abuse and subsequent development of resistance, a number of countries have responded by promoting antibiotic stewardship programmes [14,15]. South Africa has a number of such programmes, but few are aimed at children [16,17].

* Corresponding author at: Department of Paediatrics and Child Health, University of Pretoria, Steve Biko Hospital, Steve Biko Street, Pretoria, 0001, South Africa.
E-mail address: u14120535@tuks.co.za (F. Mustafa).

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In addition to practicing evidence-based health care as reflected in guidelines, doctors are expected to consider antibiotic use carefully. Healthcare in South Africa is aligned with World Health Organization Integrated Management of Childhood Illness (IMCI) guidelines. The South African national Essential Medicines List (EML) has been sourced along similar lines and public sector hospitals also use local policy documents [18].

2. Materials and methods

The management of children admitted to hospital was reviewed for consistency with the Essential Medicine List (EML) and hospital antibiotic stewardship programme from January 2017 to January 2019. The antibiotic stewardship programme at this central hospital was outlined in 2016 and implemented in January 2017. It was built on the national programme and incorporated the standard elements of programmes used internationally, namely consultation with stakeholders, policy formulation, guideline development and implementation, education of clinicians, creation of networks for prescribing and audit practices, policy creation to limit antibiotic prescription practices and reporting structures. In September 2017, the policy was strengthened in paediatrics by stricter adherence to antibiotic prescribing for obvious viral infective processes.

The EML is a document that has been used in South Africa since 1996. It was based on the national drugs policy (NDP). The key goal of the NDP was to issue an EML and standard treatment guidelines for health care professionals in the public sector. The EML ordained for tertiary hospitals is a document with a list of recommendations and non-recommendations for the treatment of specific conditions.

Medical records of children aged from 3 months up to 13 years of age were reviewed to obtain the primary diagnosis, laboratory investigations conducted and antibiotic prescriptions. The management was adjudicated as consistent with policy by a score system.

The Academic Hospital is an 875-bed tertiary referral hospital for public sector patients with complicated disease. Most children are referred from the northern half of Gauteng and Mpumalanga, in South Africa. The prescription of an antibiotic for every patient during their admission was documented. All patients with a suspected infectious disease, as well as those with obvious non-infectious conditions, were included, irrespective of whether or not an antibiotic was prescribed. Patients for whom no antibiotic was prescribed were included because it is equally important not to prescribe an antibiotic when not indicated in order to evaluate adherence to the antibiotic stewardship guideline of the hospital. This local guideline has been created from national and international guidelines [19]. Children younger than 3 months or older than 13 years of age, and patients admitted to paediatric intensive care and paediatric oncology units were excluded.

The adjudication of the correct use of an antibiotic was based on application of the EML criteria [20] for the patient's disease condition, using the International Classification of Diseases 10th Edition (ICD-10) code. The score applied allowed the care giver to make only a 5% error or deviation from the EML management policy. Management was considered to be incorrect where an antibiotic was inappropriately prescribed, including incorrect class for the suspected clinical condition, incorrect duration or prescribed where not indicated (according to the hospital stewardship guideline).

Patient records were reviewed, after which the data with the specified variables were recorded onto the data collection form (DCF) and into a central database. Patient data were kept anonymous. All hospitalised children were enrolled sequentially whether or not they required an antibiotic.

For patients diagnosed with multiple medical conditions, each medical condition was separately considered.

Patient records were reviewed from admission to discharge. All special investigations that were ordered for the specific participant were checked on the laboratory database and measured against the patient records. Antibiotic changes (class, duration, timing, de-escalation and dose) made according to the results of special investigation were noted.

The management was then determined as either correct or incorrect according to the criteria outlined above. All diagnoses that were recorded from the patient folder review were then entered into an ICD-10 category from 0 to 11 (Table 1).

The final process of how patients were deemed as correctly or incorrectly managed according to the EML is highlighted in Fig. 1.

2.1. Statistical analysis

The observed data for this study are categorical and presented as frequency, proportion and percentage using Stata Release 15.1 (Stata Corporation 2017) statistical software.

3. Results

Records of 388 hospitalised patients were reviewed. The study reveals that for ICD-10 coded paediatric conditions management was in agreement with standard guidelines in 69.3% of cases, with a range from 33% (patients with diseases associated with immune deficiency and doubtful infections) to 77% (patients with viral respiratory tract infections).

In the largest category of patients 94 had a diagnosis in category 8 (pneumonia) of whom 73 were managed correctly (73/94, 78%).

Table 1
List of ICD-10 codes used in the analysis.

ICD-10 Category description	Total number of participants
0: Gastroenteritis	20
1: Tuberculosis	18
2: HIV, and related infectious diseases	17
3: Malnutrition	12
4: Meningitis	26
5: Central nervous conditions[a]	29
6: Otitis media (suppurative)	5
7: Viral respiratory tract infections	88
8: Pneumonia[b]	94
9: Asthma	13
10: GIT disorders, gall bladder and liver disorders	38
11: Skin, soft tissue infections and trauma	28

[a] Including epilepsy, convulsions, cerebral palsy, tuberous sclerosis, delayed milestones.
[b] Including cystic fibrosis, bronchiectasis, empyema, IC drains, bullae.

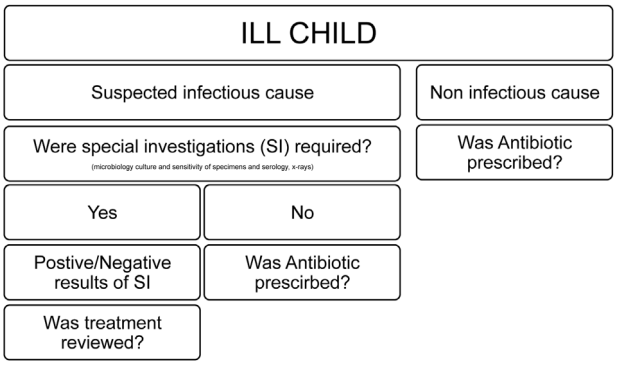

Fig. 1. Management algorithm adjudication.

Cultures were conducted in 74 patients. Among the patients managed incorrectly, cultures were performed in only 13 which resulted in change in prescription in six cases. Of the eight children in whom no cultures were conducted, antibiotic prescription was changed in five cases according to clinical assessment. Table 2 highlights the correct number and percentage of children managed for each category of disease.

The efficacy of the antibiotic stewardship programme is demonstrated in children with upper and lower respiratory tract 'viral' infections. At the start of the study in January 2017 the stewardship programme for this group of patients was poorly used, reflected by a percentage of guideline concordant treatments of just 41%. In January 2019 there was a significant increase in the number of patients with respiratory tract infections who were treated correctly to 73%. This occurred as a result of an educational intervention to motivate staff to pay attention to non-antibiotic management of disease patterns suggesting a viral aetiology.

From the total number of prescriptions, 388 (72.94%) of the prescriptions were not changed. Of the prescriptions that were changed, 15.21% were changed because of treatment failure, 7.73% were changed according to special investigation results (microbiology culture and sensitivity of specimens and serology) and 6.96% were changed as a result of a change in diagnosis.

4. Discussion

This study demonstrates the influence of a paediatric antibiotic stewardship programme in a tertiary public sector academic hospital in a developing country, and the need to continually review the programme in order to curb the growing threat of antibiotic resistance.

This study also suggests that, although more than two-thirds of patients were managed according to the standard treatment guideline, there is still a large number of children who were treated incorrectly. This management discrepancy may be attributed to many factors that cannot be controlled. As an example, this hospital shares training clinicians (e.g. interns, residents and fellows) who rotate through a number of referral hospitals, and, although the EML is used as the standard guideline, it is not equally implemented at all hospitals. The drugs listed in the EML are considered to be the most effective option for a certain condition. The selection of these drugs is a lengthy process.

This study excluded patients admitted to the paediatric oncology and ICU units, neonates and infants <3 months old. These patients are more susceptible to serious and life-threatening illness and the individualisation of care is balanced against strict adherence to treatment guidelines. These patients may provide additional comparative information to support antibiotic stewardship programmes and the plan is to include these critically ill patients in future studies. Categories 7 and 8 (viral respiratory infections) demonstrate the positive effect of the antibiotic stewardship programme in this tertiary hospital. During the period January to September 2017, patients with 'viral' respiratory infections made up the largest number of incorrectly managed patients. After a strict adherence to antibiotic prescription policy was implemented in September 2017, there was an immediate and

Table 2
Correct antibiotic selection numbers (%) based on appropriate, or not, specimen collection for culture and sensitivity.

ICD-10 category number/description	Correct management				Total (%)
	Appropriate specimen culture performed; antibiotic not changed	Appropriate specimen culture performed; antibiotic changed	No specimen culture necessary; antibiotic change	No specimen culture necessary; no antibiotic change	
0: Gastroenteritis	10	3	3	0	16 (80)
1: Tuberculosis	8	5	0	0	13 (72)
2: HIV, and related infectious disease	10	1	4	0	15 (88)
3: Malnutrition	3	1	0	0	4 (33)
4: Meningitis	14	5	1	1	21 (81)
5: Epilepsy and CP, tuberous sclerosis, delayed milestones, febrile convulsions	4	12	5	0	21 (72)
6: Otitis media (suppurative)	0	0	2	1	3 (60)
7: Viral respiratory tract infections	22	4	30	3	59 (67)
8: Pneumonia	46	15	9	3	73 (78)
9: Asthma	2	0	6	0	8 (62)
10: GIT disorders, gall bladder and liver disorders	10	0	12	0	22 (58)
11: Skin, soft tissue infections and trauma	9	2	3	0	14 (50)

noticeable improvement in limiting unnecessary and incorrect antibiotic prescriptions for children with obvious 'viral' respiratory tract infection. In children the management of respiratory tract infections with inappropriate antibiotics is one of the greatest drivers of antibiotic resistance. This change in management is critical to the antibiotic stewardship programme. There is no doubt that the antibiotic stewardship programme has been successful at least in this category of diseases.

A further step is to roll out the correct prescription practices across all other disease conditions to perform appropriate cultures where applicable and act on positive cultures according to the sensitivity of organisms.

The antimicrobial stewardship programme in this central hospital is implemented in line with paediatric NEML guidelines for secondary level hospitals. Most of the antibiotics that are currently registered for use in children are available in this tertiary hospital. However, having all these antibiotics available adds to the risk of inappropriate antibiotic prescribing and increasing antibiotic resistance. This risk underlines the importance of having an adjustable and enforceable antibiotic stewardship programme in place.

The study has a number of limitations, including the small sample size (especially within each designated ICD-10 grouping), a lack of well-defined parameters to adjudicate correct antibiotic use and the inability to conduct real time analysis for change.

In conclusion, it appears that most paediatric patients at this tertiary hospital are being managed in accordance with the stewardship programme. The study demonstrates that ongoing education is required to modify antibiotic prescription practices for diseases with an obvious viral aetiology and that such educational practices can bear immediate results. This analysis is critical as central hospitals lead the care of patients across other levels of care in South Africa and other developing nations.

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Conflict of interest

None declared.

Ethical approval

Approval to conduct this study was obtained from the University of Pretoria, Faculty of Health Sciences, Research Ethics Committee (No.: 109/2019).

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