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ORIGINAL ARTICLE

IMPACT OF A URINE CULTURE FOLLOW-UP PROGRAM ON THE REDUCTION OF INAPPROPRIATE ANTIBIOTIC USE IN CHILDREN

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ABSTRACT

Objectives: We aim to characterize the follow-up management of urine culture results from a pediatric emergency department and thus quantify the unnecessary days of antibiotic therapy avoided due to this approach.

Materials and Methods: We conducted a retrospective study in a hospital in the metropolitan area of Lisbon. Data was collected through a dataset referring to pediatric patients who visited the emergency department and had a urine culture performed in 2021. We analyzed the rate of continuation, start, suspension and switch of antibiotics after acknowledgment of urine culture results.

Results and Discussion: 851 children and adolescents were included in the study. 71.5% of patients who were prescribed an antibiotic in the emergency department and had a negative urine culture were contacted to discontinue the antibiotic. 494 days of inappropriate antibiotic treatment were avoided, corresponding to a 44.5% reduction in the number of antibiotic treatment days for these patients.

Conclusion: Our follow-up management led to a reduction of unnecessary antibiotic therapy days, thus leading to better patient care and potentially contributing towards a decreased spread of antibiotic resistance. Limitations of the study include the lack of records of the patient's medical history or clinical outcomes after discontinuation of antibiotic therapy.

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ABBREVIATIONS:

AMS – antimicrobial stewardship; ECDC – European Centre for Disease Prevention and Control; ED – emergency department; UTI – urinary tract infection

Introduction

In the pediatric population, antibiotics are among the most prescribed medicines.[1,2,3] However, its' prescription is often inappropriate, potentially leading to negative consequences, including adverse events and the emergence of bacterial resistance[4,5], a major public health threat. The term antimicrobial stewardship (AMS) refers to the use of the right antimicrobial at the right time, at the right dose and route and for the right duration.[6] The identification of microorganisms responsible for the infection with susceptibility testing and adequate follow-up is part of AMS' strategy.[6] Urinary tract infections (UTIs) are one of the most common bacterial infections in the pediatric population.[7,8] UTI symptoms are often nonspecific, especially in younger children, and results of confirmatory urine testing may take up to 48 hours, which might lead to overprescription of antibiotics.[7] The lack of a guaranteed follow-up after an emergency department (ED) visit further contributes to the overuse of these medicines.[7] Ensuring a follow-up of results of urine cultures contributes to improve patient care, enabling several actions, including the start of antibiotic therapy in view of a positive result, drug switch according to the sensitivity test, and therapy suspension when the result is negative. This approach is particularly relevant when concerning antimicrobial stewardship, allowing to avoid days of inappropriate antibiotic treatment. In our study we aim to characterize the follow-up management of urine culture results obtained in a pediatric ED, and thus quantify the days of inappropriate antibiotic therapy avoided.

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Methods & Materials

We conducted a retrospective study in a hospital in the metropolitan area of Lisbon. Data was collected through a dataset available to doctors of the pediatric department. Patients from 0 to 17 years and 364 days who visited the pediatric ED and had a urine culture performed from January 1st, 2021, to December 31st, 2021, were eligible for the study. Patients were prescribed antibiotics for a suspected UTI based on urinary tract symptoms and result of dipstick urinalysis. Urine culture was performed on urine collected by midstream or catheterization. They were excluded if an antibiotic was prescribed either (1) for a duration ≤2 days or (2) for an alternative diagnosis, such as acute otitis media or pneumonia.[7] In accordance with hospital protocol, all prescribed urine cultures in the ED were introduced into a dataset to allow a follow-up of culture results. The dataset includes the following information: date of urine sample collection, prescribed antibiotic, duration of prescribed antibiotic (in days), result of the urine culture (positive, negative, or mixed flora), sensitivity test, date of contact of the patient upon result and action taken upon contact (maintained antibiotic, switched antibiotic, started antibiotic, discontinued antibiotic, others). Urine culture results were reviewed every weekday by a medical resident and patients were contacted, with attempts in at least two consecutive days. Six possible scenarios arise from the urine culture results review: (1) urine culture is positive and the patient was prescribed an appropriate antibiotic according to the sensitivity test – no action is needed; (2) urine culture is positive and the patient was prescribed an inappropriate antibiotic according to the sensitivity test – patient is contacted in order to switch to an appropriate antibiotic; (3) urine culture is positive and the patient was not prescribed an antibiotic – patient is contacted in order to initiate an appropriate antibiotic according to the sensitivity test; (4) urine culture is negative and the patient was not prescribed an antibiotic – no action is needed; (5) urine culture is negative and the patient was prescribed an antibiotic – patient is contacted in order to discontinue the prescribed antibiotic; (6) urine culture result is mixed flora – an individualized decision is made based on the patient's symptoms and previous medical history. If urine culture was repeated, only the second result was considered for the study. Cases in which the action taken did not match one of the mentioned scenarios were individually reviewed and are reported in the study. For patients with a negative culture and a prescribed antibiotic, the difference between the prescribed days and the actual days of therapy were established by using the date of start, the prescribed duration and the date of contact by the health professional, allowing to determine the avoided days of unnecessary antibiotic treatment. Concerning patients with a positive urine culture who were prescribed an inappropriate antibiotic according to the sensitivity test, the same method was used to determine the days of inappropriate therapy avoided due to drug switch. We analyzed the data using frequencies, counts and percentages for categorical variables. The study was approved by local hospital's Ethics Committee.

Results

During the year of 2021 a total of 38275 pediatric patients visited the ED of a hospital in the metropolitan area of Lisbon. Amongst these, 900 patients had a urine culture performed and were inserted into a dataset for follow-up, which corresponds to 2.4% of visits. A total of 851 patients met the inclusion criteria, while 49 were excluded from the study due to antibiotic prescription for ≤ two days or prescription towards an alternative diagnosis. Approximately half of the patients (n=436, 51.2%) who performed a urine culture were not prescribed an antibiotic, and 90.8% of them (n=396) had a negative urine culture result, with no action needed upon follow-up (Table 1). Among the 19 patients with a positive urine culture who were not prescribed an antibiotic, 16 patients were contacted to initiate an appropriate antibiotic according to the sensitivity test, two patients were unreachable by telephone, and one patient had no information registered concerning the action taken. These 19 patients correspond to 7.9% of all positive urine cultures. Regarding the 21 mixed flora results, a case-by-case decision was made based on patients' symptomatic evolution and previous medical history, including no antibiotic prescription after patient contact or repetition of urine culture. The other half of the patients (n=415, 48.4%) was prescribed an antibiotic with a median duration of seven days (five to 14 days), and urine culture was positive in 223 patients (53.7%). Amongst these, 96.0% were prescribed an appropriate antibiotic in the ED according to the sensitivity test later available and no action was needed upon follow-up. The remaining nine patients (4.0%) were contacted to switch to an adequate antibiotic according to the sensitivity test, resulting in 29 days of inappropriate therapy avoided. Concerning the 151 patients with a negative urine culture result who were prescribed an antibiotic in the ED, 108 (71.5%) were contacted to discontinue the antibiotic. Antibiotic discontinuation occurred on average four days after its' start (one to six days). Among this group, 494 days of inappropriate antibiotic treatment were avoided, corresponding to a 44.5% reduction in the number of antibiotic treatment days for these patients. Adding to the previously described 29 days, a total of 523 days of incorrect antibiotic treatment were avoided. Twenty-one patients with negative urine culture results were contacted but the antibiotic was not discontinued due to clinical decision, either because of assumption of falsely negative urine culture or decapitated urine culture due to antibiotic exposure prior to the collection of urine. Contacts were missed in 22 patients who were not reachable by telephone. Forty-one patients with mixed flora results were individually approached, with actions after contact including repetition of urine culture, maintaining the prescribed antibiotic, missed contacts and a few patients without information registered regarding the action taken.

Table 1. Urine culture results and antibiotic prescription in the ED

	Nr. and (%) of patients		
Urine culture result	**No antibiotic prescribed 436 patients (51.2%)**	**Antibiotic prescribed 415 patients (48.4%)**	**Total 851 patients**
Positive	19 (4.4%)	223 (53.7%)	242 (28.4%)
Negative	396 (90.8%)	151 (36.4%)	547 (64.3%)
Mixed flora	21 (4.8%)	41 (9.9%)	62 (7.3%)

Discussion

In this study we aimed to evaluate the impact of a urine culture follow-up program on the reduction of inappropriate antibiotic use in children. Our study shows that this approach allowed a significant decrease in the number of days of inappropriate antibiotic treatment. Children without a UTI who were initially prescribed an antibiotic benefitted from a 44.5% reduction of inappropriate antibiotic treatment days, thus minimising harmful consequences of an unnecessary treatment. A total of 523 days of incorrect treatment were avoided between drug suspension and drug switch to adequate antibiotic according to the sensitivity test. In our study 7.9% (n=19) of children with positive urine cultures were not initially given an antibiotic, and 3.7% (n=9) were given an incorrect antibiotic according to the sensitivity test. Early and adequate treatment of UTIs is warranted to mitigate the risk of disease progression and renal scarring[9], thus the review of urine cultures and the resulting patient contact allowing for a correct treatment contributes to better patient care. The time to follow-up with an average of four days in our study might be explained by several aspects, including the fact that follow-up only takes place on weekdays and difficulty in contacting parents due to incorrect contact numbers or unanswered calls. Other studies have measured the impact of implementing urine culture follow-up strategies, with results similar to our work. A study published in 2017 reported having avoided 40% of unnecessary antibiotic days[7] after implementation of follow-up protocol, comparable to the 44.5% in our study. Similarly, another study described an increase in the rate of discontinuation of unnecessary treatment to 74.4%[9], comparable to the 71.5% rate in our study. UTIs are often challenging to diagnose in young children due to unspecific symptoms, with a high risk of misdiagnosis based on clinical assessment and dipstick urinalysis[9,10], posing the need of urine culture for definitive diagnosis.[8] Unfortunately, results might take up to 48 hours to confirm infection, leading to unnecessary empiric antibiotic therapy for presumed UTIs.[7,9,10] The review of antibiotic therapy when microbiological results are available is recommend for optimal patient care11. A recent study analyzed 293 patients discharged from an ED with suspicion of a UTI based on symptoms or dipstick urinalysis and reported almost all of them being discharged on antibiotics (98.4%), which contrasts with the 48.4% in our data.10 In the same study, 46.4% of patients received antibiotics despite negative urine cultures and none of these patients was contacted to stop the treatment.[10] Concerning the pediatric population, antibiotics are amongst the most prescribed therapeutic classes.[1,12,13] An analysis of the United States 2010 and 2011 national data reported the annual antibiotic prescription rate being highest among children under two years.[12] The same study estimated that 30% of outpatient oral antibiotic prescriptions may have been inappropriate[12], as has been reported in other studies.[14,15] The EDs and primary care are settings where the risk of overprescription seems particularly high.[16] Antibiotic use is the main driver for antibiotic resistance.[17,18] A systematic review revealed a significant positive association between antibiotic consumption and resistance.[4] A study in France focusing on UTIs in the pediatric population showed that antibiotic exposure in the 12 months preceding a UTI diagnosis was associated with an increased risk of bacterial resistance.[19] The Portuguese antimicrobial resistance landscape is still unclear, with not enough data published on the subject. According to the European Centre for Disease Prevention and Control (ECDC), in 2020 10-25% of Escherichia coli isolates were resistant to quinolones and third generation cephalosporins in the country.[17] Quinolone-resistant Escherichia coli collected from uncomplicated UTIs in Portugal have been found to be more prevalent when compared to other European countries.[20] Although the ECDC 2020 report shows a decreasing trend in the antimicrobial resistance percentage since 2016, including in Portugal[17], more than half of the Escherichia coli isolates were resistant to at least one antimicrobial group, and combined resistance to several groups was a frequent occurrence.[17] The implementation of AMS measures is crucial to decrease the emergency and spread of antibiotic resistant bacteria, using antibiotics prudently and only when necessary.[17] A systematic review on the impact of pediatric AMS programs reported that 79.6% of studies showed a significant reduction in inappropriate prescriptions.[13] Furthermore, some studies revealed an increase in bacteria susceptibility and decrease in the rate of resistance after reduction of the number of antibiotic days of therapy[13], thus supporting the importance of implementation of programs as the one portrayed in our study. Common examples of the misuse of antibiotics include prescribing antibiotics unnecessarily, incorrect spectrum of antibiotic therapy, inappropriate dose and duration of antibiotic treatment and failure to review antibiotic treatment when microbiological culture data become available.[6] The latter attitude is approached in our study, with a discontinuation rate of treatment in 71.5% of patients who were given unnecessary antibiotics and 523 days of inappropriate treatment avoided. These results portray the critical importance of reviewing antibiotic therapy according to the availability of microbiology test results and the patient's clinical response[6], in an individualized patient-centered care. AMS programs have showed a significant impact on the reduction of antibiotic use, healthcare costs and antimicrobial resistance[13], hence further expansion of these programs is urgently needed. Additional to an appropriate treatment, our follow-up strategy contributes to parental education concerning the diagnosis and managing of UTIs, offering parents the possibility to settle their doubts and referring children to further medical evaluation, when necessary, in a patient-tailored approach. Clear communication and shared decision making provides an opportunity to involve caretakers in the discussion of the best available treatment, with evidence that this approach might clarify parental misperceptions and decrease antibiotic use[21]. Parents can and should be part of AMS programs in order to assure its full implementation. Improvements to our follow-up management include a reduction in the rate of failed contacts through a simple measure of confirming parental contacts prior to ED discharge. Enhancements in dataset records are an ongoing mechanism of improving patient follow-up and avoiding lack of information. There are some limitations to our study. Information was gathered through a dataset, leading to a potential lack of information if clinicians do not fill it out correctly. There was no information regarding intake of antibiotics at the time of urine sample collection, which might hinder urine culture results. We cannot affirm with certainty if parents who were contacted and advised to suspend antibiotic therapy really discontinued the treatment, which could overestimate the impact of our approach. Furthermore, records did not concern short nor long term outcomes of patients after discontinuation of therapy. Moreover, different clinicians might differ in individualized decisions towards patients. Being a single centred study, the results might not be generalizable to all hospitals.

Conclusion

In conclusion, our follow-up management led to a reduction of unnecessary antibiotic therapy days, thus leading to better patient care, potentially reducing adverse effects of therapy, lowering healthcare costs, and contributing towards a decreased spread of antibiotic resistance. Moreover, it improved parental education towards the diagnosis and management of UTI, while being able to settle parental doubts through an individualised patient centred care. Similar follow-up methods could be implemented in other hospitals with minimal added resources and with clear benefits for patients. Further efforts in implementing AMS strategies in pediatric settings are needed.

Compliance with Ethical Standards

Funding None
Conflict of Interest None

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