Bacteria and Antimicrobial Resistance in Children at Damascus Hospital

Fares Kahal (✉ Fareskahal@hotmail.com)

Syrian Private University

Ahmed Helwani

Syrian Private University

Maher Al Bani MD

Syrian Private University

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Abstract

Background: Antimicrobial resistance is the third top-ranking global causative of death.

Aims: The aim is to evaluate antimicrobial resistance and sensitivity to aid the assessment of the efficacy in Syrian management protocols.

Methods: A retrospective study was conducted to analyze children with positive culture results presenting with nosocomial or community-acquired infections in Damascus Hospital, Damascus, Syria.

Results: 117 patients with 183 positive culture results were included in the study. The most antibiotic-resistant bacterium was *Pseudomonas aeruginosa*. The highest bacterial antibiotic resistance occurred with Ceftriaxone, *Pseudomonas aeruginosa* (89%), *Escherichia coli* (77%), *Enterobacter* (74%), and *Proteus* (42%). *Staphylococcus* sensitivity towards vancomycin was only 3%. The mortality was 19(16%), nosocomial infection 11(55%) and community infections 9(45%).

Conclusion: The efficacy of the remaining antibiotics to which the bacteria are sensitive must be maintained through rationalization of its use. Strict precautionary measures must be implemented to ban the illegal dispensation of antibiotics.

Introduction

The third top-ranking worldwide cause of death is due to antibiotic resistance. Antibiotic resistance is highly related to both high mortality rates and high medical costs in the healthcare system. New predictions show there were 4.95 million deaths in 2019 due to bacterial antibiotic resistance. Projections revealed that death will soar to an estimated 10 million deaths by 2050 as a result of antibiotic resistance.^[1]

In Syria, self-diagnosing and self-medicating is a common ritual among Syrians, seeking advice from local pharmacists is customary to avoid doctor visit expenses with a prevalence of 57%.^[2, 3] Over-the-counter sales of antibiotics have been reported in various countries of the Middle East; the prevalence of antibiotic self-medication ranged between 19 and 82%.^[4] A study carried out on pharmacists in the capital, Damascus, found that 87% of pharmacists sold antibiotics without prescription, 10% sold with prescription, and 3% refused to sell antibiotics without prescription;^[5] despite the law issued by the Ministry of Health in 1988 that specified that antibiotics were not among the drugs that could be sold without a prescription.^[6] This has resulted in the emergence of antimicrobial resistance in both nosocomial and community infections in Syria. Also, with the increased number of Syrian immigrants, this local problem evolved into a global issue as several studies conducted in Europe on Syrian immigrants have revealed many multidrug-resistant pathogens (MDR) bacteria. The presence of MDR gram-negative microbes was found in 60% of the immigrants who underwent the microbiological tests.^[7, 8]

This study aims to provide an insight into the Syrian paediatric population at Damascus hospital during the current Syrian crisis and the Covid-19 pandemic. This study aims to describe the epidemiology, culture results, bacterial antibiotic resistance and sensitivity, and outcomes of children with positive culture results presenting with nosocomial or community-acquired infections. Evaluating antimicrobial resistance and sensitivity is an integral part of assessing efficacy in our management protocols.

Methods

A cross-sectional descriptive retrospective study was conducted at the Pediatric Division in Damascus Hospital (Al Mujtahid Hospital), Damascus, Syria, between 7/31/2020 and 7/31/2021. 117 patients with 183 positive culture results were included in the study. The inclusion criteria for evaluation were medical records of children admitted to the pediatric division ≤ 13 with positive culture results. Cases with positive culture results attending the pediatric accident and emergency department were excluded (70 cases). Of 123 records found, 6 patients were admitted with positive culture results on 2 separate occasions. Data extracted from medical records in the pediatric archive included: gender, age, diagnosis, outcome (recovery or death), culture result, type of infection acquired (community or nosocomial), and types of antibiotics administered before and after culture results. Culture reports included information on the type of sample (Urine, blood, sputum, cerebral spinal fluid, cutaneous swabs, lower respiratory tract secretions, respiratory tract swabs, ascites fluid, pleural fluid, pus, swabs from central and venous catheters, swabs from urinary catheter, swabs from intubation tubes, and swabs from ICU ventilators), bacteria cultured, and bacteria's sensitivity and resistance towards antibiotics. When culture reports were missing from medical records in the pediatric archive, the culture report was found among the archives of the histopathology laboratory. Ethical approval was obtained from Damascus Hospital Institutional Review Board (IRB). Data frequencies, percentages, and means were calculated via SPSS (Statistical package for social sciences) 25.0 program for Windows.

Results

Of 117 patients, 55(47%) were male, and 62(53%) were females, the ages ranged from 3 hours to 13 years. Cases of positive culture results peaked at the age of 0-11 months 59(50%) were children aged 13 years (1%) represented a minority (Figure 1).

The bacteria that appeared in the samples were: Staphylococcus (33%), Enterobacter (21%), Pseudomonas aeruginosa (15%), Escherichia Coli (12%), Proteus (10%), Klebsiella (3%), Acinetobacter (2%), Streptococcus (2%), Gram-positive bacilli (1%), Serratia (1%), and coliform (0.5%). The percentage of nosocomial infections was 35%, gram-positive bacteria accounted for 34% of the bacteria in the sample, while gram-negative bacteria constituted 66% of the sample. Among the community-acquired bacteria, the percentage of gram-positive bacteria was 37%, and the percentage of gram-negative was 63%. Among the nosocomial bacteria, the percentage of gram-positive bacteria was 33%, and the percentage of gram-negative bacteria was 67%. Staphylococcus aureus was the most prevalent bacteria in both nosocomial and community-acquired infections.

Staphylococcus was the most common bacteria among all age groups. The distribution of bacteria differed across each age group: Neonatal stage (< 4weeks): Staphylococcus (55%), Enterobacter (22%), Escherichia coli (11%), and Proteus (11%). Infant stage (1month-1year): Staphylococcus aureus (33%), Enterobacter (23%), Escherichia coli (15%), Proteus (8%), and Pseudomonas aeruginosa (8%). Early childhood stage (1-6years): Staphylococcus (26%), Pseudomonas aeruginosa (22%), Enterobacter (18%), Proteus : (13%), and Escherichia coli (9%). Late childhood stage (6-13years): Staphylococcus aureus (35%), Pseudomonas aeruginosa (21%), Enterobacter (21%), Escherichia coli (10%), and Proteus (6%).

The most common foci of infections were the urinary tract (37%), blood (25%), respiratory tract (21%), cutaneous (6%), and meninges (3%). The most common nosocomial infections were blood (31%), and urinary tract (31%). They were followed by respiratory tract (17%), cutaneous (9%), and meninges (6%). The most common community-acquired infections were the urinary tract (42%), and respiratory tract (24%). They were followed by blood (21%), cutaneous (4%), and meninges (3%).

The most cultured bacteria found to cause urinary tract infections were Enterobacter (30%), Staphylococci (22%), and Escherichia coli (20%), followed by Proteus (14%), Pseudomonas (10%), Klebsiella (2%), Coliform (2%). The most cultured bacteria in respiratory infections were Staphylococcus (30%), Pseudomonas aeruginosa (23%), and Enterobacter (19%), followed by Klebsiella (8%), Escherichia coli (8%), Serratia (8%), and Proteus (4%). Regarding cerebrospinal fluid (CSF), staphylococcus was the most common causative (75%), followed by streptococci (12.5%) and gram-positive bacilli (12.5%). Regarding skin infections, staphylococcus was the most common causative (58%), followed by Proteus (17%), Pseudomonas aeruginosa (8%), Enterobacter (8%), and Escherichia coli (8%). Regarding sepsis, the most common microorganisms were staphylococcus (48%), followed by Pseudomonas aeruginosa (7%), Acinetobacter (7%), Escherichia coli (4%), Klebsiella (4%), Proteus (4%), and gram-positive bacilli (2%).

The following 3 antibiotics were used as pretreatments: Ceftriaxone 67%, and was appropriate in 50% of the cases; Vancomycin 55%, and was appropriate in 56% of the cases; Azithromycin 22%, and was appropriate in 53% of the cases.

The most antibiotic-resistant bacterium was Pseudomonas aeruginosa while the least antibiotic-resistant bacterium was staphylococcus. The highest resistance occurred with Ceftriaxone, Pseudomonas aeruginosa (89%), Escherichia coli (77%), Enterobacter (74%), and Proteus (42%). Staphylococci sensitivity towards vancomycin was only 3% (Table 1).

The mortality was 19(16%), 11(55%) were due to nosocomial infection and 9(45%) were due to community infections. The age group associated with the most deaths was the newborns (33%), followed by the infants (18%), late childhood (17%), and early childhood (11%). Respiratory tract infections were the leading cause of death (59%), followed by urinary tract infections (22%), blood 11%, and cutaneous 5%; no deaths were associated with meninges. Mortality by pathogen: Enterobacter (27%), Pseudomonas aeruginosa (24%), Staphylococcus (18%), Escherichia coli (9%), Proteus (6%), Klebsiella (6%), Serratia (6%), and gram-positive bacilli (3%).

Discussion

This first study describes the outcomes of children with positive culture results presenting with nosocomial or community-acquired infections.

The percentage of nosocomial infections in our study was 35%, which is very high compared with a Chinese study, 2.56% in 2019, and decreased to 1.39% in 2020.^[9] A similar study in Iran reported the incidence of nosocomial infections as 3%.^[10]

Staphylococcus aureus was the most common in both nosocomial and community-acquired infections. *Escherichia coli* was the most common in a Chinese study.^[11]

Staphylococcus was the most cultured bacteria (75%) from cerebrospinal fluid (CSF). This is likely to be high due to the presence of only 8 CSF-positive bacterial cultures. *Staphylococcus* was also the most common causative of meningitis in a study conducted in China, the number of few positive CST bacterial cultures reflects the effect of pretreatments with antibiotics before the CSF sample collection.^[12]

There is an extremely high bacterial resistance to most of the mentioned antibiotics, especially: ceftriaxone, cefepime, cefotaxime, trimethoprim, gentamycin, levofloxacin, piperacillin with tazobactam. Our results are higher in comparison with a study conducted in China.^[11]

Shockingly *Staphylococcus* sensitivity towards vancomycin was only 3% despite the usage of vancomycin with treating susceptible infections such as methicillin-resistant *Staphylococcus aureus*.^[13]

Sadly, the number of deaths was: 19(16%), nosocomial infection 11(55%) and 9(45%) community-acquired infections 9(45%). Our results are excruciatingly higher compared with nosocomial infections in China (0.02%).

We acknowledge that there are some limitations to this study mainly with the retrospective aspect of data collection. Struggles with data collection included: disorganized medical records, subjective aspects, and illegible handwriting.

Conclusion

There is an extreme increase in bacterial resistance to most antibiotics. Pretreatment with antibiotics seems inappropriate before receiving the culture results due to the low bacterial sensitivity and high resistance. Also, unwanted side effects of antibiotic use, and incurring financial expenses without any benefit. The efficacy of the remaining antibiotics to which the bacteria are sensitive must be maintained through rationalization of its use. Educational programs targeting doctors, pharmacists, and the community will aid rational use of antimicrobials; similar programs have been implemented in various countries.

Declarations

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Availability of data and materials:

All data related to this paper's conclusion are available and stored by the authors. All data are available from the corresponding author on a reasonable request.

Conflict of interest:

The authors declare that they have no conflict of interest.

Authors' contributions:

FK and AH conceptualized the study, participated in the design, wrote the study protocol, performed the statistical analysis, participated in data collection, did a literature search, and drafted the manuscript. MA did a literature search and revision of the draft. All authors read and approved the final draft.

Tables

Table 1. Antibiotic resistance and sensitivity bacteria

Resistance					
	Escherichia coli	Enterobacter	Proteus	Pseudomonas	Staphylococcus
Amikacin	23%	36%	33%	59%	27%
Augmentin	27%	28%	50%	52%	12%
Cefuroxime	14%	28%	17%	56%	20%
Ceftazidime	32%	18%	22%	41%	28%
Ceftriaxone	77%	74%	72%	89%	53%
Cefaclor	32%	26%	28%	48%	20%
Cefepime	50%	46%	44%	63%	37%
Cefixime	45%	46%	61%	19%	28%
Cefotaxime	68%	59%	56%	67%	53%
Trimethoprim	82%	77%	61%	59%	53%
Cefpodoxime	32%	36%	50%	37%	45%
Cefdinir	50%	41%	0%	15%	20%
Ciprofloxacin	55%	23%	28%	26%	22%
Colistin	5%	3%	6%	7%	15%
Fosfomycin	14%	23%	44%	22%	3%
Gentamicin	50%	41%	72%	33%	33%
Imipenem	14%	26%	22%	44%	12%

Levofloxacin	50%	31%	28%	44%	37%
piper/tazo	27%	31%	44%	70%	20%
Nalidixic Acid	41%	38%	44%	15%	15%
Norfloxacin	5%	8%	0%	4%	3%
Pefloxacin	18%	5%	11%	26%	13%
Clarithromycin	5%	28%	33%	44%	33%
Vancomycin	-	-	-	-	27%
Sensitivity					
	Escherichia coli	Enterobacter	Proteus	Pseudomonas	Staphylococcus
Amikacin	41%	28%	17%	30%	40%
Augmentin	14%	5%	0%	0%	27%
Cefuroxime	0%	0%	0%	0%	5%
Ceftazidime	5%	3%	0%	4%	5%
Ceftriaxone	5%	0%	6%	0%	25%
Cefaclor	0%	0%	0%	0%	17%
Cefepime	9%	0%	0%	11%	15%
Cefixime	0%	5%	0%	4%	7%
Cefotaxime	5%	3%	0%	0%	20%
Trimethoprim	0%	5%	6%	0%	17%
Cefpodoxime	0%	0%	0%	0%	2%
Cefdinir	5%	3%	6%	0%	10%

Ciprofloxacin	5%	10%	0%	4%	15%
Colistin	18%	8%	0%	7%	12%
Fosfomycin	32%	18%	0%	0%	15%
Gentamicin	0%	23%	11%	15%	12%
Imipenem	23%	36%	17%	22%	43%
Levofloxacin	32%	31%	33%	11%	28%
piper/tazo	18%	15%	17%	4%	23%
Norfloxacin	14%	0%	6%	0%	0%
Vancomycin	-	-	-	-	3%
Clarithromycin	0%	0%	0%	4%	0%

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Abbreviations

MDR: Multidrug-Resistant, CSF: Cerebrospinal Fluid.

Figures

Figure 1

Positive culture results by age incidence