e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 16(3); 41-48

Original Research Article

Study to Determine the Prevalence of Urinary Tract Infection and Identify the Causative Organism and their Antibiotic Sensitivity Pattern in Moderate Acute Malnutrition and Severe Acute Malnutrition Children

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Received: 01-12-2023 Revised: 15-01-2024 / Accepted: 21-02-2024
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Conflict of interest: Nil

Abstract

Background: The purpose of this study was to ascertain the frequency of urinary tract infections in malnourished children, to identify the causal organisms, and to investigate the antibiotic sensitivity pattern of these organisms.

Methods: A Hospital-based Cross-sectional Observational Study was carried out on 160 moderately and severely malnourished children admitted to the Paediatrics department of the Nutritional Rehabilitation Centre (NRC), District Hospital Tumkur, over the course of a 12-month period from January 1, 2021, to December 31, 2021. The study was approved by the Institutional Ethics Committee, and participants provided written informed consent.

Results: In 45 (28.13%) of the children had severe acute malnutrition, while 115 (71.88%) had moderate acute malnutrition. 25 children (15.63%) were < 3SD, and 135 (84.38%) were < 2SD. The mid-upper arm circumference of 25 children (15.63%) was less than 11.5 cm, whereas the mid-upper arm circumference of 135 children (84.38%) was between 11.5 and 12.5 cm. Of the children, 146 (91.25%) had no oedema, 131 (81.88%) had no visible severe wasting, and 29 (18.13%) had visual severe wasting. The most frequent presenting symptom was fever (42.5%), which was followed by convulsions (26.68%), vomiting (26.78%), and cough (26.78%). Abdominal discomfort (6.88%), diarrhoea (6.88%), urinary bladder soreness (3.75%), increased frequency of micturition (2.5%), and renal angle tenderness (2.5%) were present in fewer than 10% of the cases. In 29 (18.13%) of the children, the urine cultures were positive, and in 131 (81.88%), they were negative. Therefore, 18.13% of the sample had a UTI. Of the 29 children whose urine cultures were positive, E. Coli was found in 15 (51.72%), Klebsiella in 5, (17.24%), Proteus in 4, (13.79%), Pseudomonas in 4, (13.79%), and Acinetobacter in 1 (3.45%). E. Coli was the most often isolated organism.

E. coli was completely susceptible to Imipenem, followed by Meropenem (93.3%), Nitrofurantoin (87%), Amikacin (86.6%), Gentamicin (73.3%), Co trimoxazole (26.66%), Cefixime (20%), Co-Amoxiclav (13.33%), Cefotaxime (13.33%), and Ceftriaxone (6.67%).

Conclusion: E. coli is the most frequent gram-negative bacilli isolated. Imipenem, Meropenem, Amikacin, Nitrofurantoin, and Gentamicin are the most effective antibacterial medicines against these species. These observations have served as the foundation for the current diagnostic and therapeutic guidelines for clinicians treating children with complex Moderate Acute Malnutrition (MAM) and Severe Acute Malnutrition (SAM).

Keywords: Urinary tract infection, Causative organism, Antibiotic, Acute malnutrition, Malnutrition Children.

Introduction

Malnutrition in children is a major global public health concern in developing countries around the world, with wide implications. Although preventable child mortality continues to decrease, under nutrition is responsible for 45% of deaths of children younger than 5 years, amounting to more than 3 million deaths each year [1]. India has the world's largest population of severely malnourished children and accounts for more than 20% of all under-five childhood deaths each year, with 2.1 million children dying before reaching their fifth birthday [2]. According to the National Family Health Survey (NFHS-3), 45.9% of India's children under the age of three are underweight, 39% are stunted, and 23% are wasted. Additionally, around 8 million (6.4%) children suffer from acute severe

malnutrition (SAM), with a mortality rate ranging from 20% to 30%. [3]. severely malnourished children have a significant mortality rate; malnutrition accounts for over 56% of all paediatric deaths. Malnutrition affects twice as many children in India as it does in Sub-Saharan Africa, and more than one-third of the world's wasted children reside there.

Malnourished children are more likely to develop invasive bacterial infections such as bacterial pneumonia [4], bacterial diarrhoea [5,6], and bacteraemia [7,8], which are primarily caused by gram-negative bacteria. Most infections and fatalities in malnourished children occur in low-income settings; therefore the organisms causing sickness are rarely discovered. Malnutrition is not only an important cause of childhood morbidity and mortality, but leads to impairment of physical and possibly of mental growth of those who survive. These children are more prone for infections [9,10].

The judicious use of antibiotics in these children is depended on culture reports. The ability of malnourished child to handle infections is lower, hence common infections from Streptococcus pneumoniae, Klebsiella pneumoniae, Escherichia coli and Hemophilus influenza is more common in them [11] leading to pneumonia, septicaemia, diarrhoea, meningitis, tuberculosis and a higher incidence of urinary tract infections as compared to non-malnourished has been documented in severely malnourished children [12]. Malnutrition and infection are a vicious cycle. The incidence of Urinary Tract Infection (UTI) in malnourished children is quite high and ranges from 5 to 35%.

Urinary tract infection is the one which may not present with overt clinical symptoms in a child who is malnourished and it is of utmost importance to identify such children who have UTI and treat them accordingly to prevent the squeal of an untreated UTI [13].

Urinary Tract Infection (UTI) is the third most common bacterial infection in infants and young children in developing countries after those of respiratory and gastrointestinal tract infection. Because of nonspecific signs and vague symptoms in very young children, they may remain unrecognized, and therefore precise data on incidence and prevalence of UTI is not available. The commonest age for occurrence of first UTI is the first year of life in both sexes but particularly in boys which mainly affect the upper urinary tract. Rapid evaluation and treatment of UTI is important to prevent renal parenchymal damage and renal scarring that can cause hypertension and progressive renal damage [14]. There is a significant association between UTI and the degree of malnutrition [15] or a sub clinical vitamin A deficiency present in the malnourished children may have predisposed them to UTI [16] and it should be routinely investigated. Most data on infections in malnourished children come from Africa. There has been very little information on prevalence of infections in children with Severe Acute Malnutrition (SAM) from India.

Aims and Objectives

- A study to determine the prevalence of urinary tract infection and identify the causative organism and their antibiotic sensitivity pattern in moderate acute malnutrition (MAM) and severe acute malnutrition children (SAM) at a tertiary care hospital, Tumkur.
- To determine the prevalence of urinary tract infection in patients with MAM and SAM.
- To identify the organisms causing UTI in patient with MAM and SAM.
- To study the antibiotic sensitivity pattern of the causative organisms

Methods

After receiving approval from the Institutional Ethics Committee and written informed consent from the study participants, A Cross-sectional Observational Study was carried out on 160 moderately and severely malnourished children who were admitted to the Department of Paediatrics at the Nutritional Rehabilitation Centre (NRC), District Hospital Tumkur, over the course of a 12-month period from January 1, 2021, to December 31, 2021.

Inclusion Criteria

- Children between the ages of 6 months to 60 months who are fulfilling the criteria for MAM and SAM
- Weight for height or Weight for length < -2 SD, using the WHO Growth Charts.
- Presence of visible severe wasting.
- Presence of bipedal oedema of nutritional origin.
- Mid upper arm circumference (MUAC) < 125 mm

Exclusion criteria -

- Children less than 6 months and more than 60 months of age.
- Children who were born either premature or post mature and/or were small for gestational age or large for gestational age.
- Children greater than 70% of the expected weight for age, non-nutritional cause of oedema.
- Children having congenital anomalies of the kidney and urinary tract (CAKUT) and anatomical abnormalities that could influence the renal size including hydronephrosis, vesicoureteral reflux, nephrolithiasis.

- Those who routinely took antibiotics/ had taken any antibiotics within one week prior to presentation.
- Children with chronic diseases such as AIDS and Tuberculosis.
- Children with known HIV infection and therefore receiving Cotrimoxazole prophylaxis.
- Inability to obtain informed consent for participation in study.

Sample size:

Sample size was calculated by using the formula for "Sample size calculation for estimating proportion". Values of proportion and standard deviation are taken from previously published article.

Z 2 □(1□□)

n□ 1□□/2 d 2

$Z_{1-\square/2}$ is the table value from the Standard Normal Distribution = 1.96

□ is population proportion= 0.155

d: the absolute precision required on either side of true value of the population proportion= 0.06

Substituting the values in the above formula we get

n= 140

Assuming Non response rate of 10% (140 + 14 = 154 ~ 160)

Total sample size is 160.

Hence study will be undertaken with minimum 160 moderate and severe malnourished children.

Statistical Methods

Data collected was entered in Microsoft excel 2010 and analysed using Epi Info software.
Descriptive statistics such as proportion mean and Standard deviation was calculated. 'p' value less than 0.05 is considered as statistically significant. Results were graphically represented where deemed necessary.

Results

Table 1: Distribution of patients according to status of Urine culture and sensitivity report

Symptoms	**Frequency**	**Percent**
Fever	68	42.50
Cough	43	26.88
Increased frequency of		
micturition	4	2.50
Pain abdomen	11	6.88
Vomiting	43	26.88
Diarrhoea	11	6.88
Urinary bladder tenderness	6	3.75
Renal angle tenderness	4	2.50
Convulsions	43	26.88
Distribution of patients according to presence of various symptoms		
Urine microscopy Pus Cell Count/hpf	**Frequency**	**Percent**
<5	131	81.88%
5 to 10	26	16.25%
>10	3	1.88%
Total	160	100.00%
Distribution of patients according to Urine microscopy pus cell count/hpf		
Urine culture and		
sensitivity report	**Frequency**	**Percent**
Positive	29	18.13
Negative	131	81.88
Total	160	100.00%

In our study group, urine examination revealed that 131 (81.88%) children had <5 pus cell count/hpf, 26 (16.25%) had 5 to 10 pus cell count/hpf, and 3 (1.88%) had more than 10 pus cell count/hpf. In our study group, 131 (81.88%) children had negative urine cultures, while 29 (18.13%) had positive ones.

Table 2: Distribution of patients according to other blood investigations

Organism Isolated	Frequency	Percent
E coli	15	51.72%
Klebsiella	5	17.24%
Proteus	4	13.79%
Pseudomonas	4	13.79%
Acinetobacter	1	3.45%
Total	29	100.00%
Distribution of patients according to organism isolated in Urine culture positive patients		
Blood investigations	**Frequency**	**Percent**
Anaemia	56	35.00%
Leucocytosis	61	38.13%
Raised CRP	46	28.75%
Altered RFT	6	3.75%

29 children whose urine cultures are positive Fifteen (51.72%) children had E. Coli isolated, five (17.24%) had Klebsiella, four (13.79%) had Proteus, four (13.79%) had Pseudomonas, and one (3.45%) had Acinetobacter. Blood tests in our study group indicated anaemia in 56 (35%) children, leucocytosis in 61 (38.13%), elevated CRP in 46 (28.75%) children, and changed RFT in 6 (3.75%).

Table 3: Distribution of patients according to blood culture report

Blood Culture	Frequency	Percent
No	148	92.50%
Yes	12	7.50%
Total	160	100.00%

In our study group, blood cultures were positive in 12 (7.5%) youngsters and negative in 12 (7.5%).

Table 4: Distribution of sensitivity and resistant pattern of different drugs

Drugs	Sensitive	% of sensitivity	Resistant	%of resistant
Meropenem	27	93.10	2	6.90
Imipenem	29	100.00	0	0.00
Nitrofurantoin	17	58.62	12	41.38
Co trimoxazole	6	20.69	23	79.31
Cefotaxime	6	20.69	23	79.31
Co Amoxiclav	2	6.90	27	93.10
Cefixime	3	10.34	26	89.66
Ceftriaxone	1	3.45	28	96.55
Gentamicin	17	58.62	12	41.38
Amikacin	21	72.41	8	27.59

Of the 29 cases that tested positive for culture, 29 (93.1%) had sensitivity to Meropenem, 100% had sensitivity to Imipenem, 17 (58.62%) had sensitivity to Nitrofurantoin, 6 (20.69%) to Co Trimoxazole, 6 (20.69%) to Cefotaxime, 2 (6.9%) to Co Amoxiclav, 3 (10.34%) to Cefixime, 1 (3.45%) to Ceftriaxone, 17 (58.62%) of Gentamicin, and 21 (72.41) cases had sensitivity to Amikacin.

Table 5: Distribution of sensitivity pattern of different drugs with each organism isolated

Organisms isolated	Meropenem	Imipenem	Nitrofurantoin	Cotrimoxazole	Cefotaxime	Co Amoxiclav	Cefixime	Ceftriaxone	Gentamicin	Amikacin
E coli	14(93.33)	15(100)	13(87)	4(26.66)	2(13.33)	2(13.33)	3(20)	1 (6.67)	11(73.3)	13(86.66)
Klebsiella	4(80)	5(100)	0	2(40)	2 (40)	0	0	0	0	0
Proteus	4(100)	4(100)	0	0	0	0	0	0	2 (50)	4(100)
Pseudomonas	4(100)	4(100)	3 (75)	0	2 (50)	0	0	0	4 (100)	4(100)
Acinetobacter	1(100)	1(100)	1 (100)	0	0	0	0	0	0	0

Discussion

There were 160 malnourished children in all, of which 17 (10.63%) were between the ages of 6 and 12 months, 19 (11.88%) between 13 and 24 months, 45 (28.13%) between 25 and 36 months, 48 (30.00%) between 37 and 48 months, and 31 (19.38%) between 49 and 60 months. Most of them were between the ages of three and four. Similar results were noted by Singh JK et al [17]. However, the bulk of the children were found to be between the ages of 13 and 36 months, according to I K Sharma et al [18]. In contrast to the results of studies by I K Sharma et al, Dholakia PJ et al [19], Rakesh Kumar et al [20], and Choudhary et al [21], where the mean age was 27.04±15.59 months, 23.8 months, 14.29 months, and 14.92+7.48 months respectively, the mean age of our study group was 35.55+14.65 months.

Among our study group, 89 (55.63%) were male and 71 (44.38%) were girl children There isn't a gender imbalance. The results aligned with research conducted by Singh JK et al, IK Sharma et al, A I Rabasa et al [22], Grish Gopal et al [23], and Anne-Laure Page et al [24], which found that there were more male children than female children in those studies. The results of this study differed from those of studies conducted by Dholakai PJ et al., Rakesh Kumar et al., and Allah Bux Ghanghro et al. [25], which found that there were more female children than male children. Among our study group, 115 (71.88%) were moderately acute malnourished children and 45 (28.13%) were severely acute malnourished children. 135 (84.38%) children were <-2SD and 25 (15.63%) were <-3SD. 25 (15.63%) children's mid upper arm circumference was less than 11.5 cms and 135 (84.38%) children's mid upper arm circumference was between 11.5 and 12.5 cms. 14(8.75%) children had edema whereas 146 (91.25%) had no edema., 29(18.13%) children had visible severe wasting whereas 131 (81.88%) had no visible severe wasting.

A study done by IK Sharma et al observed that the weight for height <-3SD was observed among 73 (85.9%) of the patients followed by MUAC<11.5 cm among 40 (47.1%) of the patients, edema positivity seen in 14 (16.5%) of the patients and visible severe wasting was in 28 (32.9%) of the patients. Rakesh Kumar et al. found that 24.03% of cases showed significant visible wasting, 27% had bilateral pitting edema, and 75.8% of cases had weights for height below -3SD. In a study conducted by K Singh et al. [26], the results showed that 70.7% of children had both a MUAC <115 mm and a weight-for-height/length z-score (WHZ) below -3 SD, while 89.7% of children had a MUAC <115 mm. Our findings are consistent with a study by Anne-Laure Page et al. that discovered 15.4% of SAM children had edema.

The most frequent presenting symptom, according to our study, was fever (42.5%), which was followed by coughing (26.68%), vomiting (26.68%), and convulsions (26.68%). Abdominal discomfort (6.88%), diarrhoea (6.88%), urinary bladder soreness (3.5%), increased frequency of micturition (2.5%), and renal angle tenderness (2.5%) were present in fewer than 10% of the cases.

According to IK Sharma et al.'s study, the most prevalent clinical symptom was fever, which affected 72 patients (84.7%). Other common clinical symptoms included loose stools (35 patients; 41.2%), convulsions (28 patients; 32.9%), cough (23 patients; 27.1%); vomiting (21 patients; 24.7%); and abdominal pain (3 patients; 3.5%). Merely 1.2% of the population saw an increase in micturition frequency, urinary bladder discomfort, or renal angle tenderness. The findings were similar to those of Mukesh Chaudhary's study, which identified fever as the most typical manifestation. Diarrhoea was identified by Rakesh Kumar as the most prevalent symptom in 54% of SAM children. Grish Gopal and R. Premalatha discovered that the most frequent presenting complaint in 3% of cases was vomiting. In our study, urine examination revealed that 131 (81.88%) children had <5 pus cell count/hpf, 26 (16.25%) had 5-10 pus cell count/hpf, and 3 (1.88%) had more than 10 pus cell count/hpf.

In a study conducted by IK Sharma, pus cell count ≤4/hpf was found in 77 samples (90.6%), 5-10/hpf in 8 samples (9.4%), and >10/hpf in none of the samples. Urine cultures were positive in 29 (18.13%) of the children and negative in 131 (81.88%). So, the UTI prevalence in our sample was 18.13%. Similar data were reported by IK Sharma et al, who found that 19 urine samples (22.4%) were culture positive out of 85 samples, resulting in a UTI prevalence of 22.4%. The prevalence of UTI in our study is slightly greater than in a similar study conducted on severely malnourished children by Anne-Laure Page et al, Bagga A, Tripathi P, Jatana V et al [27], who reported a prevalence of 16% and 15.2%, respectively. E. coli was recovered in 15 (51.72%) of the 29-urine culture-positive children, Klebsiella in 5 (17.24%), Proteus in 4 (13.79%), Pseudomonas in 4 (13.79%), and Acinetobacter in 1 (3.45%).

Similarly, IK Sharma et colleagues found that E. coli was the most prevalent bacterium in 13 of the 19 culture-positive cases (68.4%), followed by Citrobacter in two instances (10.5%), Pseudomonas in two cases (10.5.5%), and Acinetobacter and Klebsiella in one each (4.8%). This is consistent with the literature, as E. coli was discovered to be the most common bacteria causing UTI in children with SAM by Uduak A Okomo et al [28], AnneLaure Page et al, Allah Bux Ghanghro and

Arshad Hussain Laghari, A I Rabasa and MM Gofama et al, and Francis Fredrick et al [29]. Blood tests in our study group indicated anaemia in 56 (35%) children, leucocytosis in 61 (38.13%), elevated CRP in 46 (28.75%) children, and changed RFT in 6 (3.75%). Blood culture results were positive in 12 (7.5%) children and negative in 148 (92.5%). In a prior work, Arvind Bagga et al described acute phase reactants as an indirect proof of bacteriuria in asymptomatic children with UTI.

Meropenem was sensitive in 27 (93.1%) cases, Imipenem was 100% sensitive, Nitrofurantoin was sensitive in 17 (58.62%) cases, Co trimoxazole in 6 (20.69%) cases, Cefotaxime in 6 (20.69%) cases, Co amoxiclav in 2 (6.9%) cases, Cefixime in 3 (10.34%) cases, Ceftriaxone in 1 (3.45%) case, Gentamicin in 17 (58.62%) cases, and Amikacin in 21 (72.41) cases. In a study conducted by IK Sharma et al, Imipenem was sensitive in all samples, but Meropenem was sensitive in 94.7% of the samples. Co-amoxiclav was the least sensitive of the medicines, while Ceftriaxone demonstrated resistance to all samples.

In research by Aiyegoro O. A. et al [30]., 301 youngsters (aged 5 to 18) had urine samples taken; 11.96% of the samples had UTIs. An analysis of the isolates' sensitivity patterns revealed that 47% of them were sensitive to Amoxicillin, 33.3% to Cotrimoxazole, 50% to Nitrofurantoin, 77.8% to Ofloxacin, 73.5% to Nalidixic Acid, 63.9% to Gentamycin, 97.1% to Ofloxacin, 27.8% to Co-Amoxiclav, and 30.6% to Colistin. Of S. Faecalis, 100% Were Responsive to Erythromycin and Chloramphenicol, 61.1% to Tetracycline, and 50% to Cloxacillin.

In our investigation, Imipenem was the antibiotic that E. Coli was 100% sensitive to. Meropenem, Nitrofurantoin, Amikacin, Gentamicin, Co trimoxazole-Amoxiclav, Cefixime, Cefotaxime, and Ceftriaxone came in second, third, and sixth, respectively. Imipenem exhibited 100% sensitivity in Klebsiella, whereas it was resistant to Nitrofurantoin, Amikacin, Gentamicin, Cefixime, Co-amoxiclav, and Ceftriaxone. Meropenem exhibited 80% sensitivity, Co trimoxazole 40%, and Cefotaxime 40% resistance. Proteus was resistant to Nitrofurantoin, Co-Trimoxazole, Cefixime, Cefotaxime, Co-Amoxiclav, and Ceftriaxone, but 100% susceptible to Imipenem, Meropenem, and Amikacin, followed by Gentamicin.

Pseudomonas was resistant to Co-Amoxiclav, Cefixime, Cotrimoxazole, and Ceftriaxone, but 100% susceptible to Imipenem, Meropenem, Amikacin, and Gentamicin. Nitrofurantoin was next, at 75%, and Cefotaxime, at 50%. Acinetobacter was resistant to Co-Amoxiclav, Cefixime, Cefotaxime, Imipenem, and Nitrofurantoin, but 100% susceptible to these drugs. In an investigation led by IK Sharma. Imipenem and Nitrofurantoin showed 100% sensitivity in E. Coli, while Meropenem and Amikacin showed 92.3% and 7.7% sensitivity, respectively.

Ceftriaxone resistance was observed in E. coli. Nitrofurantoin, Cefixime, and Ceftriaxone were resistant to Pseudomonas and Klebsiella, but they were 100% sensitive to Meropenem, Imipenem, Gentamicin, and Amikacin. While resistant to amikacin, cefixime, and ceftriaxone, Acinetobacter and Citrobacter are 100% sensitive to Meropenem, Imipenem, and Nitrofurantoin.

E. coli is 86.6% susceptible to amikacin in this investigation, which is consistent with a study by Francis Fredrick et al. that indicated 88% sensitivity to Amikacin. According to research by Francis Fredrick et al., Maimuna Ahmed et al [31]., Aiyegoro O. A., et al., A I Rabasa, and MM Gofama, they discovered sensitivity to Co-Amoxiclav at 12%, 14.3%, and 31.7%, respectively, and E. coli is 13.3% sensitive to it in our study.

In contrast to the study conducted by Francis Fredrick et al., A I Rabasa, and MM Gofama et al., which demonstrated 100% resistance to Cotrimoxazole, ours only discovered 26.6% sensitivity to the drug. In studies by Maimuna Ahmed et al. and Francis Fredrick et al., sensitivity to the third-generation cephalosporin Ceftriaxone was 65.7% and 64%, respectively, however in our investigation, we discovered sensitivity to Ceftriaxone to be just 6.6%. While Aiyegoro O. A. et al. observed 63% sensitivity to Nitrofurantoin, our study found that all E. coli were 87% sensitive to the drug.

Conclusion

According to the study's findings, the prevalence of UTI is higher in moderate acute malnutrition (MAM) and severe acute malnutrition (SAM) children. Gram-negative bacteria are the most prevalent isolates from urine cultures. E. coli is the most frequent gram-negative bacilli isolated. Imipenem, Meropenem, Amikacin, Nitrofurantoin, and Gentamicin are the most effective antibacterial medicines against these species. These observations have served as the foundation for the current diagnostic and therapeutic guidelines for clinicians who manage children with difficult MAM and SAM.

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