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Original Research Article

Yale observational score (YOS) to detect serious bacterial infections in young febrile children

Ganeswar Sethy[1], Biswajit Pattanaik[2], Abinash Panda[3], Prasanta Purohit[4], Geetanjali Sethy[5,*]

[1]*Dept. of General Medicine, MKCG Medical College, Berhampur, Odisha, India*
[2]*Dept. of of Pediatrics, MKCG Medical College, Berhampur, Odisha, India*
[3]*Dept. of Pharmacology, MKCG Medical College, Berhampur, Odisha, India*
[4]*Multidisciplinary Research Unit (MRU), Berhampur, Odisha, India*
[5]*Dept. of Pediatrics, PRM Medical College, Baripada, Odisha, India*

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ABSTRACT

Introduction: Fever is one of the common presentation of children to paediatric emergency. Fever is defined as axillary temperature of ≥ 99.5 °F. A young febrile child without definite localizing sign of infection may develop bacteraemia and serious bacterial infection (SBI) leading to fatal outcome. Hence, an early diagnosis of SBI in a febrile child is crucial to reduce childhood mortality. Yale observation scale utilizes some simple clinical parameters to predict serious bacterial infection in young children.
Hence this study is undertaken to test the utility of YOS in predicting serious bacterial infection in small children so as to investigate them in time and start treatment early to prevent complications.
Materials and Methods: 150 consecutive children 1-36 months of age with axillary temperature>99.5˚F were enrolled and YOS scoring assigned to each of them. This was followed by physical examination and extensive laboratory testing with CBC, Urine and routine microscopy, chest x-ray, CRP, blood and urine cultures.
Results: In patients with SBI, the YOS of ≤10 was observed in only 9.23% (6/65) of patients compared to 48.24% (41/85) of patients without SBI. There was a significantly high YOS i.e. >10 in patients diagnosed with SBI (χ^2 =24.26; P <0.0001).
Mean temperature elevation, higher values of TLC, ANC and CRP positivity results in higher YOS scoring and more chance to have serious bacterial infection.
Conclusion: YOS score is very useful in ruling out serious bacterial infection in 1-36 months age group at cut-off value of 12. Significantly higher scores (>16) depict essentially serious bacterial infection and poorer outcome.

1. Introduction

Fever is one of the commonest presenting symptom seen in the pediatric outpatient and emergency department.[1] In about 20% of febrile children, the cause is obscure even after a proper history and clinical examination.[2] The etiology and outcome varies across the age groups. An algorithmic approach to etiology and management of fever in different age groups helps to arrive at a definite diagnosis. Majority of children with an acute febrile illness suffer from acute viral infection, which usually subside by its own with symptomatic treatment without any complication. Very less number of young children suffer from Serious Bacterial Infection (SBI), and benefit from timely use of antibiotics.

* *Corresponding author*.
E-mail address: geetanjalisethy@gmail.com (G. Sethy).

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Most common cause of fever without focus in male infants (3-4%) is urinary tract infections who are not circumcised. It is also common in girls (8-9%) less than two years of age. Recognition of SBI is a challenge to the pediatrician and poor differentiation of SBI from self-limiting illnesses usually lead to either delayed treatment or over-treatment of such illnesses.[3] The innate and adaptive immune system is immature in younger children. So they have a higher risk of infection due to viral, bacterial, fungal and parasitic etiology. The risk of serious bacterial infection decreases between 3 and 36 months and is minimal after 36 months as the immune system reach maturity.

Fever signifies an infection or inflammation. Fever in pediatric age group is due to viral infection which is self-limiting unlike bacterial infections.[4] Temperatures in the range of 37.8 to 4 0°C do not pose much danger but antipyretics are given as a symptomatic relief and to relieve parental anxiety.[5] Sponging with lukewarm water is uncomfortable for the child, and results in crying and shivering.[6,7] The recommended treatment for fever in children are use of antipyretics for fever of 39 degree C or more.[8–11] The antipyretic effect of acetaminophen is well documented but the efficacy of tepid sponging for fever is still controversial.

Globally, pneumonia (16%), prematurity and its complications (16%), birth related complications (11%), diarrhea (9%), neonatal sepsis (7%) & malaria (5%) are few infections that contribute to maximum mortality in children. Infections and neonatal complications are leading cause of under-five deaths around the world.[12]

Different institutes have attempted to assess risk of SBI in infants and young children to guide treatment. Criteria obtained from Philadelphia, Boston, Rochester, Baraff et al in 1993[13] as well as AAP: all these include certain investigations which may require hospitalization.

Bacteremia needs prompt diagnosis and treatment as it leads to serious complications and death. As small children cannot communicate their physical perception of illness, a pediatrician depend on the clinical indicators of the presence of severe disease in them. Hence, the use some clinical scores become essential which would represent a distinctive paradigm drawing on simple observations.[14,15] The Yale observation score (YOS) is one such clinical tool.

This YOS scoring was first assigned to pediatric patients to suspect serious bacterial infection by P.L.McCarthy in 1982.[16] It is a sensitive as well as validated clinical index indicating risk of febrile infection in children less than 36 month of age. YOS is a 3 point scale for six ordinal variables with a total score range of 6 to 30. This study was carried out in MKCG medical college and hospital to test the usefulness of Yale Observation Scale in health facility to predict serious bacterial infection in children of age 1- 36 months.

2. Aim of the study

To assess the usefulness of YOS in predicting bacteremia and correlating it with clinical and laboaratory diagnosis of serious bacterial infection in children.

3. Objectives

1. Primary: To assess the usefulness of YOS in detecting serious bacterial infection.
2. Secondary: To know the prevalence and pattern of infections in children 1 to 36 months.

3.1. Methods

This cross sectional study is a hospital based observational study carried out in the department of pediatrics in MKCG Medical College, Berhampur, Orissa from October 2016 to September 2018 in all babies of age between 1 month to 36 months.

3.2. Inclusion criteria

Healthy babies within age 1 month to 36 months presenting to outpatient department with fever (axillary temperature ≥99°F) on presentation.

3.3. Exclusion criteria

1. Children with suspected non-infectious cause of fever (post vaccine, autoimmune etc.)
2. Known case of immune-compromised babies, suspected immunodeficiency, and babies having systemic diseases.
3. Children with history of using antibiotics within the past 1 week.

3.4. Sample size

A random sampling method was used. According to previous studies prevalence of bacteremia in age group 3 – 36 months varies between 2 to 15 percent. Taking the middle value of 10 percent prevalence, confidence level of 95 %, and a precision of 0.05, sample size of 138 ($n= z^2pq/d^2$) was calculated. But to make calculations easy, 150 number of babies were included in the study with optimum care taken not to miss any case and taken for statistical calculations, after excluding those who lost to follow up.

3.5. Methodology

The details of all eligible babies were entered in a prescribed format. Prior consent from parents was taken. Detailed history, preliminary physical examination was carried out. Blood sample was drawn for investigations. The Yale Observation Scale (YOS) was applied and scoring was at the first interaction preferably prior to history taking and physical examination. Every attempt was made to place the child in a state of quiet wakefulness before scoring. All the relevant investigations were done in the departments of Pathology, Microbiology and Biochemistry, M.K.C.G Medical College, Berhampur like C-reactive protein, Total Leukocyte Count and Urinalysis. Blood culture, Urine culture and chest x-ray were also done when child's clinical condition warranted.

3.6. Case management and follow up

Optimal treatment was given to all the cases declared as seriously ill as per the score. Each inpatient was followed up to complete clinical cure or death. Each outpatient was initiated home treatment depending upon the score. Those babies who were started with home treatment were followed up after 48 hours and YOS score was reassigned to them. Depending upon the repeat YOS score, either they were admitted or continued the same treatment and followed up at a later date preferably after 7 days from starting of treatment. This method was applied to all out patient babies. Any baby lost to follow up was excluded from the study.

Serious bacterial illness was defined as (having any one or more of the following)

1. Bacterial pathogens isolated from blood, urine, stool, CSF, joint aspirates, soft tissue etc.
2. Significant abnormalities of X-ray or an abnormal CSF.
3. Abnormal haematological parameter (leucocytosis/leukopenia, thrombocytopenia, absolute neutrophilia/ neutropenia, positive CRP.

The inpatients were followed till they were discharged from the hospital. The duration of hospital stay, the route of antibiotics, the type and the duration of antibiotic therapy were noted.

3.7. Statistical analysis

The generated data was entered in a predesigned excel Microsoft window sheet for further analysis. The data were presented either in number (percentage) or Mean±SD. The categorical data were compared by using Chi-square test. The comparison of mean among the two groups was analysed by using Mann-Whitney test. A p value of <0.05 was considered for statistical significant. Graph Pad Instat version 3 for window was used for all statistical data analysis.

4. Results

During the study period, 150 patients of 1-36 months of age were finally included. There were 77 males and 73 females. Majority of patients were in 13 to 36 months of age followed by 57 patients in 4 to 12 months and 26 patients in 1 to 3 months of age. Out of 150 patients, 65 were diagnosed with SBIs. The majority of cases of SBI presented with pneumonia (33%), followed by UTI (20%), Meningitis (18%), Sepsis (11%), Septic arthritis (8%), Occult bacteremia (5%) and Rickettsial infection (5%) (Table 1). Out of 150 patients, 47 patients were having YOS of 10 or less and rest 103 patients were having YOS of more than 10. Body temperature, total leucocytes count and absolute neutrophil count were found to be significantly higher (p<0.0001) in patients with YOS of >10 compared to patients with YOS of ≤10 (Table 2). Patients with SBI were having significantly high (χ2=93.07; p<0.0001) CRP positivity (92.31%, 60/65) compared to patients without SBI (12.94%, 11/85). The number of patients with TLC of >15,000 was significantly more (χ2=61.49; p <0.0001) in patients with SBI (66.15%) compared to patients without SBI (5.88%). Similarly, number of patients with ANC of >10,000 was significantly more (χ2=66.25; p <0.0001) in patients with SBI (70.77%) compared to patients without SBI (5.88%). The mortality was found to be high (6.15%) in patients with SBI compared to patients without SBI (1.18%). The comparison of positivity of CRP, TLC, ANC and mortality between patients with SBI and patients without SBI has been illustrated in Table 3.

In patients with SBI, the YOS of ≤10 was observed in only 9.23% (6/65) of patients compared to 48.24% (41/85) of patients without SBI (Figure 1). There was a significantly high YOS i.e. >10 in patients diagnosed with SBI (χ^2 =24.26; P <0.0001).

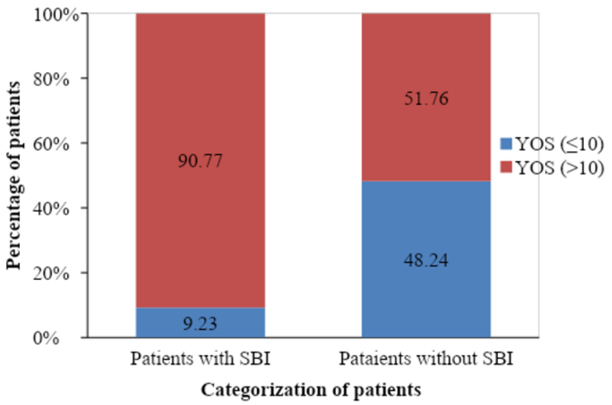

Fig. 1: Distribution of patients on the basis on YOS value with respect to with and without SBI.

5. Discussion

The present study was conducted with 150 subjects as participants. Most of the study subjects were in the age group of 13-36 months, whereas the least number of patients belonged to 1-3 months age group. In a similar study carried out by Bang et al, it was observed that out of 219 subjects in the age group 3-36 months, 71 were in 3-6 months of age

Table 1: Types of severe bacterial infections in children of 1-36 months

Diagnosis	Frequency	Percentage
Pneumonia	22	33
UTI	13	20
Meningitis	12	18
Sepsis	7	11
Septic arthritis	5	8
Occult bacteremia	3	5
Rickettsial infection	3	5

Table 2: Comparison of laboratory parameters in patients with respect to their YOS

Parameters	YOS of ≤10 (n=47)		YOS of >10 (n=103)		Mann-Whitney U statistics(p value)
	Mean±SD	Min-Max	Mean±SD	Min-Max	
Temperature (^{o}F)	100.08±0.24	99.8-100.6	101.3±1.04	99.8-104.0	<0.0001
Total Leucocytes Count (x10^3)	8.88±2.32	4.6-17.0	13.27±5.25	4.4-28.0	<0.0001
Absolute neutrophil Count (x10^3)	6.13±1.68	2.76-11.9	9.07±3.79	2.64-22.0	<0.0001

Table 3: Comparison of positivity of CRP, TLC, ANC and mortality between patients with SBI and patients without SBI.

Parameters		Patients with SBI(n=65) Number (%)	Patients without SBI(n=85) Number (%)	χ^2 test; P value
CRP	Positive	60 (92.31)	11 (12.94)	93.07; <0.0001
	Negative	5 (7.69)	74 (87.06)	
TLC	≤15,000	22 (33.85)	80 (94.12)	61.49; <0.0001
	>15,000	43 (66.15)	5 (5.88)	
ANC	≤10,000	19 (29.23)	80 (94.12)	66.25; <0.0001
	>10,000	46 (70.77)	5 (5.88)	
Mortality	Survived	61 (93.85)	84 (98.82)	1.498; 0.22
	Death	4 (6.15)	1 (1.18)	

group and a lesser number of patients were in the age group of 25-30 months.[17] The difference in the demographic predisposition may be due to ethnic difference in study population. Younger infants of 3-5 months age constituted the largest number and YOS was also higher in them in comparison to older age group. Most of the sick patients had temperature in the range of 101.1-103 °F. Isolated high temperature did not have a direct correlation with SBI in small children. This finding is similar to the observations in the study done by Jaffe D.M, Gary Fleisher et al[18] where they have used the total leukocyte count and temperature as indicators for serious illness. It was observed that fever (temp>39 degree C was associated with SBI , but as the temperature rise above 39 degree C, the sensitivity of this association decreased. According to Pantel et al, age of the child and height of core temperature were two important factors that could predict the probability of serious illness in a febrile child.[19] Fever >40^{0}C (104^{0}F) sets a high specific pre-examination probability of serious illness. McCarthy et al found that a temperature greater than or equal to 40.3^{0}C showed more specificity for bacteremia than lower temperature.[20]

In this study, 43% patients suffered from SBI. Maximum patients had suffered from pneumonia (33%) followed by UTI (20%), meningitis (18%) and others. So the incidence and prevalence of pneumonia in form of SBI is more common in our set up. Kansakar et al. have found that 33% children were suffered from SBI in their study population.[21] Serious bacterial illness(SBI) contribute to 33% of cases while the commonest cause of SBI was pneumonia. This observation issimilar to a study done by McCarthy et al.[22] It was observed that the sensitivity (87.7%) and specificity (70.6%) were higher in YOS >12 to detect SBI. 12 was cut off value to predict SBI. Similarly higher TLC and ANC were having higher sensitivity and specificity. So these parameters were good indicators to predict SBI along with YOS. McCarthy and Sharpe have used the YOS and have found a sensitivity and specificity value of 88%, 77% respectively with a cut off score '10' to detect SBI.[23] Teach and Fleischer have also found that higher score is associated with bacteremia.[24]

The prevalence of SBI was higher in patients of 1-3 months old as compared to older age group. Baker et al have also found a high prevalence of SBI in 26-56 days old babies.[25] McCarthy et al found an intermediate prevalence in children less than 24 months. Out of 71 CRP positive patients, 60 patients had statistically significant serious bacterial infections. Pulliam et al have examined the role of CRP in management of febrile illness in children. CRP was a better screening tool than WBC for pediatric patients. Taking a cutoff value of 7 mg/dl, its sensitivity is around 79% and specificity of 91%.[26] This study observed that patients having lower TLC and ANC count had a statistically significant lower YOS and also less chance of having serious bacterial infection. In patients having higher YOS, most were CRP positive as compared to lower YOS. Blood culture and urine cultures were also positive in patients having higher YOS. Bachur et alhave concluded that WBC count in isolation was neither sensitive nor specific predictor of SBI in infants.[27] Galletto-Lacour et al. have also confirmed that total and differential leukocyte count are poor predictor of SBI when compared to PCT and CRP. WBC count at a cut-off value of 15 x 10^9/l had a sensitivity and specificity of 68% and 77% respectively.[28] Thapar et al have also observed a poorer outcome in patients having higher YOS (>10).[29] It was found that ANC is a reliable parameter to detect SBI because of its high sensitivity, specificity and high LR+ values. So it can be used along with YOS to detect SBI in febrile children in 1 to 36 months. Kupperman et al have also observed that ANC value of >10000cells/mm^3 perform better than isolated WBC count of >15000cells/mm^3 in the diagnosis of bacteremia. So we may conclude that ANC is a more accurate test in detecting occult bacteremia.[30]

6. Conclusion

YOS scoring is a useful tool in early evaluation of critically ill children from 1 to36 months of age. It must be used in conjunction with laboratory investigations and vital parameters for early triage of sick children as it increases diagnostic accuracy. YOS can be used to monitor admitted patients for early anticipation of deterioration or non-responsiveness to ongoing treatment. As YOS is a very easy and simple tool ,this can be used by the junior residents, nurses and primary health care workers in initial evaluation of a sick and febrile child. Vital parameters like temperature, heart rate and respiratory rates must be monitored frequently so as to diagnose any critical illness. However, biomarkers alone do not offer any advantage and must be correlated with clinical parameters for evaluation of febrile children.

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8. Conflict of Interest

The authors declare they have no conflict of interest.

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Author biography

Ganeswar Sethy, Associate Professor

Biswajit Pattanaik, Post Graduate

Abinash Panda, Associate Professor

Prasanta Purohit, Research Scientist I

Geetanjali Sethy, Professor

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