

Clinical Characteristics and Treatment Outcomes of Pediatric Bacterial Skin and Soft Tissue Infections in Central Vietnam: A Prospective Study

Global Pediatric Health
Volume 11: 1–6
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DOI: 10.1177/2333794X241283785
journals.sagepub.com/home/gph



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Abstract

Objective. This study examined bacterial skin and soft tissue infections (SSTIs) in pediatric patients at a hospital in Vietnam. **Methods.** An April 2022–June 2023 prospective observational study at a Tertiary Paediatric Centre in Vietnam. **Results.** From We analyzed 87 cases and found that the greatest occurrence rates were reported during the summer season. Common symptoms were fever, edema, and lower leg involvement. Curiously, although blood cultures seldom verified the offender, *Staphylococcus aureus* was the most common cause. Additionally, the study found that children with infections including pus were administered a more extended course of antibiotics. Approximately one-third of the patients underwent surgical procedures, and most of them were administered intravenous antibiotics. Fortunately, all the youngsters made a full recovery. **Conclusions.** In summary, the results indicate that children with purulent SSTIs, primarily attributed to *Staphylococcus aureus*, may need longer courses of antibiotics. Intravenous antibiotic administration emerged as the predominant therapeutic modality.

Keywords

skin and soft tissue infections, children, Vietnam, antibiotics, *Staphylococcus aureus*

Received January 18, 2024. Received revised August 3, 2024. Accepted for publication August 26, 2024.

Introduction

Bacterial skin and soft tissue infections (SSTIs) represent commonly encountered infectious conditions, manifesting with diverse clinical presentations across varying degrees of severity.¹ This constitutes a significant factor leading to the escalating hospitalization rates of pediatric patients.²

SSTIs encompass surface infections such as impetigo, cellulitis, folliculitis, necrotizing fasciitis, infections related to animal or human bites, surgical site infections, and infections in immunocompromised hosts.¹ In children with systemic lupus erythematosus, increased susceptibility to SSTIs has been observed. Research suggests that SSTIs are the second most common type of infection among this population, highlighting their significant clinical importance.³

The clinical manifestations of the disease result from the interplay between bacterial invasion and the host's defense mechanisms. The clinical diversity of SSTIs necessitates physicians distinguishing cases requiring active therapeutic intervention from those of lesser

severity.⁴ Failure to effectively treat severe infections may lead to the deeper infiltration of bacteria from the dermal and subcutaneous lesions, culminating in blood-stream infections.

The primary etiological agents of the disease are *Staphylococcus aureus* and β -hemolytic *Streptococcus group A*.⁵ Given the escalating antibiotic resistance of bacteria globally, particularly the increasing prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA), there is a pressing concern necessitating more effective antimicrobial strategies.⁶ Timely and accurate antibiotic prescriptions are imperative for achieving high treatment efficacy. Presently, a growing

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number of pediatric patients seek medical intervention for treatment, underscoring the need for a more in-depth understanding of the disease.

Our hospital serves as a specialized medical facility in an urban area, providing care to a wide range of patients with varying degrees of illness. We also treat patients from central Vietnam, extending beyond the immediate city core.

In pursuit of heightened diagnostic precision, timely intervention, and the preemptive mitigation of complications, this research endeavors to elucidate the clinical and laboratory features of SSTIs in pediatric populations, with a principal emphasis on the aforementioned objectives.

Materials and Methods

Setting and Data Collection

All children under 16 years old were diagnosed with skin and soft tissue infections and receiving treatment at a Tertiary Pediatric Center in Central Vietnam from April 2022 to June 2023.

Inclusion Criteria

- Patients diagnosed with SSTIs based on clinical manifestations, bacterial culture, and identification of the causative bacteria from the infected site specimen.¹
- Children and their families consented to participate in the study.

Exclusion Criteria

- Children with immune deficiency or underlying skin conditions.
- Absence of Informed permission: children or their caregivers have shown an inability or reluctance to furnish informed permission for their involvement in the study.

Study Design and Data Definition

The study was executed employing a prospective observational research design.

The study utilized a convenience sample technique, which involved choosing all patients who satisfied the predetermined inclusion and exclusion criteria within the designated study period.

Study Variables

- General characteristics: age, gender, and season.

- Clinical characteristics: fever, swelling, warmth, redness, pain, site of infection, disease type, and severity level.
- We evaluated the seriousness of SSTIs by employing the 2014 Infectious Diseases Society of America (IDSA) Guidelines for the Diagnosis and Management of Skin and Soft Tissue infections. The IDSA standards categorize SSTIs into 3 levels of severity: mild, moderate, and severe.⁷
- Paraclinical measures: white blood cells, C-reactive protein (CRP), pus culture, blood culture, and ultrasound.
- Treatment: treatment response and treatment outcomes.

Statistical Analysis

The clinical and laboratory features were described using count, percentage, median, and interquartile range. Chi-square tests compare the proportions of 2 or more independent groups to determine the link between non-parametric variables. When quantitative variables follow a normal distribution, a 1-way analysis of variance (ANOVA) test compares independent group means. If at least 1 quantitative variable is not normally distributed, the Kruskal-Wallis test compares independent group means. All statistical analyses were done using IBM SPSS Statistics 20.0 (IBM, New York, USA).

Ethical Consideration

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of Pediatric Center—Hue Central Hospital (Date: 2022-11-25, No: 57/NCKH-BVH). The personal information of the patient (name, phone number, and address) was not collected. Other data was anonymized and maintained with confidentiality.

Results

Demographic Features of the Study Population

The study comprised 87 patients, the majority of whom were between the ages of 1 and 4 years (48.3%), with the lowest proportion being between 13 and 16 years old (5.7%). There were more males than females. In the summer, 43.7% of the cases of illness were recorded (Table 1).

Table 1. General characteristics of SSTIs in Children.

Characteristic		N=87	Percentage (%)
Age (years old)	<1	24	27.6
	1-4	42	48.3
	5-12	16	18.4
	13-16	5	5.7
Gender	Male	51	58.6
	Female	36	41.4
Season	Spring	8	9.2
	Summer	38	43.7
	Autumn	23	26.4
	Winter	18	20.7

Clinical features of SSTIs patients

Fever is the most common symptom among patients. The likelihood of experiencing heat symptoms in affected skin is lower than the likelihood of experiencing edema (93.1%), redness (69%), and discomfort (62.1%). In terms of severity, the lower limbs are affected the most (40.2%), followed by the buttocks and perineal region (8%). Infections of the skin and soft tissue with purulent discharge were the most prevalent, accounting for 67.8% of all cases. This was significantly higher than the proportion of cases without purulent discharge (32.2%). Notably, moderate intensity infections exhibited the highest occurrence, representing 73.6% of all cases (Table 2).

Laboratory Features of SSTIs Patients

Among patients, 56.3% exhibited a white blood cell count below 15 k/ μ L, while 74.7% had a C-reactive protein value below 40 mg/L. Notably, *Staphylococcus aureus* growth was observed in 76.9% of purulent cultures, whereas the rate of positive blood cultures was remarkably low at 2.4% (Table 3).

Treatment and Outcomes of SSTIs Patients

For 27.6% of patients, a combination of antibiotics and drainage was necessary for treatment. Notably, 57.5% of patients exhibited a favorable response to treatment, and 100% of patients achieved full recovery from the illness (Table 4).

The percentage of children with a treatment time of less than 7 days was the highest at 42.5%. The median treatment duration for purulent infections was 8 days (interquartile range: 6-12 days), which was substantially longer than the treatment duration for non-purulent infections, which was 5 days (interquartile range: 4-6 days; $P < .05$). Intravenous antibiotics were used most often, followed by oral antibiotics (Table 5)

Discussion

Among the 87 children in our study, those aged 1 to 4 years had the highest infection rate, comparable with earlier studies. This may be due to increased environmental exposure and sensitivity to pathogenic agents in this age group, as well as poor hygiene and a propensity for accidents and insect bites. After 6 months, passive maternal immunity declines, making children more susceptible to illnesses. Infections are more common in men and peak in the summer. Due to poor hygiene and warm, humid weather, thin, sensitive skin in children makes bacterial infiltration easy. SSTIs are most common in the summer due to outdoor activity and environmental factors.⁸

Among clinical symptoms, 67.8% of the pediatric cohort had fever, which commonly prompts families to seek medical attention. Fever, a sign of systemic inflammation, correlates with disease severity. Lower extremities were more afflicted, followed by the head, face, neck, and upper extremities. The lower extremities were frequently implicated in these presentations, as in earlier studies.

The incidence of fever in our study was markedly greater than that documented in other studies conducted globally. As reported by Chand et al⁹, the incidence of fever was 25.1% among a total of 343 cases with pediatric cellulitis. Yueh et al. (2022) discovered that children with positive pus cultures had a fever rate of 47.3%, which was substantially higher than the fever rate of 45% in children with negative pus cultures.¹⁰ This indicates a distinctive pattern of how diseases are spread in Vietnam, where parents may have limited ability to take care of their children, resulting in delayed medical attention until the symptoms become serious.

When comparing the symptoms of SSTIs with other research, Yueh et al¹⁰ found that swelling was present in 85.1% of cases, redness in 89.1%, pain in 55.6%, warmth in 35.4%, purulence in 50.1%, vesicles in 5.54%, and uncommon papules without hemorrhagic patches. Chand S. conducted a study focused exclusively on the presence of purulence at the site of the lesion. This characteristic was found in 42.3% of the cases.⁹

The purulent culture investigation showed 76.9% *Staphylococcus aureus*, consistent with the disease's geographical pattern. The main cause of SSTIs with abscesses, furuncles, and carbuncles is *Staphylococcus aureus*. Blood cultures had a 2.4% positive rate, consistent with previous investigations. Given the low frequency of bloodstream infections in simple SSTIs in children without underlying health issues, blood culture may not be necessary.¹¹

Table 2. Clinical of SSTIs Patients.

Characteristic		N=87	Percentage (%)	
Symptoms	Fever	59	67.8	
	Swelling	81	93.1	
	Heat	45	51.7	
	Redness	60	69.0	
	Pain	54	62.1	
Skin infection area	Craniofacial	30	34.5	
	Body	12	13.8	
	Upper limb	16	18.4	
	Lower limbs	35	40.2	
Classification	Purulent SSTIs	Abscess	41	47.1
		Furuncle	17	19.6
		Carbuncle	1	1.1
	Non-purulent SSTIs	Cellulitis	26	29.9
		Erysipelas	2	2.3
Severity of the SSTIs	Mild	18	20.7	
	Average	64	73.6	
	Severe	5	5.7	

Table 3. Laboratory Features of SSTIs Patients.

Characteristic		N=87	Percentage (%)
White blood cell (k/ μ L)	<15	49	56.3
	\geq 15	38	43.7
C-reactive protein (mg/L)	<40	65	74.7
	40-100	12	13.8
	\geq 100	10	11.5
Purulent culture (N=39)	<i>Staphylococcus aureus</i>	30	76.9
	Negative	9	23.1
Blood culture (N=42)	MRSA	1	2.4
	Negative	41	97.6

MRSA: Methicillin-resistant *Staphylococcus aureus*.

Table 4. Treatment Response and Outcomes.

Characteristic		N=87	Percentage (%)
Treatment method	Antibiotics	63	72.4
	Antibiotics and drainage	24	27.6
Treatment response	Good response	50	57.5
	Partial response	37	42.5
Treatment outcome	Cured	87	100
	Not cured	0	0

In this study, the percentage of children with a treatment time of less than 7 days was the highest at 42.5%. This is in contrast to the findings of a study by Hurley et al,¹² in which the majority of patients (63.8%) were

treated for 7 to 10 days, with only 4.4% treated for less than 7 days and 1.4% treated for more than 14 days. Intravenous antibiotics were used most often (78.2%). In a study of 399 children with MRSA abscesses,

Table 5. Treatment Duration and Route of Antibiotic Administration.

Characteristic		Purulent SSTIs (N=59)		Non-purulent SSTIs (N=28)		Total (N=87)		P value
		n	%	n	%	n	%	
Treatment duration (days)	Under 7	15	25.4	22	78.6	37	42.5	<.0001
	From 7 to 14	30	50.8	3	10.7	33	37.9	
	From 14 or more	14	23.7	3	10.7	17	19.5	
	Median 25th-75th	8 (6-12)		5 (4-6)		7 (5-11)		
Route of antibiotic administration	Oral	6	10.2	2	7.1	8	9.2	.87
	Intravenous	46	78.0	22	78.6	68	78.2	
	Both routes	7	11.	4	14.3	11	12.6	

Papastefan et al¹³ reported that 53.9% of patients received only intravenous antibiotics, 41.6% received both intravenous and oral antibiotics, and only 4.5% received only oral antibiotics.

There are multiple constraints in this study. Initially, it is important to note that this study is conducted at a single center, which restricts the capacity to apply the findings to a broader population. Furthermore, the sample was not chosen by a random sampling technique, potentially leading to biased outcomes. Furthermore, the sample size was determined by convenience sampling, which may not be suitable to ensure sufficient statistical power. Therefore, it is important to regard the conclusions of this study as initial and investigative.

Potential Avenues for Further Development

In future research, we intend to overcome these constraints by creating a study design that is more rigorous. This will involve employing a multicenter methodology, employing random sampling techniques, and increasing the sample size. In addition, we will gather more comprehensive information regarding patient demographics, clinical features, and results. The inclusion of these further data will enable us to carry out more comprehensive studies and arrive at more conclusive findings about the epidemiology and clinical progression of SSTIs.

Conclusion

SSTIs represent prevalent infections presenting with varied clinical manifestations. In this investigation, cellulitis and abscess formation emerged as the predominant infection types, predominantly affecting the lower extremities. *Staphylococcus aureus* was the most frequently identified pathogen. A comprehensive recovery was observed in all treated patients. The treatment duration for purulent SSTIs exceeded that for nonpurulent infections. Intravenous antibiotic administration emerged as the predominant therapeutic modality.

Acknowledgments

We would like to acknowledge all individuals and the hospital involved in the implementation of the survey.

Author Contributions

Chau Duc Nguyen-Huu designed and supervised the entire project. Thi Nhung Cao designed the study, contributed data analysis, and participated in writing the manuscript. Van-Tuy Nguyen designed the study, conducted the experiments, analyzed the data, and participated in writing the manuscript. All authors read, commented on, and approved the manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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