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Epidemiological, Diagnostic and Therapeutic Aspects of Acute Thoracic Syndrome in Sickle Cell Patients at the Ziguinchor Peace Hospital

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Abstract

Introduction: *Acute chest syndrome (ACS) is an acute and serious pulmonary complication of sickle cell disease. ACS is the second leading cause of hospitalization and the leading cause of death in sickle cell patients. In our country, there is little data on this condition, which prompted this study focusing on the epidemiological, diagnostic and therapeutic aspects of acute chest syndrome in sickle cell patients at the Peace Hospital in Ziguinchor.*

Materials and Methods: *We conducted a retrospective descriptive study from 1 January 2018 to 31 March 2025 in the pediatric department of the Peace Hospital in Ziguinchor. The study included all homozygous SS sickle cell patients and composite SC heterozygotes who were regularly monitored in the department and hospitalized during the study period for ATS. AST was defined in our patients by the combination of a recent chest X-ray with at least one of the following respiratory symptoms: cough, dyspnea, chest pain, hypoxia, fever. The data were entered and analyzed using Sphinx software, Microsoft Excel 2020 and Google Forms.*

Results: *During the study period, 44 patients were hospitalized in the department for STA, representing a hospitalization rate of 0.68%. The average age was 7.3 years [1–19 years]. Patients were 100% homozygous SS, with a mean baseline hemoglobin level of 7.79 g/dl [6.3–9 g/dl], previous hospitalization in 54.4% of cases, previous transfusion in 29.5% of cases, and comorbidity such as asthma in 11.4% of cases. The main reasons for hospitalization were cough (75%), chest pain (61.4%) and dyspnea (59.1%). The signs observed during examination were predominantly pallor (88.6%), pulmonary condensation syndrome (68.2%), fever (65.9%), altered general condition (47.7%) and hypoxia (45.5%). AST was mainly associated with pneumonia (72.7%), CVO (43.2%) and acute anemia (34%). The mean hemoglobin level on admission was 6.9 g/dl. Chest X-rays showed bilateral parenchymal involvement in 31.8% of cases; on the right in*

29.5% of cases and on the left in 20.5% of cases. One patient underwent a chest CT scan, which showed pneumonia with a ground-glass appearance. Patients received hydration (88.6%), oxygenation (56.8%) and transfusions (77.3%).

Paracetamol was the most commonly used analgesic (97.8%). It was used alone in 43.2% of cases or in combination with non-steroidal anti-inflammatory drugs in 27.3% of cases, with tramadol in 15.9% of cases and with morphine in 9.1% of cases. The combination of C3G-based antibiotics + aminoglycosides + macrolides was the most commonly used (28.6%).

***Conclusion:** Acute chest syndrome is a serious acute complication of sickle cell disease. Treatment must be early and appropriate to prevent the condition from worsening.*

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Introduction

Sickle cell disease is a chronic genetic disorder transmitted as an autosomal recessive trait linked to a hemoglobin abnormality, characterized by the replacement of glutamic acid with valine on the β chain. It is the most common genetic disorder in the world [1,2].

The majority of people with this disease live in sub-Saharan Africa, with prevalence rates varying between 10 and 20% [3]. In Senegal, one in ten people, regardless of ethnicity, geographical origin or social class, carries the sickle cell gene. The majority have inherited it from only one parent and show no signs of the disease. These are carriers of the sickle cell trait, AS. However, their children are born with sickle cell disease, SS, with a 25% risk with each pregnancy. The homozygous SS form manifests itself through anemia, susceptibility to infections and painful bone and/or abdominal crises. Without appropriate treatment for this SS form, 50% of children die before the age of 5, mainly due to acute complications [4].

Acute chest syndrome (ACS) is a progressive complication of sickle cell disease. It is defined by a set of respiratory symptoms or clinical signs (chest pain, dyspnea, cough, fever, auscultatory abnormalities) associated with a new radiological image of the lungs [4].

This condition results from occlusion of the pulmonary capillaries by deformed sickle cell red blood cells, accompanied by inflammation and hypoxemia, which lead to worsening of the occlusive phenomenon [5,6]. It is a serious event that can lead to acute respiratory failure in less than 48 hours [7].

The frequency of AHS in children with sickle cell disease increases with age [8]. It is a frequent cause of hospitalization in children with sickle cell disease and is associated with high morbidity and mortality. Infant and child mortality related to sickle cell disease is estimated at 19% in sub-Saharan Africa [9].

In our country, there is little data on this condition in children, and to our knowledge, no studies have been conducted in Ziguinchor. Furthermore, sickle cell patients in the Casamance region have been treated at the Peace Hospital in Ziguinchor (HPZ) since 2016. The aim of our study was to evaluate the epidemiological, diagnostic and therapeutic aspects of acute chest syndrome in children with sickle cell disease at the

Peace Hospital in Ziguinchor.

Methodology

We conducted a retrospective descriptive study over a six-year period, from 1 January 2018 to 31 December 2024, comprising all children and adolescents monitored for major sickle cell syndrome in the pediatric department of the Peace Hospital in Ziguinchor (HPZ).

The study included all homozygous SS sickle cell patients and composite SC heterozygotes regularly monitored in the department and hospitalized during the study period for acute chest syndrome (ACS). ACS was defined in our patients by the combination of a recent chest X-ray with at least one of the following respiratory symptoms: cough, dyspnea, chest pain, hypoxia, fever.

Data were collected from hospitalization and follow-up records. Data were entered and analyzed using Sphinx software, Microsoft Excel 2020 and Google Forms.

Results

During the study period, 49 children were hospitalized in the department for acute chest syndrome out of 7,130 hospitalizations, representing a hospitalization rate of 0.68%. The average age of patients on admission was 7.3 years, ranging from 1 to 19 years. Children under the age of 5 accounted for 40.9% of cases, closely followed by children aged 5 to 10 (40.68% of cases).

The sex ratio was 1.59. Socioeconomic status was low in 72.7% of cases. Parental consanguinity was found in 11.4% of cases. All patients in our study population were homozygous SS, with previous hospitalization in 54.4% of cases, previous transfusion in 29.5% of cases, and comorbidity such as asthma in 11.4% of cases. One patient had received corticosteroid therapy in the month prior to hospitalization.

During the study, the vaccination coverage rate against encapsulated germs (excluding Senegal's expanded vaccination programme (PEV)) was higher against salmonella, at 38.6% **(Table 1).**

Table 1: Distribution of Patients According to Vaccination Coverage rate Against Encapsulated Germs

Vaccines	Effective	Percentages %
Salmonella	17	38,6
Méningococcus	16	36,4
Pneumococcus	9	20,5

The mean baseline hemoglobin level was 7.79 g/dL, with a range of 6.3 to 9 g/dL. The reasons for hospitalization were predominantly cough (75%), followed by chest pain (61.4%) and dyspnea (59.1%) (Figure-1). Fever was present in 65.9% of cases and hypoxia in 45.5%. Physical examination findings were dominated by pallor (88.6% of cases), pulmonary consolidation (68.2%), heart murmur (56.8%), general malaise (47.7%), and bronchial obstruction (18.2%) (Table 2).

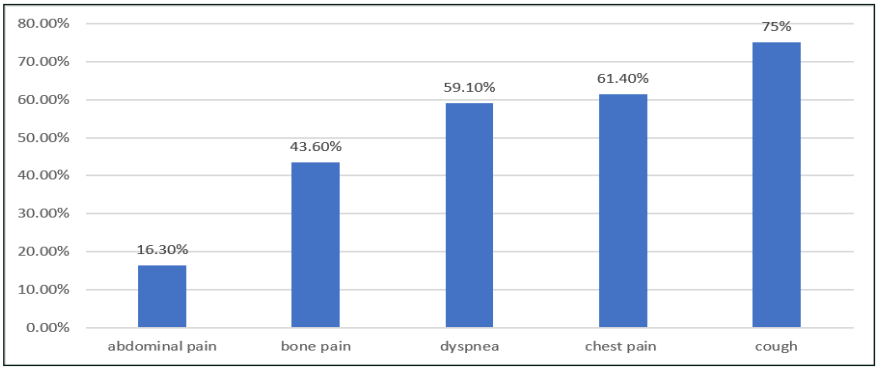

Figure 1: Distribution of patients according to reasons for hospitalization.

Table 2: Distribution of Patients According to Physical Signs upon Admission.

Exam	Effective	Percentages %
Pallor	39	88,6
pulmonary consolidation syndrome	30	68,2
Heart murmur	25	56,8
Altered general condition	21	47,7
Bronchial obstruction syndrome	8	18,2
Splenomegaly	4	9,1
Dehydration	4	9,1
Malnutrition	4	9,1
Pleural effusion syndrome	3	6,8

At admission, the mean hemoglobin level was 6.9 g/dL, and 72.7% of the study population had a hemoglobin level between 5 and 8 g/dL (Figure -2). The mean white blood cell count was 25,791.6 cells/mm³, with a range of 9,580 to 89,210 cells/mm³. Leukocytosis greater than 25,000 cells/mm³ was noted in 14 patients (31.8%). C-reactive protein (CRP) was positive in 28 patients (63.6%). One patient underwent a blood culture, which was negative. The mean platelet count was 420,888.4 cells/mm³, with a range of 111,700 to 918,000 cells/mm³.

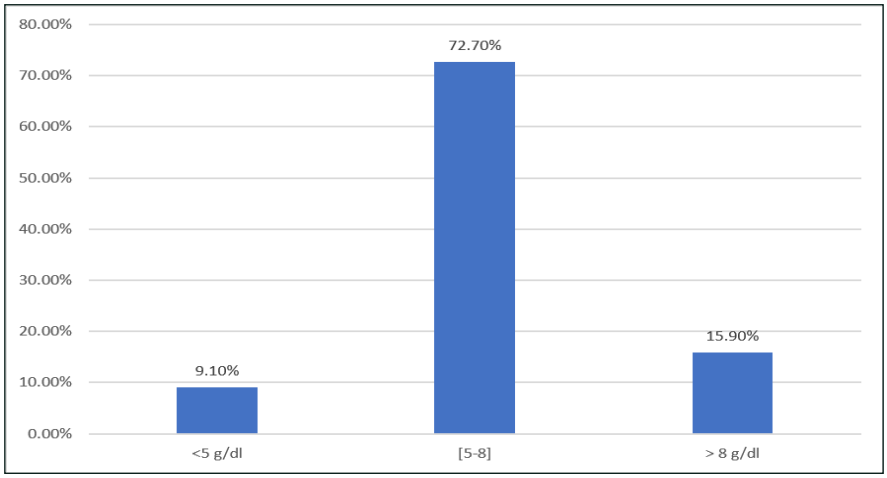

Figure 2: Distribution of patients according to hemoglobin level.

One patient had a platelet count below 150,000 cells/mm³. All patients in our series underwent chest X-rays. Interpretation of the chest X-rays revealed bilateral parenchymal involvement in 31.8% of cases; on the right in 29.5% of cases and on the left in 20.5% of cases (Table 3). One patient underwent a chest CT scan, which showed ground-glass opacities (suspected of SARS-CoV-2 pneumonia associated with acute chest syndrome). In our series, acute chest syndrome was primarily associated with pneumonia (72.7%), abdominal and bone vaso-occlusive crisis (43.2%), and acute anemia (34%) (Table 4).

Table 3: Distribution of Patients According to Lesions Observed on Chest X-ray.

Chest X-ray results	Effective	Percentages %
Bilateral parenchymal involvement	14	31,8
Parenchymal involvement on the right	13	29,5
Parenchymal involvement on the left	9	20,5
Bilateral thoracic distension	2	4,6
Right pleural involvement	1	2,3

Right parenchymal and pleural involvement	2	4,6
Left parenchymal and pleural involvement	2	4,6
Bilateral hilar overload	1	2,3

Table 4: Distribution of Patients According to Diagnoses Associated with STA

Related diagnostics	Percentages (%)
Pneumonia	72,7
Abdominale vaso-occlusive crisis	43,2
Bone vaso-occlusive crisis	43,2
Acute anemia	34
Pleuropneumonia	9
Acute osteomyelitis	4,5
Severe acute malnutrition	4,5
Pleurisy	2,3
Priapism	2,3
Splenic sequestration	2,3
Others (shingles; gallstones; acute cholecystitis)	6,9

In our study, 88.6% of patients received hydration at a rate of 2 liters per m² of body surface area with 5% glucose solution plus electrolytes. More than half (56.8%) of patients received simple oxygen therapy via nasal cannula. A blood transfusion with whole blood was performed in 77.3% of our patients (n=34).

All our patients received analgesic treatment. Paracetamol was the most frequently used, accounting for 97.8% of cases (Figure 3). In our series, all patients received antibiotic therapy. The combination of a third-generation cephalosporin (3GC) + aminoglycoside + macrolide was the most common, used in 28.6% of cases (Table 5).

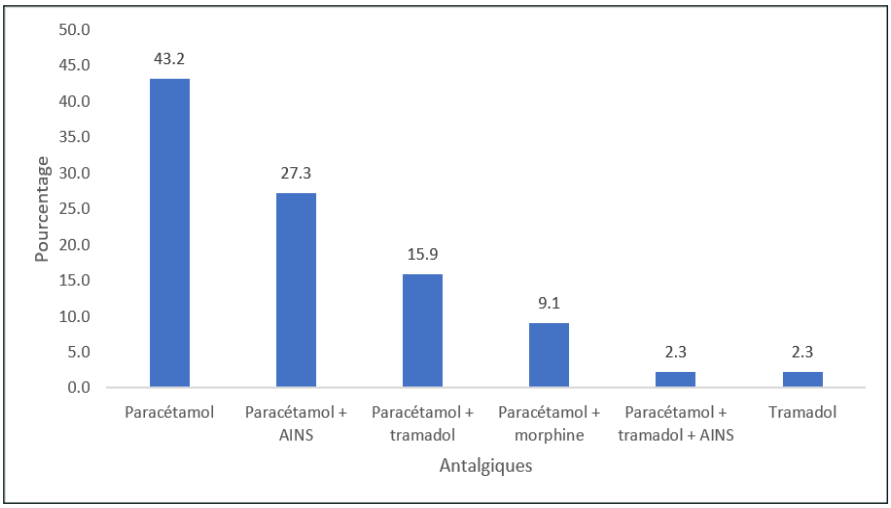

Figure 3: Distribution of Patients According to the Analgesics Administered

Table 5: Distribution of Patients According to Antibiotic Therapy

Antibiotics	Effective	Percentages (%)
Third-generation cephalosporin + aminoglycoside + macrolide	13	28,6
Third-generation cephalosporin + aminoglycoside	8	18,2
Third-generation cephalosporin + macrolide	6	13,7

Third-generation cephalosporin	5	11,4
Fluoroquinolone	4	9,2
Third-generation cephalosporin + aminoglycoside + imidazole	2	4,5
Amoxicillin clavulanic acid	2	4,5
Amoxicillin clavulanic acid + macrolide	1	2,3
4th generation cephalosporin	1	2,3
Carbapenem	1	2,3
Fluoroquinolone + aminoglycoside + macrolide	1	2, 3

Discussion

The hospital incidence rate was 0.68% in our study. This result is close to that of Ly et al., which was 1.1%, and also to that of Diagne et al., which was 1% in Dakar [10,11]. However, a review of the literature shows higher incidence rates, reaching 10 to 20% [3]. Acute chest syndrome (ACS) is a common emergency in children, often underdiagnosed in our African context for several reasons and sometimes confused with pneumonia or a thoracic vaso-occlusive crisis, which are its main causes [12].

In our cohort, the mean age of patients was 7.3 years. The under-5 age group was predominant, contrary to some studies [13,14,15]. Sickling syndrome (SS), occurring in the under-5 population, is often confused with other pulmonary conditions, particularly infectious diseases, given the lack of early detection and the frequency of infectious diseases in sub-Saharan Africa. The literature reports a male prevalence [3].

In Senegal, Seck et al. found that the majority of patients (80%) came from low-income or zero-income households, as did Thiam et al., who reported a low socioeconomic status in 65.75% [2,4]. Without health insurance coverage, the average cost of managing a child with sickle cell disease is estimated at 500,000 CFA francs per year in Senegal [16].

The clinical profile of sickle cell patients presenting with acute venous thromboembolism (AVTE) was primarily that of homozygous SS patients with low baseline hemoglobin levels, who may have received multiple transfusions, and sometimes had comorbidities such as asthma. The mean baseline hemoglobin level in our patients was 7.79 g/dL. This result is comparable to that of Ly et al., 7.9 g/dL [10]. Studies in the literature have shown that children with sickle cell disease and asthma are 2 to 5 times more likely to experience an AVTE episode during vaso-occlusive crises (VOCs) [17]. Vaccines against encapsulated bacteria (outside the Expanded Program on Immunization (EPI)) are recommended for sickle cell patients by the WHO. However, these vaccines are not covered by health insurance in our setting, and there is no social security system. Vaccination coverage was very low during our study.

The main pulmonary symptoms of acute respiratory distress syndrome (ARDS) in our study were consistent with those reported in the literature in sub-Saharan Africa and worldwide; the difference sometimes lay in their order of frequency. The assessment of respiratory distress must be rigorous in order to classify it and allow for rapid management. This management will consist of early oxygen therapy and improvement of hemoglobin levels through transfusion, which will improve oxygen transport to the tissues [13].

Biological abnormalities reflect the multifactorial mechanism of acute chest syndrome (ACS) in children with sickle cell disease. Thus, the typical biological diagnosis of ACS includes a biological inflammatory syndrome with leukocytosis, thrombocytosis, and acute anemia. The mean hemoglobin level on admission in our series was 6.93 g/dL. There is a relationship between hemoglobin level and the prognosis of ACS. According to Castro et al., a hemoglobin level < 7.8 g/dL on admission is associated with an unfavorable outcome. The international recommendation is to aim for a return to the patient's baseline hemoglobin level during an acute episode. A hemoglobin level < 7 g/dL in cases of ACS is a criterion of severity justifying urgent transfusion [18].

A leukocytosis greater than 25,000 cells/mm³ was present in 14 of our patients (31.8% of cases). Indeed,

chronic inflammation often results in a persistently high leukocyte count, and an associated infection is suspected when the count exceeds 25,000 cells/mm³. Furthermore, a review of the literature shows that infection can initiate or precipitate the development of acute squamous cell carcinoma (ASC) in sickle cell patients [19,20].

In children with sickle cell disease, acute chest syndrome (ACS) is characterized on chest X-ray by the appearance of a recent pulmonary lesion. Chest X-rays should be included in the evaluation of patients with sickle cell disease who present with fever, chest pain, or respiratory symptoms. No child underwent a lung ultrasound, although this technique remains highly valuable for the early diagnosis of acute chest syndrome.

The mechanisms underlying acute chest syndrome (ACS) are multifactorial, potentially involving pleuropulmonary infection, fat embolism, pulmonary infarction, and hypoventilation. In our study, 84% of ACS cases had an infectious origin, predominantly pneumonia (72.7%). Our results are comparable to those reported in the literature [12, 13, 3].

Patients admitted for painful episodes should be considered to be in the prodromal phase of acute chest syndrome; they will require incentive spirometry and daily monitoring of lung disease [21].

Management is based on hydration, antibiotic therapy, oxygenation, analgesics, and transfusion [19, 20, 15]. In our cohort, 39 patients, or 88.6%, received hydration. Indeed, intravenous hydration helps reduce dehydration factors, which could promote sickling and worsen respiratory symptoms [22]. However, when administering hydration, the child's needs and the risk of fluid overload with pulmonary edema must be taken into account. In fact, fluid intake should not exceed 2 L/m² of body surface area [23].

In our cohort, analgesic treatment was administered to all patients in accordance with the literature [19,20]. The limited use of morphine in our African setting may be explained by problems related to availability, handling, and the risk of hypoventilation. Thirty-four patients (77.3%) received transfusions in our series. This could be explained by the fact that the majority of children arrived with a hemoglobin level that had dropped by at least 2 points at the time of diagnosis, and that transfusion could improve oxygen transport and be very beneficial in children hospitalized for acute chest syndrome (ACS) [13]. All patients received antibiotic therapy, primarily consisting of a third-generation cephalosporin + aminoglycoside + macrolide combination in 28.6% of cases. A review of the literature supports this antibiotic combination in the management of ACS in children with sickle cell disease [24]. Incentive spirometry helps reduce the occurrence of atelectasis, which is more likely in cases of chest pain and pulmonary superinfection [25].

None of our patients had undergone spirometry. Ideally, spirometry should have been performed in all patients over 5 years of age to limit hypoventilation and the worsening of severe forms of the disease, but our study lacked financial resources, the unavailability of the test, and its high cost in the hospital [19].

Conclusion

Acute chest syndrome is a serious acute complication of sickle cell disease. It should be considered in any child being treated for sickle cell disease who presents with respiratory symptoms. Along with close respiratory monitoring and symptomatic treatment, broad-spectrum antibiotic therapy is strongly recommended. Transfusions also have proven effects on improving established acute chest syndrome and preventing it.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

All authors have read and approved the final version of the manuscript.

Ethical Considerations

All records were used in strict compliance with confidentiality requirements.

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