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Evaluation of the Care of Children Aged 0 to 10 Years Hospitalized for Severe Malaria at the Tambacounda Health Center, Senegal

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Abstract

Introduction: Malaria remains a public health priority in Senegal, particularly in Tambacounda, where it is one of the main causes of child mortality. The objective of this work was to evaluate the care of children under 10 years of age hospitalized at the Tambacounda Health Center and the factors associated with recovery. **Methods**: An analytical, retrospective, and descriptive cross-sectional study with exhaustive recruitment of children 0 to 120 months hospitalized at the Tambacounda reference health center for severe malaria (according to WHO criteria) between 1 January 2018 and 31 December 2021 was performed. Data collection was done through a questionnaire. Records, hospitalization records, and treatment records were the sources of collection. Data entry and analysis were performed on Epi Info 7.2 and R. **Results**: A total of 481 children hospitalized with severe malaria were recruited. The highest number of cases was recorded in 2018 (33.05%). In the four years of the study, peaks were always observed between October and November and the highest peak in November 2020 with 95 cases. The mean age was 65.64 months with a standard deviation of 29.28 months and a predominance of male (53.43%). The majority of people were admitted from the outpatient clinic (57.79%) and the rest (42.21%) on the recommendation of a peripheral health post. All hospitalized patients had a positive RDT and/or a positive thick drop. However, the sharp decline at admission or during hospitalization

was positive in 93.80% of patients in our series, negative in 5.20% and not achieved in 1.00%. Seizures and severe anemia topped the list of signs of severity with 45.94% and 8.11%, respectively. In terms of evolution, for all hospitalized patients, there were 81.29% recovery, 10.19% referral to the Tambacounda regional hospital center for hospitalization, 4.99% death, 0.83% discharge and 2.70% unknown evolution. There was a statistically significant association between recovery without referral from a health post (OR = 1.85), absence of 2 or more signs of severity (OR = 1.82), absence of seizures (OR = 1.51), prostration (OR = 2.78), cardiovascular shock (OR = 6.67), coma (OR = 7.69), lack of evidence of biological severity (OR = 3.70), and hypoglycemia with blood glucose less than 0.4 g/L (OR = 5.88). **Conclusion:** In addition to the routine malaria prevention and management strategies implemented in Tambacounda, and the early referral of cases of severe malaria from health posts to the health center, all children hospitalized for severe malaria with certain symptomatology such as coma, prostration, cardiovascular shock, etc. Seizures and/or hypoglycemia should be systematically referred to the regional hospital to increase their chance of recovery.

Keywords

Severe Malaria, Children, Tambacounda, Senegal

1. Introduction

Malaria is caused by parasites of the *genus Plasmodium* and transmitted by female mosquitoes belonging to the *genus Anopheles*. Although perfectly preventable and treatable, malaria continues to have a devastating impact on the health and livelihoods of people around the world [1]. It is therefore a public health priority in the world. Despite the efforts made in the global strategy to combat malaria, this disease remains a scourge in Africa, especially in the sub-Saharan region, where it is one of the main factors in child mortality. Globally, the number of malaria cases is estimated at 241 million in 2020 in 85 malaria-endemic countries, up from 227 million in 2000 [2]. The number of deaths related to this parasitosis was estimated at 627,000 in 2020, of which children under 05 years of age and pregnant women are the most vulnerable [3]. In most malaria-endemic countries, the disease disproportionately affects the poor and disadvantaged groups, who have limited access to health facilities and can barely afford the recommended treatment [1]. The WHO African Region bears a large and disproportionate share of the global malaria burden. In 2021, around 95% of malaria cases and 96% of malaria deaths were recorded on the African continent with 80% of all deaths among children under five years of age [4]. Malaria is also a priority in Senegal, especially in the south-east of the country with the regions of Kolda, Kédougou and Tambacounda, which accounts for 90% of malaria cases, 64% of severe cases, 58% of deaths of all ages and 84% of deaths under 5 years of age [5]. Despite the implementation of at least three-monthly visits each year

of seasonal malaria chemoprevention (SMC) in the 3-to-120-month age group since 2014, malaria is one of the leading causes of infant mortality in the health districts of southeastern Senegal. Thus, the general objective of this study was to evaluate the management of children aged 0 to 120 months hospitalized for severe malaria at the Tambacounda health center from 2018 to 2021 according to the guidelines of the National Malaria Control Program (NMCP).

2. Data and Methods

2.1. Study Framework

The health district of Tambacounda is located in the department and region of the same name. It is located in the southeast of the country with an area of 11,416 km^2, an estimated population in 2022 of 317,016 inhabitants, a density of 28 inhabitants/km^2 and a natural increase rate of 2.7%. It consists of 27 health posts and 1 referral health centre with an area of responsibility. The Tambacounda health centre, which houses the district headquarters, covers a population of 25,859 people, or 8% of the district's overall population. All health posts in the district refer their patients with severe malaria or other severe pathology to this health centre for better care. It is located in the municipality of Tambacounda with three other secondary health centers, five private clinics, four private practices, and a level 2 public health facility which is the regional reference structure. Its premises have been built since the 1950s and it is run by a doctor supported by its management team, its paramedical staff and a health development committee (HDC). In 2022, the health centre had four doctors, a pharmacist, a dental surgeon, two senior biology technicians, eight state nurses, fifteen state midwives, eleven community care workers and seven matrons. Organisationally, the centre is composed of a general medicine outpatient unit, a paediatric consultation unit, a rehabilitation and nutrition education centre (RNEC), a rehabilitation and nutrition education unit (RNEU), an inpatient pavilion, a vaccination unit, a maternity ward, a laboratory, a social service, an odontology department, a tuberculosis treatment centre (TTC), an administrative department, a medicine depot for the health centre, a district medicines depot. Medicines for the management of simple malaria and severe inpatient malaria are free of charge, as are thick drops and rapid diagnostic tests for malaria.

2.2. Type and Period of Study

We carried out a cross-sectional, descriptive study with an analytical purpose. It covered the period from 1 January 2018 to 31 December 2021. An archival retrospective evaluation of patient records was conducted.

2.3. Study Population and Sampling

2.3.1. Study Population

These were children under 0 to 120 months of age hospitalized at the Tambacounda Health Center for severe malaria between January 1, 2018, and Decem-

ber 31, 2021.

- **Inclusion criteria**: Included in our study were all children aged 0 to 120 months hospitalized at the Tambacounda Health Center for severe malaria between January 1, 2018, and December 31, 2021. The severity criteria used for the assessment were: seizures, jaundice, coma, hypothermia < 36˚, hyperthermia at 41˚C, respiratory distress, haemoglobinuria, malnutrition, anaemia with haemoglobin level < 6, hypoglycaemia < 2 mmol/l or 0.4 g/l, renal failure with diuresis < 400 ml or serum creatinine > 265 micromol/l, hyperparasitaemia greater than 5%.
- **Non-inclusion criteria**: Children over 120 months of age were excluded from the study, as were children 0 to 120 months of age who were under observation for simple malaria or hospitalized for other non-malarial febrile conditions at the onset of hospitalization.

2.3.2. Sampling

We conducted an exhaustive recruitment of all records of patients aged between 0 and 120 months hospitalized for malaria between 2018 and 2021.

2.4. Data Collection

2.4.1. Collection Tools and Sources

Data were collected from a questionnaire divided into 50 items.

2.4.2. Collection Technique

i. It took place during the period from August 16 to September 15, 2022. The collection was carried out by a trainee physician assisted by the Primary Health Care Supervisor (S/PHC), the pharmacovigilance focal point, and the health center major. The evaluation was made on the basis of the National Malaria Control Programme (NMCP) scoring grid with the criteria for defining severe malaria.

2.4.3. Operational Definition of Variables

- **Dependent variable**: In our study, the dependent variable was cure. All patients who received an exeate with a favorable course were considered cured. The other types of outcomes (referred, dead, discharged, unknown) were classified as not cured at the time of analysis.
- **Independent variables:** These were:

- Socio-demographic factors (age, gender, address, etc.),
- Clinical data (fever and other clinical symptoms),
- Biological factors (results of thick droplet, signs of biological gravity),
- Therapeutic data (prescribed treatment, time between hospitalisation and start of treatment, etc.),
- Other types of patient outcomes other than recovery (referred: patient transferred to the regional hospital, death: patients who died in hospital, discharged: patients discharged against medical advice, unknown: evolution not mentioned in the file).

The quality of care was assessed as:

- Good: if the NMCP score was greater than or equal to 90/100,
- Acceptable: if the NMCP score was between 70/100 and 89/100,
- Fair: if the NMCP score was 50/100 and 69/100,
- Poor: if the NMCP score was less than 50/100.

2.5. Data Capture and Analysis

The data collected was entered into the Epi Info software version 7.2. Controls were built during the creation of the input mask in order to limit input errors. A cleanup of the entered files had been done with the software's analysis program and had made it possible to correct the outliers.

The data analysis was done in several stages. First, we did a descriptive study with univariate analysis that determined the position parameters of the quantitative (mean, standard deviation, median, extent, extremes) and qualitative (absolute and relative frequencies) variables.

Then, we carried out an analytical study with bivariate analyses on R-Studio. To study or assess the relationships between the different variables, we used statistical tests. However, before applying any test, we had previously checked the conditions under which it was carried out. Thus, with the comparison between two qualitative variables, we used:

- The KHI 2 PEARSON test if the theoretical effective is greater than 5,
- The KHI 2 YATES test if theoretical effectiveness between 3 and 5, or
- FISHER's KHI 2 if theoretical effective is less than 3.

It should be noted that in all our tests, the p cut-off was 0.05.

2.6. Presentation of Results

The results are presented in the form of tables and figures with a descriptive and an analytical part.

2.7. Ethical Considerations

This study was carried out in strict compliance with the rules of medical deontology and ethics, including anonymity and confidentiality. The results of this work were used to develop a problem-solving plan.

3. Results

Descriptive part:

As a result of this work, 481 cases of children hospitalized for severe malaria were enrolled.

- **Epidemiological characteristics:**

From 2018 to 2021, hospitalized cases of severe malaria in children were almost non-existent between January and June. The increase in cases starts from July for all four years. The peak is always reached between October and November, regardless of the year. The highest peak was recorded in November 2020

with 95 cases. The highest number of cumulative hospitalized cases was noted in 2018 with a total of 159 patients (33.05%). In 2019, only 60 children were hospitalized for severe malaria (12.47%). An increase in cases was seen in 2020 with 137 patients, or 28.48% of the cases in our series (Figure 1).

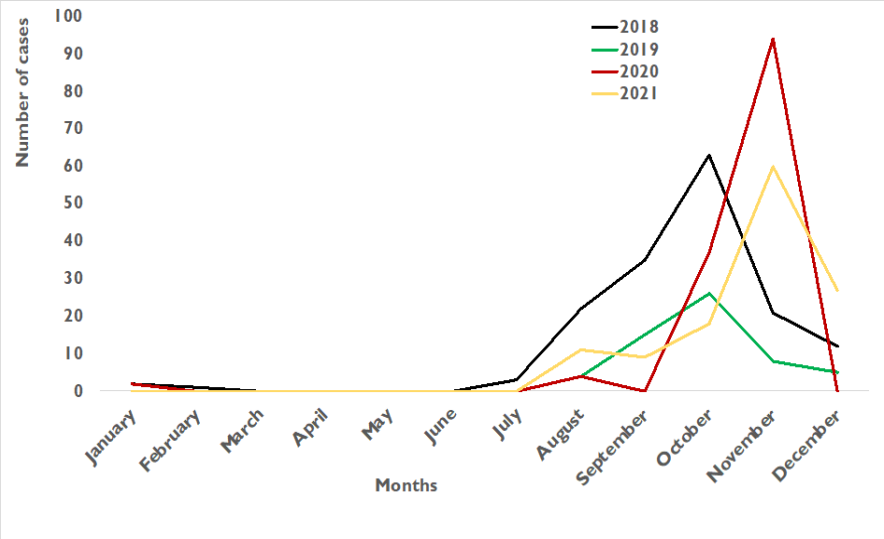

Figure 1. Monthly evolution of severe malaria cases among children aged 0 to 120 months, hospitalized at the Tambacounda health center from 2018 to 2021.

- **Sociodemographic, Clinical and Biological Characteristics**

The mean age was 65.64 months with a standard deviation of 29.28 months. The minimum age was 7 months and the maximum was 120 months. Children under 60 months accounted for 39.50%.

Males accounted for 53.43% with a sex ratio of 1.15. The Poular ethnic group was the most representative with 58.38% of cases, followed by the Mandinka (28.89%).

Among the seven health districts in the Tambacounda region, the majority of hospitalized children were from Tambacounda district (95.63%), followed by the border districts of Goudiry (3.12%), Maka Colibantang (0.83%) and Dianké Makhan (0.42%). The other three districts (Koumpentoum, Kidira and Bakel) were not represented. The majority of individuals were admitted from the outpatient clinic (57.79%). A total of 203 children (42.21%) were hospitalized for severe malaria at the Tambacounda Health Center following a referral from another peripheral health facility. Of the 27 health posts in the district, 22 referred cases of severe malaria to the Tambacounda health centre. The majority of referred cases came mainly from the health posts of Sinthiou Malem and Gouye (less than 15 km from the health centre) with 14.93% and 14.03% of referrals respectively.

The reasons for consultation varied (Table 1), but fever and/or history of fever were in the foreground (97.51%), followed by vomiting (42.20%). However, all children had RDT and/or thick droplet (GE) positive (100%). Only 354 children in the series (74.01%) showed signs of malaria severity according to WHO criteria, 15.80% showed no signs of severity, and in 10.60% of hospitalized chil-

dren, signs of severity were not mentioned in the record. Clinical signs of severity were observed in 67.36% of children and signs of biological severity were present in 17.67% of patients. In hospitalization, GE was positive in 93.80% of cases, negative in 5.20% of cases and results were unavailable (rupture of GE) in 1.00% of cases. In more than half of the series (50.94%), CBC was performed and 33.68% of them had anemia.

Table 1. Representation of reasons for consultation and clinical and laboratory severity signs in children 0 to 120 months of age hospitalized for severe malaria.

	Signs/Symptoms	Number of employees n (%)
Reasons for consultation	Fever and/or history of fever	469 (97.51%)
	Vomiting	203 (42.20%)
	Headache	182 (37.84%)
	Diarrhea	49 (10.19%)
Clinical Signs of Severity	Seizures	221 (45.94%)
	Prostration	122 ((25.36%)
	Hyperthermia (above 40˚C)	61 (12.68%)
	Jaundice	19 (3.95%)
	Coma	18 (3.74%)
	Shock	05 (1.04%)
	Hypothermia (Inf 36˚C)	03 (0.62%)
	Acute oedema of poumou	03 (0.62%)
Signs of Biological Gravity	Anaemia HB < 6 g/dl	39 (8.11%)
	Hypoglycaemia	22 (4.57%)
	Renal impairment	6 (1.24%)

- **Therapeutic and evolutionary characteristics**

All patients in the series received injectable artesunate as treatment (100%). According to the guidelines and the NMCP supervision grid, management was good in 46.55% of hospitalized children, acceptable in 42.61% of children, fair in 8.13% and poor in 2.71% of children in the series. A recovery rate of 81.29% was recorded, 10.19% of patients were referred to the regional hospital, 0.83% were discharged against medical advice. Deaths accounted for 4.99% of cases and in 2.70% of patients the evolution was not reported.

Analytical part:

Analytical analysis shows that not being referred to a health post, not having several signs of severity, not having a state of shock, not being in a coma, not having serious biological signs and not having serious hypoglycaemia were positively associated with recovery in children aged 0 - 120 months hospitalised for severe malaria (Table 2).

Table 2. Factors associated with cure in children aged 0 - 120 months hospitalized for severe malaria at Tambacounda Health Center from 2018 to 2021.

Parameters	Cure n (%)	p-Value	OR [95% CI]
Sex			
Masculine	212 (82.5%)	0.720	Ref
Feminine	181 (80.8%)		0.89 [0.56 – 1.42]
Résidence commune Tambacounda			
Yes	251 (83.9%)	0.131	Ref
Not	142(78.0%)		0.68 [0.42 – 1.08]
Referral of a health post			
Yes	155 (76.4%)	**0.013**	Ref
Not	238 (85.6%)		1.85 [1.14 – 2.94]
Fever or history of fever			
Yes	385 (82.1%)	0.245	Ref
Not	08 (66.7%)		0.43 [0.13 – 1.69]
Headache			
Yes	149 (81.9%)	1.000	Ref
Not	244 (81.6%)		0.98 [0.61 – 1.59]
Vomiting			
Yes	173 (85.2%)	0.113	
Not	220 (79.1%)		0.66 [0.40 – 1.06]
Diarrhoea			
Yes	43 (87.8%)	0.337	Ref
Not	350 (81.0%)		0.61 [0.22 – 1.39]
Existence of other signs			
Yes	275 (82.3%)	0.681	Ref
Not	118 (80.3%)		0.87 [0.53 – 1.45]
Thick Drop			
Positive	230 (84.2%)	0.754	Ref
Negative	105 (85.1%)		1.14 [0.63 – 2.17]
At least 2 signs of clinical severity			
Yes	256 (79.0%)	**0.039**	Ref
Not	137 (87.3%)		1.82 [1.07 – 3.22]
Jaundice			
Yes	15 (78.9%)	0.762	Ref
Not	378 (81.8%)		1.23 [0.33- 3.57]
Seizures			
Yes	173 (78.3%)	0.094	Ref
Not	220 (84.6%)		1.51 [0.96 – 2.43]

Continued

Prostration			
Yes	84 (68.9%)	**<0.001**	Ref
Not	309 (86.1%)		2.78 [1.69 – 4.54]
State of shock			
Yes	02 (40.0%)	**0.045**	Ref
Not	391 (82.1%)		6.67 [1.01 – 50.00]
Coma			
Yes	7 (38.9%)	**<0.001**	Ref
Not	386 (83.4%)		7.69 [2.94 – 20.00]
Sign of biological gravity			
Yes	64 (75.3%)	**<0.001**	Ref
Not	168 (91.8%)		3.70 [1.78 – 7.69]
Hypoglycaemia			
Yes	10 (45.5%)	**<0.001**	Ref
Not	383 (83.4%)		5.88 [2.50 – 14.28]
Anemia with Hb < 6g/dl			
Yes	34 (87.2%)	0.480	Ref
Not	359 (81.2%		0.65 [0.21 – 1.58]
Renal impairment			
Yes	04 (66.7%)	0.330	Ref
Not	389 (81.9%)		2.32 [0.28 – 12.50]
Compliance with severity criteria guidelines			
Yes	117 (76.0%)	0.459	Ref
Not	74 85.1%)		1.33 [0.72 – 2.63]

4. Discussions

Despite the implementation of malaria prevention campaigns in children such as seasonal malaria chemoprevention (SMC) in children under 10 years of age, and free distribution of long-lasting insecticide-treated nets (LLINs) in children under 5 years of age, children are still hospitalized in Tambacounda for severe malaria. In our work, among hospitalized children under 10 years of age, the 24 - 48 months age group was the most representative (28.92%). These results were comparable to those of Jacob *et al.* [6] in Côte d'Ivoire in 2017 and those of Keita *et al.* in Bamako [7] with 83.90% and 73.50% of malaria cases in children under 5 years of age, respectively. The predominance at this age could be explained by the fragility of this age group linked to the immaturity of the immune system. At this age, premunition is not yet acquired, and for effective protection against asexual forms of *plasmodium* in the blood in sub-Saharan areas, a minimum age

of 5 years is very often required [8]. Male children were the most affected in this series (53.43%). These results were similar to those of Jacob (33) and Camara at the Albert Royer Children's Hospital in Dakar (36), who also found a male predominance with sex ratios of 1.1 and 1.4 respectively. On the other hand, Coulibaly *et al.* in Mali [9] had regained a female predominance in her series (56.50%). However, neither of these studies nor ours was able to establish a statistically significant link between cure following antimalarial treatment and sex.

The seasonal nature of malaria was found in this work, with the beginning of hospitalization of children for severe malaria after the beginning of the winter. The highest numbers of children hospitalized for severe malaria were recorded in 2018 and 2020. This could be related to the fact that in 2018, some health care providers across the country observed a strike movement with a boycott of the strategy of seasonal malaria chemoprevention in children aged 3 to 120 months and the distribution of LLINs. In 2020, the COVID-19 pandemic handicapped the country's health system, both in terms of attendance at health facilities for preventive purposes and in the quality of patient care. In its 2021 report, the *World Malaria Report* objectified these same findings with an increase in hospitalized malaria cases [2]. During these years, because the study health centre was the reference centre in the district, a large number of children hospitalized for severe malaria were admitted following a referral from a health post (42.20%). However, there was a statistically significant association between admission by referral and cure. Children hospitalized for severe malaria admitted for non-referral were almost twice as likely to be cured as children hospitalized for severe malaria and referred from a health post. The delay in adequate care through pre-transfer treatment, the delay in consultation at the rural level as shown by the study by Alassani *et al.* in Benin [10], and especially the delay in decision-making from the referral from the health post to the health center as highlighted by Berthé *et al.* [11] (could be explanatory factors for this significant link between healing and referral. However, there is a discrepancy with the work of Mandoko *et al.* [12] in Kinshasa, which showed that the delay in referral did not have a negative influence on the evolution of patients. Clinically, fever and/or history of fever were present in almost all hospitalized children (97.50%). This result is consistent with the literature in which fever is the primary reason for consultation in malaria [13].

The WHO criteria recommend the presence of at least one sign of severity for hospitalization of a patient for severe malaria [14]. However, in this work, 74.01% of the children showed at least one sign of severity. This was mostly related to the fact that providers hospitalized children for severe malaria on the basis of 2 to several episodes of vomiting only. However, it should be noted that the presence of at least 2 signs of severity had a statistically significant association with non-recovery. Children who showed two or more signs of severity were 1.89 times more likely not to be cured of malaria. These results were also similar to those of Faye in Dakar [15] and Moyen [16] who also showed that the presence of several signs of clinical severity had a strong influence on the adverse

course of malaria. Among the signs of severity, seizures were most objectified in children (45.90%) and there was a statistically significant association between recovery and the existence of seizures. Children with seizures were 1.51 times more likely to be not cured of malaria than those without malaria. These results were in agreement with those of Matumbo *et al.* in the Democratic Republic of Congo in 2018 [17] and Keita in Mali [7] who had established that most of the adverse malaria outcomes were related to cerebral malaria with the presence of seizures. Coma was also found in 3.70% of children and had a statistically significant association on recovery ($p < 0.001$). Children hospitalized with severe malaria who were comatose were 7.69 times more likely to not recover than those who did not present with a coma. In 2016, Okoko *et al.* in Congo Brazzaville [18] confirmed in their work that coma had a strong influence on malaria lethality. The existence of prostration or shock also had a negative influence on the recovery of hospitalized children. This was consistent with the findings of Boushab *et al.* in Mauritania [19] who had shown that prostration was a factor in poor prognosis for patients hospitalized with malaria. The work of Fall *et al.* [20] and Camara *et al.* [15] also objectified that shock had a negative association with the recovery of patients with malaria. On the other hand, respiratory distress did not have a statistically significant negative influence on recovery ($p = 0.543$). These results were consistent with those of Camara *et al.* [21] in Dakar but were inconsistent with the results of Gbadoé *et al.* in Togo [22] and those of Okoko *et al* [18]. Indeed, in the studies of the latter, acute respiratory distress had a strong influence on the case fatality rate of malaria.

There was a statistically significant association between the existence of signs of biological seriousness and non-cure. In this series, children with signs of biological gravity were 3.70 times more likely to not be cured of malaria than those without malaria. Mansour *et al.* in Niger [23] in 2019 and Saissy *et al* [24]. In 2003, it was also shown that signs of biological severity were factors in poor prognosis for malaria. Severe anemia was at the forefront of the signs of biological severity in this work as well as in the study by Bobossi *et al.* (51). Although there was no statistically significant association between anaemia and malaria cure, hypoglycemia had a strong negative influence on recovery. Children hospitalized for severe malaria with hypoglycemia were 5.88 times more likely to be not cured of malaria than those who did not. These results were consistent with those of Camara *et al.* [16], Saissy *et al.* [24] and Adademy *et al.* [25] who showed that hypoglycemia was a factor associated with death in severe malaria. Among the biological signs, renal failure was also representative in this series (7.79%) but did not have a statistically significant association with cure. This was contrary to the work of Gbadoé *et al.* [22] who showed that although acute kidney injury was a rare complication, it had a strong influence on lethality. There was no statistically significant association with cure ($p = 0.459$) for health care providers' compliance with malaria severity criteria. This result was similar to that of Yaméogo *et al.* [26] in Bobo-Dioulasso in 2015 who had shown that compliance with the diagnosis of malaria severity with guidelines did not have a sta-

tistically significant association with the death rate (p = 0.78). However, more than 3/4 of the children in the series received adequate care, even though all of the children had benefited from injectable artesunate thanks to its availability and free of charge. In his work in Bobo-Dioulasso, Yamégo *et al.* [26] also showed that management was adequate in 57.40% of the cases in his series. In our work, the result of the treatment goes hand in hand with the cure rate which was 81.24%. The case fatality rate was much lower in our study (4.99%) compared to the case fatality in the work of Camara *et al.* (11.10%) [15] and Jacob *et al.* (9.83%) [6].

A limitation of our work is that potential confounding factors are not taken into account using multiple logistic regression.

5. Conclusion

Despite the implementation of proven effective malaria control strategies, malaria remains a public health priority in Senegal, particularly in Tambacounda, where it is one of the main factors in child mortality. The evaluation of the care of children under 10 years of age hospitalized at the Tambacounda Health Center from 2018 to 2021, with a search for factors associated with recovery, showed essential points on which action will have to be taken to reduce malaria-related infant mortality. Thus, in addition to the routine malaria prevention and management strategies implemented in Tambacounda, the early referral of cases of severe malaria from health posts to the health center, children hospitalized for severe malaria with certain symptoms such as coma, prostration, cardiovascular shock, convulsive seizures and/or hypoglycemia deserve special attention and could even be systematically referred to the regional hospital to increase their chance of recovery. In the future, the uptake of SMC drugs and their effectiveness will have to be established in these children hospitalized for severe malaria.

Conflicts of interest

The authors declare no conflict of interest regarding the publication of this article.

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