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Epidemiological, Clinical, Therapeutic, Evolutionary and Prognostic Aspects of Children with COVID-19 in Bouaké (Côte d'Ivoire)

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Abstract

Context: Compared to adults, there are relatively few studies on pediatric COVID-19 due to the high rate of asymptomatic or paucisymptomatic forms. The aim of this study is to determine the epidemiological, clinical, therapeutic, evolutionary and prognostic aspects of COVID-19 infection in children. **Patients and Methods:** This was a prospective analytical study carried out from February 27, 2021 to January 27, 2022 at the COVID-19 Care Center of the Infectious and Tropical Diseases Department of the Bouaké University Teaching Hospital. The study population consisted of all children under the age of 16, seen in consultation and/or hospitalized with a positive COVID-19 RT-PCR. Data analysis was performed with Epi Info 7 software. The statistical tests used were the chi-square test and Fisher's exact test depending on the conditions of validity with a significance threshold of $p < 5\%$. **Results:** Out of 955 patients received at the COVID-19 Care Center in Bouaké, there were 56 children (26 boys/30 girls), or, a prevalence of 5.86%. The mean age was 9.18 years ± 4.48 [extremes 3 months and 15 years]. Children over the age of 11 accounted for 48.21% of cases. They were contact cases in 35.71% and the contact person was the mother in 75% of cases. The main reasons for screening were cough (67.86%), fever (25%) and sneezing (21.43%). The pathological histories were asthma (83.33%), heart disease (33.33%) and sickle cell disease (16.67%). The medical examination revealed 6 cases of children in vital distress. The care consisted of home confinement for simple cases (89.29%) and hospitalization for cases presenting with vital distress (10.71%). The du-

ration of confinement or hospitalization was between 10 and 15 days in 83.93% of cases. No cases of death were noted. The factors associated with the occurrence of symptomatic forms were age ($p = 0.028$), pathological history ($p < 0.0001$), asthma ($p = 0.002$) and heart disease ($p = 0.001$). **Conclusion:** The proportion of pediatric cases of COVID-19 is low with a predominance during the season of harmattan. Pediatric infection with COVID-19 is benign and has a favorable evolution, with an almost intra-family transmission wich symptomatology is different from that of adults. Age and pathological history were the factors associated with the occurrence of symptomatic forms.

Keywords

Epidemiology, Coronavirus, SARS-Cov2, Children, Bouaké

1. Introduction

COVID-19 is a zoonosis transmissible to humans, caused by an RNA virus of the SARS-CoV species, responsible for severe acute respiratory syndrome. It emerged on November 17, 2019 in Wuhan, central China, with a rapid increase in cases and the number of deaths. The disease spread rapidly in several countries around the world and was declared on March 12, 2020 by the World Health Organization (WHO) as a pandemic [1]. Over the period from December 31, 2019 to January 27, 2022, 367,009,330 confirmed cases and 5,657,166 deaths from COVID-19 were recorded worldwide [2]. Africa has recorded 10,703,393 confirmed cases and 237,116 deaths as of 01/27/2022 since the first case of COVID-19 appeared in Egypt on February 14, 2020 [3] [4]. Côte d'Ivoire declared its first case on March 11, 2020 and 10 days later there were already more than 100 confirmed cases of COVID-19 [5]. As of January 27, 2022 in Côte d'Ivoire, there were 80,487 cases including 782 deaths [2].

With the current rapid global spread of SARS-CoV-2 infection, the number of pediatric patients with COVID-19 is expected to increase significantly or has already increased significantly [6]. However, compared to adults, there are relatively few studies on pediatric COVID-19, due to the high rate of asymptomatic or paucisymptomatic children [7]. In particular, the epidemiological and clinical characteristics of COVID-19 in children under 16 are not yet fully defined. Understanding the epidemiological and clinical characteristics of COVID-19 will help control the spread and improve the cure rate of this pandemic disease. In order to contribute to this, we are carrying out this study which aims to determine the epidemiological, clinical, therapeutic, evolutionary and prognostic aspects of COVID-19 infection in children.

2. Patients and Methods

This was a prospective analytical study carried out from February 27, 2021 to January 27, 2022. The study took place in Bouaké, more precisely at the care

center for coronavirus patients of the Infectious and Tropical Diseases Department (ITDD) of the University Teaching Hospital (UTH) of Bouaké. The ITDD of Bouaké COVID center is located within the Bouaké UTH, 350 km from Abidjan, the economic capital, the only tertiary level center covering approximately 60% of the national territory. This center has three units, namely a consultation unit, a hospitalization unit and an intensive care unit. The hospitalization and resuscitation rooms are individual and are equipped with a wall-mounted oxygen device. The medical and paramedical team is made up of 24 doctors, 36 nurses, 36 caregivers, 12 hospital service agents. The reception and the visit of the patients were daily and ensured by the doctors helped in their task by the nurses, caregivers and hospital service agents. The study population consisted of all children under 16 seen in consultation and/or hospitalized. Were included all asymptomatic or symptomatic children, contact cases or not and whose RT-PCR for COVID-19 of the nasopharyngeal swab was positive. Were not included in the study, all suspected cases and children whose parents did not give consent for the study. The study sample was formed as the children were consulted and admitted to the COVID-19 center by meeting the inclusion criteria. The sampling was exhaustive. All children admitted during the study period and fulfilling the inclusion criteria were recruited for the study. The duration of the study being fixed for 12 months, we exhaustively included all children under the age of 16 with COVID-19 during this period according to the inclusion criteria. Children meeting the inclusion criteria underwent a clinical examination by an infectious disease specialist and a pediatrician, after an interview with the parents to obtain their verbal consent. This clinical examination was meticulous and aimed to look for signs of vital distress (respiratory distress, state of shock, dehydration, hyperthermia, adynamia). Children with no signs of vital distress were confined at their homes. The children with vital signs of distress were hospitalized at the ITDD COVID-19 care center at the Bouaké UTH. Hospital and home visits were daily. The variables studied were sociodemographic, clinical, therapeutic, evolutionary and prognostic. Concerning the ethical considerations, this study was carried out after obtaining the authorization of the Medical and Scientific Direction and the Head of Service of the ITDD of Bouaké. The collection of data was done from a pre-established survey sheet, including the study variables. The information collected was made anonymous by a coding system. We studied the sociodemographic characteristics (age, sex, occupation, notion of contact), the clinical characteristics (pathological history, reason for screening, severity of the disease), the therapeutic characteristics (therapeutic modalities, molecules), the evolutionary characteristics (duration hospitalization, outcome). Data were entered and analyzed using Epi Info 7 software. Quantitative variables were expressed as mean with standard deviation and extreme values. Qualitative variables were expressed as proportions. The comparison of quantitative variables was made with the chi-square test and Fisher's exact test depending on the conditions of validity. The significance threshold is set for $p < 5\%$.

3. Results

3.1. Epidemiological Characteristics

During the period from February 27, 2021 to January 27, 2022 we received 955 patients at the care center for patients with COVID-19 in Bouaké, including 56 children under 16, or 5.86%. There are three peaks (July, October and January). Cases recorded between November and March accounted for 62.5% of cases (Figure 1). The mean age was 9.18 years ± 4.48 with extremes of 3 months and 15 years and a sex ratio of 0.87. Children aged between 11 and 15 accounted for 48.21% of cases. Students accounted for 80.36% of cases. Among these 56 children, 35.71% were contact cases. The contact person was the mother in 75% of cases. Table 1 summarizes the different epidemiological characteristics of children.

3.2. Clinical Characteristics

Among the 56 children, the reasons for screening were pulmonary signs (78.6%), general signs (62.5%), ENT signs (32.1%) and digestive signs (23.2%). These signs were cough (67.9%), fever (25%), sneezing (21.4%), and diarrhea (10.7%). There were 10% or 17.9% of children who were asymptomatic.

Table 1. Epidemiological characteristics of children.

Variable	Frequency	Percent
Sex		
Girl	30/56	53.6
Boy	26/56	46.4
Age (years)		
0 to 5	15/56	26.8
6 to 10	14/56	25
11 to 15	27/56	48.2
Occupation		
Not of age of school	9/56	16.1
Pupil	45/56	80.3
University' student	2/56	3.6
Contacts with positive patient		
No	36/56	64.3
Yes*	20/56	35.7
Persons in contact		
Mother	15/20	75
Father	3/20	15
Brother/Sister	2/20	10

*case contact: symptomatic 14, asymptomatic 6.

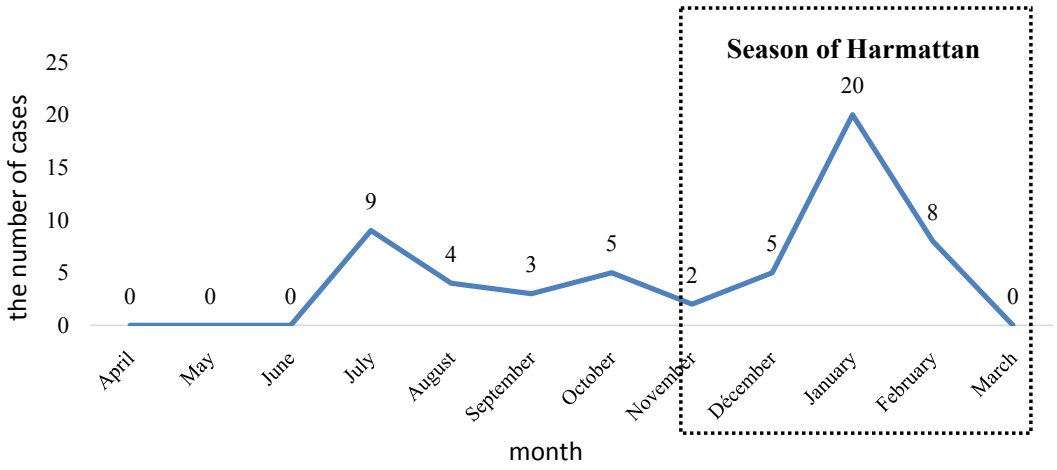

Figure 1. Distribution of children according to the period of occurrence of the cases.

The children had a pathological history in 10.7% of cases and it was asthma (83.3%), heart disease (33.3%) and sickle cell disease (16.7%). The physical examination revealed 6 cases (10.7%) of patients in vital distress. The clinical characteristics are detailed in Table 2.

3.3. Therapeutic and Evolutionary Characteristics

The care consisted of home confinement for simple cases (89.3%) and hospitalization for cases presenting with vital distress (10.7%). The treatments administered were vitamin C (66.1%), doxycycline (37.5%) and paracetamol (12.5%). All the hospitalized cases benefited from oxygen therapy with glasses or a mask, the dose of which varied according to the severity of the signs (1 l/min to 15 l/min). The therapeutic characteristics are presented in Table 3.

The duration of confinement or hospitalization was between 10 and 15 days in 83.9% of cases with a duration of confinement between 10 and 15 days in 84% of cases and a duration of hospitalization between 10 and 15 days in 83.33% of cases. The evolution was favorable in all the children.

Children over 11 years of age were likely to present symptomatic forms in contrast to those under 11 years of age with a statistically significant difference ($p = 0.028$). Also, children with a pathological history were prone to symptomatic forms ($p < 0.0001$). The pathological history statistically linked to the symptomatic forms were asthma ($p = 0.002$) and heart disease ($p = 0.0001$) (Table 4).

4. Discussion

The study took place from February 27, 2021 to January 27, 2022 and aimed to determine the epidemiological, clinical, therapeutic, evolutionary and prognostic aspects of COVID-19 infection in children. It appears from the study that the proportion of COVID-19 in the pediatric population is low with a predominance during the harmattan period. It is a mild infection with intrafamilial transmission. The clinical manifestations, the treatment as well as the evolution differ from that of the adult.

Table 2. Clinical characteristics of children.

Variable	Frequency	Percent
Pathological history		
No	50/56	89.3
Yes	6/56	10.7
Type of pathologies		
Asthma	5/6	83.3
Heart disease	2/6	33.3
Sickle cell disease	1/6	16.7
Screening reason		
General signs	**35/56**	**62.5**
• Fever	14/56	25
• Headache	13/56	23.2
• Tiredness	6/56	10.7
• Articular pain	2/56	3.6
ENT signs	**18/56**	**32.1**
• Sneezing	12/56	21.4
• Anosmia	5/56	8.9
• Odynophagia	1/56	1.8
Signes pulmonaires	**44/56**	**78.6**
• Cough*	38/56	67.9
• Respiratory difficulty	6/56	10.7
Signes digestifs	**13/56**	**23.2**
• Diarrhea	6/56	10.7
• Vomiting	3/56	5.4
• Agueusia	3/56	5.4
• Abdominal pain	1/56	1.8
No sign	**10/56**	**17.9**
Physical signs		
Vital distress**		
• No	5056	89.3
• Yes	6/56	10.7

*wet cough 14, dry cough 24; **vital distress: respiratory distress, hyperthermia.

Table 3. Therapeutic characteristics of children.

Variable	Frequency	Percent
Therapeutic modality		
Home confinement	50/56	89.3
Hospitalisation	6/56	10.7

Continued

Treatment administered		
Antiasthenic drug		
• Vitamine C	37/56	66.1
Antibiotic		
• Doxycycline	21/56	37.5
• Amoxicillin and clavulanate	3/56	5.4
• Azithromycin	1/56	1.8
Antipyretic—corticosteroid		
• Paracetamol	7/56	12.5
• Dexamethasone	1/56	1.8
Intensive care		
• Oxygen	6/56	10.7
Others treatments*	**3/56**	**5.4**

*other treatments: folic acid 1, hydroxyurea 1, ketoprofen 1.

Table 4. Factors influencing the occurrence of symptomatic form.

Variables	Symptomatic form		p
	Yes	No	
Age			
0 to 5	14	1	0.259
6 to 10	13	1	0.422
11 to 15	19	8	0.028
Sexe			
Girl	27	3	0.099
Boy	19	7	
Pathological history			
Non	1	49	<0.0001
Asthma	3	2	0.002
Heart disease	2	0	0.0001
Sickle cell disease	1	0	0.103
Contact case			
Yes	14	6	0.077
No	32	4	

However, the results obtained must be nuanced. Indeed, this is a single-center study whose results cannot be representative of the profile of children with COVID-19 in the Gbêkê region. Also, younger children, especially preschoolers, may not clearly describe their own health status and contact history, which could

contribute to data bias. In addition, due to insufficient testing, the children recruited in the study were tested by a single PCR instead of two, which could underestimate the positive cases.

Despite the methodological limitations, the results of the study raise the following points of discussion:

- **Epidemiological characteristics**

In this study, children represent 5.9% of COVID-19 cases at the care center in Bouaké. Camara *et al.* [8] in Guinea in 2020 yielded 2.59%. In the literature, children with COVID-19 represented 1.2% to 5% of cases [9]. The low proportion of COVID-19 in children could be explained by underreporting in this population due to the high rate of asymptomatic or paucisymptomatic cases [7]. Also, recent studies have shown that children have the highest seroprevalence of anti-SARS-CoV-2 antibodies among all age groups, which would protect them from the disease [10] [11]. Children have a habit of respiratory infections (respiratory syncytial virus) and therefore may have higher levels of antibodies against the virus than adults. In addition, this low proportion could be explained by an immaturity, unlike adults, of the function of the pulmonary converting enzyme (CE) converting angiotensin I into angiotensin II. Indeed, EC is known as a receptor for SARS-CoV. Since SARS-CoV-2 has amino amines analogous to SARS-CoV, recent evidence indicates that EC is probably the cellular receptor for the new coronavirus [12]. It is assumed that children are less susceptible to COVID-19 due to the binding capacity of EC to coronavirus in children, which is lower than in adults [13].

The average age was 9.18 years with extremes of 3 months and 15 years. Children between the ages of 11 and 15 accounted for 48.2% of cases. Camara *et al.* [8] in Guinea in 2020 reported a predominance of the age group from 0 to 4 years (38.62%). For Lu *et al.* [14] children between 6 to 10 accounted for 33.9%. The observed differences would be methodological due to the inclusion of suspected cases in these studies contrary to the inclusion criteria of this study.

There is a female predominance with a sex ratio of 0.87. Camara *et al.* [8] in Guinea in 2020 reported a female predominance (60.32%). As for Lu *et al.* [14], he noted a male predominance (60.8%). However, no studies have shown a significant link between gender and the disease.

These children were pupils in 80.4% of cases. Camara *et al.* [8] in Guinea in 2020 reported 62.96% of student cases. This predominance of students could be explained by the fact that schooling requires group meetings in school classes and recreational areas, which contributes to the spread and transmission of the virus. However, we must not lose sight of the possibility of intra-familial transmission due to confinement which had been observed throughout the territory with the closure of schools, thus promoting frequent and lasting contact between adults and children. Indeed, in this study 35.71% were contact cases and the contact person was the mother in 75% of cases. In the literature, exposure in the family environment was the main risk factor for contagion to COVID-19 in children [15].

During the study period, there are three peaks (July, October and January). Cases recorded between November and March accounted for 62.5% of cases. This period corresponds to the harmattan period in West Africa, caused by a dry and hot wind blowing from the Sahara Desert into the Gulf of Guinea, associated with a major incursion of dust. Virus infections are known to spread more during the dry harmattan season. A study in Nigeria showed that cases of COVID-19 infection were found to be significantly positively correlated with atmospheric parameters (temperature and humidity) [16].

- **Clinical characteristics**

In this study, 82.1% of children were symptomatic. This result is consistent with CDC data which noted that 88.7% of children were symptomatic [15]. As for Camara *et al.* [8] in Guinea in 2020 reported 52.38% asymptomatic cases. Also, Lu *et al.* [14] noted that 84% of children were asymptomatic. The high proportion of symptomatic cases in this study could be explained by the fact that the majority of cases (62.5%) occurred between November and March, which corresponds to the harmattan period in Côte d'Ivoire where the flu epidemics which have the same symptoms as coronavirus disease. However, larger series of studies confirm the benign character of the clinical forms of the disease in the pediatric population [17].

Among the 56 children, the reasons for screening were pulmonary signs (78.6%), general signs (62.5%), ENT signs (32.1%) and digestive signs (23.2%). Data from the literature show that children more readily present with ENT forms than pulmonary forms. And whatever the clinical form, they can keep the virus in the nose and throat for a period of 9 to 11 days [18].

The main signs presented were cough (67.9%), fever (25%), sneezing (21.4%), and diarrhea (10.7%). In the literature, the proportion of initial manifestations differs slightly depending on the reports, but about 50% of children have a dry cough, and some have fever (40% - 50%), sore throat (25%), shortness of breath (13%), diarrhea (13%) or experience malaise or fatigue [14] [16].

- **Therapeutic and evolutionary characteristics**

The management consisted of home confinement for simple cases (89.3%) and hospitalization for cases presenting a sign of vital distress (10.7%). Unlike adults, young people generally develop SARS-COV-2 infection of lesser clinical severity. This is illustrated, among other things, by a significantly lower hospitalization rate compared to adults. Camara *et al.* [8] in Guinea in 2020 reported that all confirmed cases in children accounted for less than 2% of hospitalized cases. The United States Centers for Disease Control and Prevention (CDC) reported that 5.7% of children with COVID-19 were hospitalized, including 0.58% in intensive care [15]. In general, children are affected by a mild form, but there are still cases of serious illness [19].

Although there are no clear guidelines for the treatment of pediatric COVID-19, in this study the treatments given were vitamin C (66.1%), doxycycline (37.5%) and paracetamol (12.5%). All hospitalized cases received oxygen therapy. These

treatments are different from those of Zhang *et al.* [20] in his study, according to the recommendations of the National Health Commission in China, which administered nebulized interferon-alpha (100%), ribavirin (44%) and antibiotic therapy (85%). Also, corticosteroid therapy and oxygen therapy were required in 15% and 9% of cases respectively. According to Guo *et al.* [6] the treatment measures for pediatric COVID-19 patients are not as complex as those for adult patients, but even relatively simple. Treatment modalities were primarily comprised of antiviral therapy, traditional Chinese therapy, antibiotic treatment, nutritional support therapy, and symptom relief.

The duration of confinement or hospitalization was between 10 and 15 days in 83.9% of cases with a duration of confinement between 10 and 15 days in 84% of cases and a duration of hospitalization between 10 and 15 days in 83.3% of cases. Zhang *et al.* [20] in their study found an average duration of 10 days. The evolution was favorable in all the children with no case of death. Camara *et al.* [8] in Guinea in 2020 reported no deaths, as did the Confidence study [21]. This could be explained by a lower severity of the infection in the pediatric population [17].

In this study, the absence of pathological history was correlated with the occurrence of asymptomatic cases ($p < 0.0001$). In the literature, young people with pre-existing health problems are at increased risk of serious illness associated with COVID-19 [22] [23]. Indeed, the odds ratios of death were 2.15 (95% CI: 1.98 - 2.34) in young people with a single comorbidity, 4.63 (95% CI: 4.54 - 4, 74) in young people with 2 comorbidities and 4.98 (95% CI: 3.78 - 6.65) in those with 3 or more comorbidities [24].

In this study, age between 11 and 15 years was correlated with the occurrence of the symptomatic form ($p = 0.028$). This result is consistent with literature data. Indeed, Musa *et al.* [25] in Qatar in 2021 noted that children under 5 years old and those over 10 years old are more likely to have symptomatic forms of COVID-19, compared to children aged 5 to 9 years old. The same observation was made in China [26]. However, the explanation behind this phenomenon remains unknown.

In addition to age, the factors statistically associated with the occurrence of asymptomatic cases were asthmatic background ($p = 0.002$) and heart disease ($p = 0.0001$). In the literature, the data do not allow any specific health problem to be associated with certainty with an increased risk of a severe case. However, some associations are reported more frequently. Certain neurological, pulmonary and cardiac pathologies seem to be associated with a sharp increase in the risk of serious illness in hospitalized young people [24] [27] [28].

5. Conclusion

In this preliminary study, we described the epidemiological, clinical, therapeutic, evolutionary and prognostic aspects of children with COVID-19 in a care center in Bouaké. This study found that the proportion of pediatric cases of COVID-19 is low with a predominance during the harmattan period. Pediatric infection with

COVID-19 is benign and has a favorable evolution, with almost intrafamilial transmission. This infection is often symptomatic with symptoms dominated by fever, rhinorrhea, headache, cough, abdominal pain, sneezing, diarrhea, asthenia. Age and pathological history were the factors associated with the occurrence of symptomatic forms. This study is a preliminary study. It is therefore important to define the epidemiological and clinical characteristics of the disease in a large cohort of pediatric patients.

Contribution of the Authors

All the authors participated intellectually in the preparation and revision of the manuscript before its submission.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Pediatric COVID-19 Survey Sheet at Bouaké

I. Sociodemographic aspects

1) Age (year): |__|__| 2) Gender: Male |__| Female |__|

3) Place of residence: Bouaké |__| Outside Bouaké |__|

4) Occupation: Not of school age |__| Primary |__| Secondary/University |__|

5) Legal guardian: Father |__| Mother |__| Others |__|

6) Contact of the legal guardian: |_____|

7) Notion of contact with a positive person: Yes |__| No |__|

If yes, contact person: Family member |__| Others |__|

8) Notion of travel in the previous 15 days: Yes |__| No |__|

II. Clinical aspects

9) Pathological history: Yes |__| No |__|

If Yes: Pneumonia |__| Asthma |__| Allergic rhinitis |__| atopic land |__| Heart disease |__| Sickle cell disease |__| Diabetes |__| Obesity |__| Epilepsy |__| HIV/AIDS |__| Congenital malformation |__| Others |_____|

10) Reason for screening: Fever |__| Arthralgia |__| Asthenia |__| Anosmia |__| Ageusia |__| Dry cough |__| wet cough Dry cough |__| Breathing difficulty |__| Abdominal pain |__| Diarrhea |__| Vomiting |__| Sneezing |__| Rhinorrhea |__| Rash |__| Lethargy |__| Disorder of consciousness |__| Others |_____| None |__|

11) Period of onset of signs (months): |_____|

12) Severity of the disease: Symptomatic |__| Asymptomatic |__|

13) Conclusion of the physical examination: stable |__| unstable |__|

14) Date of hospitalization or confinement |___/___/_____|

III. Therapeutic aspects

15) Therapeutic modality: Home |__| Hospitalization |__|

16) Treatment administered: Oxygen |__| Paracetamol |__| Vitamin C |__| antibiotic: Amoxiclav |__| Azithromycin |__| Doxycycline |__| Ceftriaxone |__| Chloroquine |__| Antiviral |__| Others |_____|

IV. Evolutionary aspects

17) Date of discharge from hospital or confinement |___/___/_____|

18) Issue: Healing |__| Death |__|