**Staphylococcus aureus** nasal carriage and its antibiotic resistance profiles in children in high altitude areas of Southwestern China

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**ABSTRACT**

**Background/Aim.** To describe the epidemiological profile of nasal carriage of *Staphylococcus aureus* (S. aureus) strains, its antibiotic resistance and mecA and Panton Valentine leukocidin (PVL) genes presence, in school children residing in high altitude areas of Southwestern China.

**Methods.** The cross sectional study screened nasal swabs taken from students for S.aureus. PCR was performed to identify mecA and PVL genes.

**Results.** Of the total 314 children 5.10% (16/314) was detected S.aureus. The resistance of isolated strains to penicillin, erythromycin, clindamycin, rifampin and cefoxitin was 100%, 81.3%, 81.3%, 0.0%, and 6.3% respectively. No strains demonstrated resistance to vancomycin; expression of mecA gene was detected in 3 isolates and 10 isolates were PVL-positive.

**Conclusion.** S. aureus was detected in 5.10% (3/314) of the study population; 0.96% (3/314) had methicillin resistant S.aureus (MRSA); expression of the mecA and PVL genes were detected in 3 and 10 isolates respectively.

**Key words:** antibiotic resistance; child; *Staphylococcus aureus*.

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**INTRODUCTION**

*Staphylococcus aureus* (S. aureus) is an important pathogen that affects children worldwide, and the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) is increasing. 1 One report found that about 80% of S. aureus infections were caused by the nasal carriage of S. aureus. 2 Resistance to β-lactam antibiotics is conferred by penicillin-binding protein encoded by the mecA gene which is located on a large chromosomal element. Recently, MRSA has been increasingly identified as the major cause of community-onset infections, usually possing Panton Valentine leukocidin (PVL) genes. For condition in high altitude, in climate from the extreme environments such as high UV and cold are believed that bacteria develop efficient mechanisms and strategies to growth and survive. 3 What’s more, the spread of bacteria resistant depends on the community of people and antibiotic usage to some extent.

In China, There are about 250 million square kilometers in high altitude and the population about 130 million, so it’s essential to know about the prevalence of S. aureus and it’s antibiotic resistance in the area. The population density and access to healthcare in Tibetan regions is lower than mainland China. In some ways, it’s bad for growth and spread of S. aureus. In China, most studies 4,5 were performed among children in mainland and only one of our studies 6 was about healthy school children 8 years ago. However, with the traffic and healthcare development, the epidemiology of S. aureus may be changed. The purposes of this study was to describe the prevalence of S. aureus, its antibiotic resistance and mecA and PVL genes presence, in school children residing in high altitude areas of Southwestern China.

**POPULATION AND METHODS**

This study was conducted between October and November of 2012 in Maerkang City (altitude ranging between 2500 and 4100 meters); a city of Aba province with a population density of
about 9 people per square kilometer. In this rural region, access to medical resources is relatively scarce. Antibiotics such as penicillin, clindamycin, erythromycin are sometimes used, though most other antibiotics are not commonly used in this population. In this study, we calculated the minimum sample size required to accurately assess the incidence of *S. aureus* carriage in the region as 233, based on the expected prevalence of nasal colonization (30%),7 with a 95% confidence interval.

Healthy Tibetan children were recruited from primary schools in Maerkang City. Children receiving antibiotic therapy or requiring hospital admission within a 4 week period preceding the time of recruitment as well as children suffering from skin infections were excluded. Samples of swabs were collected by twice rotating a sterile cotton swab pre-wetted with sterile saline solution in the vestibule of both anterior nares of the participants after obtaining oral, parental informed consent.

Nasal swabs were transported to the laboratory using the Sterile Amies Gel Transport Swab (Copan, Italy) and inoculated on the mannitol salt agar (Oxoid Ltd, Basingstoke, United Kingdom) and Columbia blood agar (bioMérieux, France) for 6 h. Next, the inoculations were incubated in 5% CO2 for 16-24 h at 35 °C. The identification of *S. aureus* was based on colony morphology, positivity of catalase and tube coagulase, and the results of a Slidex Staph Plus kit (bioMérieux, France). Antibiotic susceptibility of the isolates was performed by disc diffusion method, in accordance with the Clinical and Laboratory Standards Institute (CLSI) recommendations, for the following antibiotics: penicillin, erythromycin, clindamycin, gentamicin, cefoxitin and vancomycin. All the isolated *S. aureus* strains were screened for the *mecA* gene by PCR to identify a 162 bp target product. Primers used were *mecA* P4 5'-TCCAGATTACAACCTCACCAGG-3' and *mecA* P 7 5'-CCACTTCATATCTGTGAACG-3'. All isolates were also assayed for the presence of PVL genes by PCR using the luk-pv1:5'-ATCATAGGTAAATTGCTGACATGTCCA-3' and luk-pv2: 5'-GCATCAAAGTATTTGGATAGCAAAGG-3' primers. Only strains harbouring the *mecA* gene were classified as MRSA.9

The chi-square tests or Fisher’’s exact test were performed to detect the statistical significance (5%) between groups using SPSS 13.0 software for windows (SPSS Inc, Chicago, IL, United States of America). Ethical approval for this study was approved by the medical committee of West China Secondary Hospital, Chengdu, on 28 February 2008.

**RESULTS**

Three hundred and fourteen healthy Tibetan children including 182 (58.0%) boys and 132 (42.0%) girls participated in the study. The average age was 10.2 ± 1.2 years (ranging from 6 to 11 years) with 44.6% being above 10 years. *S. aureus* strains were isolated from 16 (5.10%) children including 10 boys and 6 girls without significant difference with regard to gender (p= 0.706). The resistance of isolated strains to penicillin, erythromycin, clindamycin, rifampicin and cefoxitin was 100%, 81.3%, 81.3%, 0.0%, and 6.3% respectively. The strain resistant to cefoxitin was proved to be MRSA. Additionally, expression of the *mecA* gene was detected in 3 isolates and 10 isolates were PVL-positive.

**DISCUSSION**

*S. aureus* is a major human pathogen that is known to cause a broad range of serious community acquired and nosocomial diseases in humans, from minor skin infections to severe infections such as septicemia.4 The carriage of *S. aureus* can be of great importance to the development of new therapeutic strategies and more effective prevention. Here we present the prevalence and antibiotic data of *S. aureus* isolates extracted from the nasal carriage of children in high altitude areas of southwest China. To our knowledge, this is the first study reporting the prevalence of MRSA in this regional pediatric population.

A few studies have previously investigated the carriage rate of *S. aureus* in low-altitude regions of mainland China5. Our team assessed the prevalence of *S. aureus* carriage within healthy school children in Chengdu, China; it was 18.35% and MRSA accounted for about 6% of the isolated *S. aureus* strains among 801 healthy children.5 Our study revealed that the nasal carriage rate of *S. aureus* among Tibetan healthy children was 5.10%. This rate was fairly low compared with reports from low-altitude studies. Interestingly, this rate is similar to a reported rate of lower respiratory infection 6.16% (22/357) in Tibetan children13 and the reported rate of 6.18% (11/178) cases of pediatric intensive care hospitalization12 in a high altitude area of China. The low rates of pediatric disease and *S. aureus* carriage in...
this region may be related to the environmental elevation in which the ambient air is thin and cold and where the population density is low. While children from areas of better economic status and greater populations (such as Chengdu) typically have greater access to medical care and receive antibiotic therapy frequently, the low rates found in our sample population could be related to lower economic states and poor medical conditions. Nonetheless, this relationship needs further determination.

In our study, the nasal carriage rate of *S. aureus* and MRSA was 5.10% (16/314) and 0.96% (3/314) in healthy children, respectively. However, another study6 by our team carried 8 years ago demonstrated that the nasal carriage rate of *S. aureus* was 2.4% in a population of 673 healthy Tibetan children, with no MRSA detected. The results show the rate of *S. aureus* is increasing in the area and attention to antibiotic usage for *S. aureus* should be considered, especially where MRSA in concerned. The results of this study indicated that in the presence of children with severe *S. aureus* infection, we should enhance antibiotics treatment based on antibiotic susceptibility test. Additional, vancomycin is needed when MRSA is detected in isolates. What’s more, the prevalence of *S. aureus* is still low but increasing in healthy children. Data about *S. aureus* prevalence in high altitudes is scarce as typically mainland China is the focus of such investigations. One, study13 reported *S. aureus* led to a mortality rate of 37.0% in neonatal septicemia in a high altitude African city. And it is important to continue investigating the environmental factors which may contribute to the incidence of pediatric *S. aureus* in these areas.

**Limitations of the study**

The present study had certain limitations. Due to the low population density of the region, it was difficult to recruit qualifying participants. The lack of differences between genders could be the result of a short number of patients. Additionally, the epidemiological study of the nasal carriage of *S. aureus* in this region needs to be further examined and dynamically monitored as it can be of great importance for this region.

**CONCLUSION**

*S. aureus* was detected in 5.10% (16/314) of the study population; 0.96% (3/314) had MRSA; expression of the meCA and PVL genes were detected in 3 and 10 isolates respectively.

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1. Song X, Cogen J, Singh N. Incidence of methicillin-resistant
Early use of continuous positive airway pressure in the treatment of moderate to severe acute lower respiratory tract infections among patients younger than 2 years old

Laura Figueroa, M.D. and Federico Laffaye, M.D.

ABSTRACT
Objective. To analyze the characteristics of patients younger than 2 years old who had a moderate to severe acute lower respiratory tract infection and were treated early with bubble continuous positive airway pressure, and factors associated with a successful intervention.

Method. Retrospective and descriptive study. Children younger than 2 years old admitted to the Pediatric Intermediate Care Unit of Hospital Provincial Neuquén between June 2009 and December 2010. Bubble continuous positive airway pressure was used, and the following outcomes were measured: heart rate, respiratory rate, Tal’s score, oxygen saturation, and fraction of inspired oxygen at 0, 2, 6, 24, and 48 h.

Results. One hundred and twenty patients were included. Their median age was 3 months old. The intervention was successful in 72% of patients. At 2 h, a 15% reduction in respiratory rate, and a 2-point decrease in Tal’s score were predictors of success, with an odds ratio of 6.41 (95% confidence interval: 2.68-15.36), and of 9.07 (95% confidence interval: 3.72-22.19), respectively.

Conclusions. A reduction in respiratory rate, heart rate, and Tal’s score at 2 hours of starting the intervention were predictors of success.

Key words: bubble CPAP, bronchiolitis, pneumonia, children.

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INTRODUCTION
Acute lower respiratory tract infections (ALRTIs) are an important cause of morbidity and mortality in our setting. The main clinical conditions included under the definition of ALRTI are bronchiolitis and pneumonia, which have a greater impact on childhood mortality, and set the basis for this study.

Non-invasive ventilation is an alternative for patients with moderate to severe ALRTIs. Different publications have mentioned a reduction in the length of hospital stay and a lower proportion of failure (less than 30%), defined as the need for endotracheal intubation.

The objective of this study was to analyze the characteristics of patients younger than 2 years old who had a moderate to severe ALRTI and treated early with bubble continuous positive airway pressure (CPAP), and factors associated with a successful intervention.

POPULATION AND METHODS
Retrospective and descriptive study. Children younger than 2 years old hospitalized between June 2009 and December 2010. Bubble CPAP was used, and the following outcomes were measured: heart rate (HR), respiratory rate (RR), Tal’s score, oxygen saturation, and fraction of inspired oxygen (FiO₂) at 0, 2, 6, 24, and 48 h.

Inclusion criteria for the use of bubble CPAP were as follows:
• Age between 1 and 24 months old.
• Weight < 12 kg.
• Tal’s score > 5 points.
• Admission to the pediatric intermediate care unit.

Exclusion criteria were the following:
• Cardiorespiratory arrest.
• Hemodynamic instability in spite of intravenous treatment with volume expanders.
• Inotrope requirement.
• Absence of gag and / or cough reflex.

Bubble CPAP consists of an interface (nasal cannula), inspiratory tubing, and expiratory tubing immersed in an underwater bottle system. The patient breathes spontaneously with positive pressure airflow, during both inspiration and expiration. Thus, continuous positive airway pressure is maintained throughout the breathing cycle.

CPAP includes an oxygen blender connected to a source of oxygen and compressed air used to supply an appropriate concentration of inspired oxygen ($\text{FiO}_2$). The humidified blended oxygen is then circulated through corrugated tubing. $\text{FiO}_2$ is estimated based on the liters of air and oxygen delivered. Blended oxygen is delivered via a nasal cannula, and pressure in the circuit is maintained by immersing the distal end of the expiratory tubing in water. The depth to which the tubing is immersed underwater determines the pressure generated in the patient's airways (Figure 1).

Prior to placing the nasal interface, airway secretions were cleared and, if deemed convenient, a dose of sedative was given (chloral hydrate or benzodiazepines).

The Hudson RCI CPAP Cannula System (USA), sizes 1-5, was used. Bubble CPAP was first connected at 5 cm H$_2$O and, eventually, this level was progressively increased up to 8 cm H$_2$O, although a higher initial pressure could be used at the discretion of the treating physician. In addition, initial $\text{FiO}_2$ was 100% and then reduced based on the patient's saturation.

Comorbidities were recorded: congenital heart disease, prematurity, malnutrition, bronchopulmonary dysplasia, and high social risk (unmet basic needs).

The presence of complications, such as abdominal distension, pressure injury, and pneumothorax, was determined.

In addition, patients’ weight, age, sex, diagnosis, virological tests (indirect immunofluorescence assay [iIFA], polymerase chain reaction [PCR]), culture results, sedative administration, length of bubble CPAP use, and length of stay in the pediatric intensive care unit (PICU) were recorded.

CPAP was considered successful if the RR reduced by 15% from the previous value and...
RESULTS

One hundred and twenty patients were included. The intervention was successful in 72% of cases, and failed in 28%.

Table 1 describes the demographic and clinical outcome measures of enrolled patients before CPAP use and compares successful and failed interventions.

All patients had an indirect immunofluorescence assay (IIFA), and respiratory syncytial virus (RSV) was detected in 70 cases. H1N1 was detected in 5% of patients.

CPAP was established at 5-8 cm H$_2$O, with an average of 6 cm H$_2$O.

Complications were observed in 3.3% of cases (abdominal distension, pneumothorax).

Mean bubble CPAP duration was 74.93 h (95% confidence interval [CI]: 65.22-84.65).

Mean length of stay in the intermediate care unit was 10 days (95% CI: 9.11-10.91); in the success group, it was 8.33 days (SD 3.36), and in the failure group, it was 14.93 days (SD 5.19) (the latter included the length of stay in the intensive care unit).

Table 2 shows outcome measures recorded during the hours after initiating bubble CPAP.

The subsequent analysis identified that a 15% reduction in HR and a 2-point decrease in Tal’s score at 2 hours of non-invasive ventilation (NIV) initiation were the factors related to success, with an OR of 6.41 (95% CI: 2.68-15.36), and of 9.07 (95% CI: 3.72-22.19), respectively.

<table>
<thead>
<tr>
<th>Table 1. Baseline characteristics of the sample and each group as per CPAP success or failure. Age is stated as median and range; the other outcome measures, as mean ± standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All (n= 120)</strong></td>
</tr>
<tr>
<td>Age (months old); X (range)</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Weight (kg)</td>
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<tr>
<td>Baseline RR</td>
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<tr>
<td>Baseline HR</td>
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<tr>
<td>Baseline FiO$_2$ (%)</td>
</tr>
<tr>
<td>Oxygen saturation</td>
</tr>
<tr>
<td>Tal’s score</td>
</tr>
<tr>
<td>Bronchiolitis</td>
</tr>
<tr>
<td>Pneumonia</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Predisposing clinical condition</strong></th>
<th><strong>All (n= 120)</strong></th>
<th><strong>Success group (n= 86)</strong></th>
<th><strong>Failure group (n= 34)</strong></th>
<th><strong>p</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prematurity</td>
<td>29 (24%)</td>
<td>23 (27%)</td>
<td>6 (21%)</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>11 (9.16%)</td>
<td>8 (73%)</td>
<td>3 (27%)</td>
<td></td>
</tr>
<tr>
<td>Bronchopulmonary dysplasia</td>
<td>6 (5%)</td>
<td>5 (83%)</td>
<td>1 (17%)</td>
<td></td>
</tr>
<tr>
<td>Congenital heart disease</td>
<td>8 (7%)</td>
<td>5 (62.5%)</td>
<td>3 (37.5%)</td>
<td></td>
</tr>
<tr>
<td>High social risk</td>
<td>14 (12%)</td>
<td>8 (57%)</td>
<td>6 (43%)</td>
<td></td>
</tr>
</tbody>
</table>

RR: respiratory rate; HR: heart rate; FiO$_2$: fraction of inspired oxygen.
When two qualitative outcome measures are combined, i.e., a 15% reduction in RR and a 2-point decrease in Tal’s score at 2 hours, OR increased to 13.31 (95% CI: 4.51-39.26).

No statistically significant findings were made at 24 and 48 h.

**DISCUSSION**

In our study, we described bubble CPAP use among patients younger than 2 years old with ALRTIs as a treatment strategy to avoid conventional mechanical ventilation.

The intervention was successful in 72% of cases, and failed in 28%. Success percentage was similar to that published by other authors (83% and 75.5%).

In this study, at 2 hours of NIV initiation with bubble CPAP, a 15% reduction in RR from the previous value and a 2-point decrease in Tal’s score were predictors of success.

Other authors have also identified a reduction in RR as a predictor of NIV success. This fact highlights the importance of monitoring clinical parameters and ongoing assessment of these patients.

Unlike other studies, Tal’s score was used in this study.

Modified Tal’s score has demonstrated to be highly useful in practice for a standardization of clinical management and decision-making.

Although HR significantly reduced at 2 hours, this outcome measure was an adequate predictor of failure as of 6 h, unlike what has been reported by Mayordomo-Colunga et al., who mentioned that HR reduction in the first hour was an adequate predictor of success.

In this study, no statistically significant differences were observed between both groups in terms of weight, age, predisposing factors, or bronchiolitis or pneumonia diagnosis. Mayordomo-Colunga et al. indicated that the presence of apnea, a lower weight, and a younger age were predictors of failure, as well as Antonelli et al., who also identified a younger age, a higher Woods’ score, acute respiratory distress syndrome (ARDS) or pneumonia.

In our experience, NIV given through bubble CPAP was a highly successful intervention among children with moderate to severe ALRTIs.

**CONCLUSION**

The early use of bubble CPAP works as a strategy to optimize patients’ access to quality care and the utilization of available resources.

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**Table 2. Results. Respiratory rate, heart rate, FiO_2, oxygen saturation, and Tal’s score**

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Overall sample</th>
<th>Success group</th>
<th>Failure group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n X ± SD</td>
<td>n X ± SD</td>
<td>n X ± SD</td>
<td></td>
</tr>
<tr>
<td>RR 2</td>
<td>120 55.79 ± 13.67</td>
<td>86 51.78 ± 11.3</td>
<td>34 65.94 ± 14.03</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>RR 6</td>
<td>114 55.72 ± 13.9</td>
<td>86 53.27 ± 12.3</td>
<td>28 63.25 ± 15.94</td>
<td>0.0008</td>
</tr>
<tr>
<td>RR 24</td>
<td>93 50.62 ± 9.61</td>
<td>86 50.17 ± 9.4</td>
<td>7 56.14 ± 11.14</td>
<td>0.1145</td>
</tr>
<tr>
<td>RR 48</td>
<td>84 48.73 ± 10.21</td>
<td>79 48.06 ± 9.74</td>
<td>5 59.20 ± 13.01</td>
<td>0.0171</td>
</tr>
<tr>
<td>HR 2</td>
<td>120 142.22 ± 19.68</td>
<td>86 139.06 ± 18.01</td>
<td>34 150.21 ± 21.66</td>
<td>0.0047</td>
</tr>
<tr>
<td>HR 6</td>
<td>114 140.46 ± 19.37</td>
<td>86 136.79 ± 17.25</td>
<td>28 151.75 ± 21.40</td>
<td>0.0003</td>
</tr>
<tr>
<td>HR 24</td>
<td>93 133.39 ± 19.21</td>
<td>86 132.84 ± 19.38</td>
<td>7 140.14 ± 16.61</td>
<td>0.3359</td>
</tr>
<tr>
<td>HR 48</td>
<td>84 127.42 ± 21.98</td>
<td>79 126.81 ± 22.02</td>
<td>5 137.00 ± 21.12</td>
<td>0.3177</td>
</tr>
<tr>
<td>FiO_2 2</td>
<td>120 98.78 ± 1.54</td>
<td>86 98.95 ± 1.37</td>
<td>34 98.35 ± 1.86</td>
<td>0.0936</td>
</tr>
<tr>
<td>FiO_2 6</td>
<td>115 98.89 ± 1.63</td>
<td>86 99.06 ± 1.38</td>
<td>29 98.38 ± 2.18</td>
<td>0.1238</td>
</tr>
<tr>
<td>FiO_2 24</td>
<td>90 98.88 ± 1.38</td>
<td>82 98.93 ± 1.34</td>
<td>8 98.38 ± 1.77</td>
<td>0.2831</td>
</tr>
<tr>
<td>FiO_2 48</td>
<td>83 98.36 ± 2.14</td>
<td>77 98.62 ± 1.81</td>
<td>6 95.00 ± 3.35</td>
<td>0.0470</td>
</tr>
<tr>
<td>Sat 2</td>
<td>119 86.5 ± 15.26</td>
<td>86 85.15 ± 15.28</td>
<td>33 90.03 ± 14.85</td>
<td>0.1188</td>
</tr>
<tr>
<td>Sat 6</td>
<td>114 82.73 ± 17.66</td>
<td>86 80.56 ± 18.02</td>
<td>28 89.39 ± 14.92</td>
<td>0.0208</td>
</tr>
<tr>
<td>Sat 24</td>
<td>87 72.26 ± 18.32</td>
<td>81 71.59 ± 18.38</td>
<td>6 81.33 ± 16.08</td>
<td>0.2108</td>
</tr>
<tr>
<td>Sat 48</td>
<td>80 66.25 ± 16.93</td>
<td>75 65.36 ± 16.47</td>
<td>5 79.6 ± 20.02</td>
<td>0.0682</td>
</tr>
<tr>
<td>Tal 2</td>
<td>120 6.08 ± 2.02</td>
<td>86 5.43 ± 1.76</td>
<td>34 7.74 ± 1.69</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Tal 6</td>
<td>114 5.54 ± 1.83</td>
<td>86 4.94 ± 1.34</td>
<td>28 7.39 ± 1.91</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

SD: standard deviation; RR: respiratory rate; HR: heart rate; FiO_2: fraction of inspired oxygen; Sat: oxygen saturation; Tal: Tal’s score; h: hours since non-invasive ventilation initiation.
In this study, RR, HR at 2 hours, and Tal's score at 2 and 6 hours after NIV initiation were predictors of the success or failure of the intervention.

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Echinococcosis in children: Experience in a tertiary care hospital outside the endemic area

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INTRODUCTION

Echinococcosis is a zoonotic parasitic disease caused by cestodes (tapeworms) of the genus Echinococcus. The only type of clinical relevance in the American continent is Echinococcus granulosus. This disease is caused by the larval stages, for which humans are accidental intermediate hosts. It is the most common cause of liver cysts worldwide, and one of the most neglected diseases1 (Figure 1). In Argentina it is considered endemic, with more than 300 new cases every year.2,3

OBJECTIVE

To establish the epidemiology, clinical characteristics, treatment, and course of children with echinococcosis hospitalized at a tertiary care children’s hospital outside the endemic area.

POPULATION AND METHODS

Retrospective review of medical records of children ≤ 18 years old with an E. granulosus infection based on the international diagnostic criteria established by the World Health Organization (WHO) considering the epidemiology, clinical characteristics, images, anatomic pathology, serology, and parasitology of echinococcosis.4

The study period covered 20 years (May 1993-October 2013).

Outcome measures of interest included age, sex, place of origin, risk factors, clinical diagnosis, images, general lab tests, serological tests, treatment, and course.

Positive findings on epidemiology were defined as the presence of one or more risk factors for acquisition, such as origin from an endemic or rural area or having dogs. Serology was established using an enzyme-linked immunosorbent assay (ELISA) and confirmed using a Western blot for special situations. Imaging tests were selected based on the location and clinical presentation of echinococcosis.

Data were processed using the Epi-Info 6.0 software. Continuous outcome measures were reported as mean or median and range.
Categorical outcome measures were expressed in number and percentage.

RESULTS
Forty-seven patients were included; their median age was 8 years old. This is a referral hospital, so patients come from different places: 43 patients (91%) were from Argentina and 4 (9%) from Bolivia. Within the Argentine region, places of origin corresponded to the province of Buenos Aires (20 patients, 47%), Northeast (9 patients, 21%), Northwest (7 patients, 16%), and Patagonia (7 patients, 16%).

Forty patients (85%) had cysts located in only one parenchyma. Out of the 54 cyst locations, the liver and lungs were the most common ones; 45 patients (96%) received medical/surgical treatment. Complications were observed in 13 patients (28%). Pulmonary complications included bronchopleural fistula, pneumothorax, diaphragmatic paresis, atelectasis, and Staphylococcus aureus bacteremia. Complications related to brain cysts included intraoperative cyst rupture and hydrocephalus. In relation to patients who had complications from liver cysts, all had infections, including wall abscesses and secondary liver abscesses. Three patients (6%) relapsed between 1 and 24 months later and required a new surgery (Table 1).

DISCUSSION
In the region of the Americas, the largest number of echinococcosis cases is reported in South America. There are different species depending on the geographic area, with at least 10 distinct genetic types of E. granulosus.5

In Argentina, it is distributed across the entire national territory, especially in rural areas for sheep and goat breeding in the Patagonia, Mesopotamia, Humid Pampa, Cuyo, and Northwest.6

Echinococcosis is a zoonotic disease, so epidemiological history is essential for diagnostic guidance. Its clinical spectrum ranges from an asymptomatic presentation to a severe form, but it is rarely fatal, depending on cyst location, size, characteristics, and the presence or absence of complications.

Echinococcosis mostly involves the liver (67-89%) and, less frequently, the lungs (10-25%). It may occur in the spleen (1-3%), peritoneum (3-5%), kidneys (2%), brain (2%) and, more rarely, the heart, bones, pancreas, and orbit.7,8 Atypical and complicated locations require to be managed in tertiary care hospitals.

Single cysts are observed in 60-80% of cases. In the series presented here, single cysts in only one parenchyma were the most common type; and the liver and lungs were the most common locations.
The biased increased in pulmonary echinococcosis is related to the need of referral for specialized surgical treatment given that this is a tertiary care hospital, so it provides care for atypical or complicated forms requiring differential diagnoses and multidisciplinary management.

Diagnosis is based on epidemiological history, clinical characteristics, and additional imaging and lab tests, surgical findings, and pathological examination. Among additional tests, imaging studies to establish cyst location are essential for diagnostic guidance.

Initially, conventional X-rays are used to diagnose pulmonary echinococcosis, unlike the case of abdominal presentation, for which the imaging technique of choice for the WHO is ultrasonography. Other studies such as computed tomography scans or magnetic resonance imaging tests are used for specific surgical guidance and classification (Figures 2, 3, and 4).

Indirect hemagglutination and ELISA tests are used for serological diagnosis, with a sensitivity ranging from 50% to 98%. Uncertain cases are serologically confirmed by Western blotting. False negative results are more common when cysts are located in the lungs compared to the liver, with a 50-60% and 85-98% sensitivity, respectively; false negative results are even higher in the case of multiple or broken cysts (90-100%). A negative serology result does not rule out echinococcosis. New diagnostic methodologies, such as the Ag5 ELISA and the polymerase chain reaction (PCR), are under assessment to improve sensitivity. For this reason, the presence of a cystic mass in a patient with a history of exposure to dogs and sheep in areas where *E. granulosus* is endemic would validate the diagnosis of echinococcosis. However, a differential diagnosis should always be done to rule out other cystic conditions, such as benign cysts, tuberculosis, fungal infections, abscesses or tumors. A chest X-ray should be done in all patients with hepatic echinococcosis to rule out its presence in the lungs, and their family should also be examined for parasitic diseases.

Treatment is provided based on the national and international WHO consensuses. Most

#### Table 1. Result of epidemiological and clinical characteristics, diagnosis, treatment, and course. N: 47 patients

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>Number (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at diagnosis (median years old)</td>
<td>8 (range: 3-17)</td>
<td>51</td>
</tr>
<tr>
<td>Male patients</td>
<td>24</td>
<td>98</td>
</tr>
<tr>
<td>Positive epidemiological findings</td>
<td>46</td>
<td>62</td>
</tr>
<tr>
<td>Living in a rural area</td>
<td>29</td>
<td>62</td>
</tr>
<tr>
<td>Time until diagnosis (median months)</td>
<td>3 (range: 1-32)</td>
<td>62</td>
</tr>
<tr>
<td>LOCATION:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lungs</td>
<td>24</td>
<td>44</td>
</tr>
<tr>
<td>Liver</td>
<td>21</td>
<td>39</td>
</tr>
<tr>
<td>Brain</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Eyes</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Kidneys</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Retroperitoneum</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>One parenchyma involved</td>
<td>40</td>
<td>85</td>
</tr>
<tr>
<td>Multiple cysts (one or more parenchymas)</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>Cysts in multiple organs</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Eosinophilia (&gt; 500/mm³)</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>Positive serology (ELISA)</td>
<td>21</td>
<td>45</td>
</tr>
<tr>
<td>Medical/surgical treatment</td>
<td>45</td>
<td>96</td>
</tr>
<tr>
<td>Open surgery</td>
<td>41</td>
<td>91</td>
</tr>
<tr>
<td>Laparoscopy</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>PAIR</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Complications</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>Lungs</td>
<td>8</td>
<td>62</td>
</tr>
<tr>
<td>Liver</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>Brain</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Relapse</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

PAIR: puncture, aspiration, injection, reaspiration; ELISA: enzyme-linked immunosorbent assay.
guidelines are based on expert opinions because no good-quality evidence comparative studies have been conducted so far. Until 1980, surgery was the only treatment option; however, antiparasitic drugs and new percutaneous methods have replaced conventional surgical excision.

Treatment may be summarized into 4 basic modalities: conventional surgery, percutaneous techniques, antiparasitic drugs, and non-intervention (watch and wait). Surgery depends on the clinical course, location, size and characteristics of the cysts and the surgeon’s experience. The most commonly recommended surgical techniques include open surgery (radical or conservative) and laparoscopy. Percutaneous techniques include puncture, aspiration, injection, reaspiration (PAIR). Conventional surgery is the main choice for symptomatic patients and those with large cysts, overinfected cysts, or cysts located in the brain, lungs or kidneys; in this case, mortality rate ranges between 0.5% and 4%. The PAIR technique is a minimally invasive method used for cysts especially located in the liver and other locations, such as the abdomen, when these cannot be accessed through conventional techniques. It is contraindicated for superficial liver cysts and for inactive or calcified cysts, or in the case of bile duct communication and lung cysts. It has been estimated that the risk for post-puncture anaphylactic shock is 0.047%, based on 16 cases suffering from this complication out of 4209 cyst punctures.

Antiparasitic drugs are recommended for all cases as an adjuvant to surgery, or as monotherapy for asymptomatic patients with small cysts or multiple cysts that cannot be treated and cured with surgery.

Albendazole and mebendazole have shown to be effective for echinococcosis treatment; however, results with albendazole have been superior due to its pharmacokinetics, intestinal absorption, and cyst penetration. Albendazole is the treatment of choice for continuous therapy starting one month prior to surgery up to 3-6 months after the procedure. The addition of praziquantel is recommended for surgical accidents with broken cysts or for severe cases to prevent secondary dissemination. The frequency and type of post-surgical complications range between 8.5% and 22%, and depend especially on the location (complications are more common in the case of lung cysts).

In this series, 13 patients (28%) had complications; most commonly among patients

Figure 2. Lung location

Computed tomography scan of the chest.

Figure 3. Brain location

Magnetic resonance imaging of the brain.
with lung cysts because this is a referral hospital. No patient died as a result of this disease.

In relation to prevention strategies, mathematical models have shown that the most effective intervention is a combination of cattle immunization and periodic dog deworming. This way, echinococcosis reduction is achieved among intermediate and definitive hosts. This should be combined with health education to prevent home slaughter of livestock and feeding dogs with viscera.

CONCLUSION

Echinococcosis should be considered in the diagnosis of children with cystic lesions, especially when cysts are located in the liver and/or lungs. The management of this disease requires multidisciplinary work, and the surgical approach is a priority.

REFERENCES


FIGURE 4. Orbital location

Computed tomography scan of the orbit and facial bones.