Clinical and Microbial characteristics of invasive *Streptococcus pyogenes* disease in New Caledonia, a region in Oceania with a high incidence of acute rheumatic fever

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No conflict of interest

Keywords: *Streptococcus pyogenes* – *emm* type – South Pacific

Short title: Invasive *S. pyogenes* disease in New Caledonia

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Abstract

New Caledonia is an archipelago in the South Pacific with high prevalence of acute rheumatic fever and rheumatic heart disease. Conducted in 2006, this study aimed at characterizing clinical manifestations and microbial features of isolates obtained from invasive Streptococcus pyogenes disease. Clinical and demographic data were collected prospectively. Isolates were biotyped, T-typed, emm sequenced, and tested for antibiotic susceptibility. Detection of speA, speB, speC, and ssa genes was also carried out. The estimated annual incidence of invasive S. pyogenes disease for 2006 was high with 38 cases/100 000 inhabitants in New Caledonia. Invasive isolates were obtained from 90 patients with necrotizing fasciitis (41 cases), bacteremia without identified focus (12), myositis (10), septic arthritis (9), erysipelas (8), post-partum infections (4), myelitis and osteomyelitis (3), severe pneumonia (2) and endocarditis (1). Most frequent associated co-morbidities were skin lesions (71%) and obesity (29%). Thirty-one different emm-types were identified where six accounted for 54% of all isolates: emm15 (15.5%), emm92 (12.2%), emm106 (8.9%) and emm74 (6.7%), emm89 (5.6%) and emm109 (5.6%). The speA, speC, and ssa genes were expressed at different frequencies in the various emm types. The first epidemiological study of invasive Streptococcus pyogenes disease in New Caledonia highlights that emm-type distribution is particular and should be taken into account for the development of an appropriate vaccine. These findings support the prevention of pyoderma and other cutaneous lesions in order to limit the development of both invasive disease and post-streptococcal sequelae in the South Pacific.
Introduction

Streptococcus pyogenes is a major human pathogen causing both mild infections such as pharyngitis or impetigo and severe infections, including sepsis, necrotizing fasciitis (NF) and lethal streptococcal toxic shock syndrome (STSS). Non-suppurative sequelae, such as acute rheumatic fever (ARF) and rheumatic heart disease (RHD), are associated with high morbidity and mortality rates, specially in developing countries (6, 9, 21). The emm typing based on the sequence analysis of the variable distal part of the gene, which encodes the M protein, a major virulence factor, is the gold standard method used to characterized S. pyogenes isolates. Currently, there are more than 170 different GAS emm-types (7, 12). Since the late 1980s, there has been an increase of reports of invasive infections caused by S. pyogenes in Europe and the United States, with a significant preponderance of emm1 and emm3-types (1, 14, 18, 20). A few studies have recently reported a different GAS type distribution in developing countries and in indigenous populations (3, 17, 22). The knowledge of the emm-type distribution in a region may shed more light on the pathogenesis of GAS infections, and is crucial for selecting appropriate vaccine candidates which would include multiple M protective epitopes. Currently, a 26 valent M protein-base vaccine in the preclinical phase testing is being developed for populations with a high risk of acute rheumatic fever or rheumatic heart disease (16, 19).

We report the first epidemiological study of invasive S. pyogenes disease in New Caledonia, an archipelago of the South Pacific where rheumatic fever is endemic (www.dass.gouv.nc). Our objectives were to characterize the demographic, clinical and microbiological features of invasive S. pyogenes disease in 2006 in New Caledonia to determine the emm-type distribution of GAS strains in the population.
Material and methods

Bacterial isolates and patients.

All isolates of *S. pyogenes* obtained as pure culture from infected body sites of patients of the largest hospital in Noumea, a 285-bed tertiary care hospital serving most of the New Caledonian population were sent to the Microbiological Laboratory of the Pasteur Institute, New Caledonia between January and December 2006. Only one isolate per patient was analyzed.

Standard patient demographics, including age, sex, ethnicity, date, and site of collection were recorded. Medical records were also examined prospectively to assess underlying diseases or conditions that may have predisposed patients to invasive disease: skin trauma, injection drug use, varicella infection, alcohol abuse, usage of non-steroidal anti-inflammatory drugs (NSAIDs), diabetes, immunosuppressive therapy, malignancy, and HIV infection. The overall fatality rate was assessed 30 days after the date of specimen sampling.

Case definitions.

Invasive cases were defined as infections associated with the isolation of *S. pyogenes* from a normally sterile site (blood, cerebrospinal fluid or other normally sterile fluid/tissue, e.g. peritoneal, pleural and joint) or as clinical presentation of necrotizing fasciitis (NF), myositis or erysipelas associated with monomorphic culture of *S. pyogenes* from the infected lesion.

Cases of streptococcal toxic shock syndrome (STSS) were defined according to published criteria (24).

Identification of *S. pyogenes*.

Identification was based on beta-hemolysis on Columbia sheep blood agar (Oxoid, Dardilly, France), Gram stain, negative catalase test, positive pyrrolidonyl arylamidase test (Oxoid) and agglutination with Lancefield group A antiserum (Slidex, Streptokit; bioMérieux, Marcy-L-Etoile, France).
Susceptibility testing.

Antimicrobial susceptibility to penicillin G, amoxicillin, erythromycin, clindamycin, tetracycline, rifampin, streptomycin, kanamycin, gentamicin, and vancomycin was tested by the disk diffusion method on Mueller-Hinton agar with 5% sheep blood, incubated overnight at 37°C in air enriched with 5% CO₂ using commercial discs (Biorad) according to the guidelines and interpretation criteria of the antibiogram committee of the French Society for Microbiology (www.sfm.asso.fr).

Typing and detection of toxin or superantigen genes.

Biotypes were obtained on rapid ID 32 STREP strips (bioMérieux) as previously described (5). T-serotypes were determined on trypsinated bacteria by slide agglutination with type-specific antisera (Sevapharma, Praha, Czech Republic) (11).

The emm gene was amplified and sequenced as described previously (2). emm-type assignments were determined according to the protocol of the Centers for Disease Control and Prevention (CDC; Atlanta, Georgia, USA) available at http://www.cdc.gov/ncidod/biotech/strep/strepblast.htm (7).

A multiplex PCR procedure was performed as previously described to detect the speA, speB, speC or ssa genes (8, 13).

Data analysis

Incidence rates by ethno-cultural group were calculated using the 1996 census of the New Caledonian population (http://www.insee.fr). The estimation for all population was based on population data for 2004 re-evaluated with an increase of 1.9 % per annum. With an estimation of 239,642 inhabitants in 2006, this Pacific group of island is a discrete epidemiological entity with a multicultural population, including Melanesian (44% of the total population), European (34%) and Polynesian (12%, mainly Wallisian-Futunian and Tahitian) and the others (10%, mainly Chinese and Indonesian). Statistical analysis were performed
using the Student t test to compare mean ages, the $\chi^2$ test, odds ratios (ORs) with 95% confidence intervals (CI95%) and the Fisher exact test (for small numbers) to compare the distribution of categorical data (STATA, version 8).
Results

In total, 90 cases of invasive S. pyogenes disease were identified in 2006. They were obtained from skin or soft tissue samples (n=64 cases), blood (n=13), synovial fluid (n=9), pleural fluid (n=2), amniotic fluid (n=1) and spinal fluid (n=1).

Since all the patients who present severe S. pyogenes infection are usually transferred to the main hospital of the country, we estimated that the annual incidence of invasive S. pyogenes disease for 2006 was 38 cases/100,000 individuals. The incidence by age or by major ethno-cultural group showed that three different groups had a higher risk of developing invasive S. pyogenes disease: children under the age of five years, adults above the age of 64, and Melanesians (Figure 1 and Table 1). The incidence of S. pyogenes positive blood culture was estimated to 10.4 cases/100,000 inhabitants in New Caledonia in 2006. No seasonal or geographical differences in the occurrence of invasive S. pyogenes disease were observed.

The median age of patients was 24 years (mean age 31 ± 24 years, range birth to 95 years) and the incidence of infection was higher among males (68% of all cases). We observed an over-representation of severe S. pyogenes disease in the indigenous Melanesian population (66 cases, 73%) and an under-representation in Europeans (13 cases, 14%) as compared with the global distribution of ethnic groups in New Caledonia, p≤0.01. The proportions of patients with various underlying diseases, outcome and risk factors are shown on table 1 and 2. Skin and soft tissue infections, such as NF (41 cases), myositis (10 cases), erysipelas (8 cases), and bacteremia without identified focus (12 cases) and arthritis (9 cases) were the most frequent clinical manifestations of invasive cases. Other clinical presentations included post-partum infections (4 cases, including one case involving the mother and the baby), pleuro-pneumonia (2 cases), osteomyelitis (2 cases), and myelitis and endocarditis (one case each). Puerperal fever cases were related to vaginal delivery of four women aged 21 to 32. The three STSS, associated with one case of bacteremia and the two cases of pneumonia, were lethal. Two
thirds of the patients underwent surgery, and 14% patients required intensive care. Irrespective of skin lesions, at least one co-morbid disease was found in 52 (58%) of 90 patients, and was found significantly more frequently in adults up to the age of 30 years (p≤0.01) and in non-indigenous patients (p≤0.03). The most prevalent underlying conditions included obesity, cardio-pulmonary diseases, ethanol abuse and usage of NSAIDs (55 of 81 studied, 68%). There were no cases of HIV infection nor intravenous drug abuse. The presence of a skin lesion in 71% of patients was the predominant local predisposing factor for invasive infection and specially, in patients without co-morbidities (p≤0.01). They were wounds (40 cases), hematomas (15 cases), furuncles (5 cases), scabies lesions (4 cases), burns (2 cases), stings (2 cases), eczema (2 cases), purpura (2 cases), psoriasis (1 case) and varicella (1 case). NF was more frequent in children and young adults from 5 to 29 years old (p≤0.03) and less frequent in Melanesians (p≤0.01). In univariate analysis emm15 strains tended to be associated with the indigenous population but this association was not statistically significant (p≤0.06).

Thirty-one different emm-types were identified among the 90 isolates distributed as following: emm15 (14 cases), emm92 (11 cases), emm106 (8 cases) and emm74 (6 cases), emm89 and emm109 (5 cases each), emm46 (4 cases), emm49, 65, 75 and 102 (3 cases each), emm71 and 103 (2 cases each), emm41, 53, 54, 56, 58, 77, 81, 86, 87, 93, 100, 101, 104, 105 and 123 (1 case each). One strain belonged to st6735; it was responsible for a post-partum infection and was isolated from the amniotic fluid of the mother, the throat of the baby and from the blood of both of them. An original strain belonged to a new sequence type st367 (available at http://www.cdc.gov/ncidod/biotech/strep/strepblast.htm), another belonged to stG1750, a sequence type previously identified from a group G streptococcal isolate, and amplification in emm gene was unsuccessfull for another strain. The proportion of disease caused by major emm-type is shown on table 3. Among the 62 typeable strains (68%), 13
different T-types were observed and T3/13/B3264 was predominant (19 strains, 31%). The
biotype distribution of strains was dominated by the biotype 3 (52 cases of 90, 58%) and
followed by biotype 1 (18 cases), biotype 29 (8 cases), biotype 6 (5 cases), biotype 5 (4
cases), 7 (2 cases), 8 and 13 (1 case each). There was a restricted association between certain
emm-types, T-serotypes, biotypes and resistance to tetracycline. The chromosomic speB gene
was found in all isolates. The speA, speC and ssa genes, which are associated with prophage
elements, were present at different frequencies in various emm-types but the highest
frequencies were found in the most prevalent types: emm15 (speA, 93% and speC, 100%),
emm92 (speC, 91%), and emm106 (speC, 100%). The analysis revealed that isolates of the
same emm-type shared a common or predominant toxin gene profile distribution. All the
strains were susceptible to all the tested antibiotics, but tetracycline. Tetracycline resistance
detected in 9 strains (10%) was distributed among six different emm-types, including emm109
whose 3 of 5 isolates were resistant, emm65 (2 cases), emm53 (1 case), emm58 (1 case),
emm104 (1 case) and stG1750 (1 case).
This study constitutes a first approach regarding the burden caused by *S. pyogenes* disease in New Caledonia, which is a French overseas archipelago located in the South Pacific, about 2 000 km North-East of Sydney, Australia. The Department and Agency of Health and Social Affairs in New Caledonia (DASS) (http://www.dass.gouv.nc/static/sante/themes) annually updates the number of cases of acute rheumatic fever (ARF). In 2002, the incidence of ARF, which was estimated to 9.8 cases per 100 000 inhabitants among the whole population of New Caledonia, reached 85.6 cases per 100 000 children aged 5-19 years, about 200 cases per 100 000 Melanesians. This information is consistent with published data from neighboring countries where active surveillance is established; the median estimated incidence of ARF cases in children aged 5-14 years has been estimated to reach 374 cases/100 000 inhabitants for the Pacific islands and indigenous populations in Australia/New Zealand vs 0.5 cases/100 000 people for developed countries (6). In temperate regions, rheumatic fever is usually associated with throat infection, but data suggest that *S. pyogenes* skin infections might play a greater role in the tropics (4, 15).

Interestingly to the present study conducted in New Caledonia, two cases of ARF were detected among the 90 patients with invasive GAS disease. Indeed the original *S. pyogenes* *emm*-type distribution, observed among invasive *S. pyogenes* disease, might be related to the local environmental and host risk factors for infection, but it seems to contribute weakly to the high prevalence of ARF in New Caledonia, as previously described in indigenous children of New Zealand (6).

Our study confirmed that invasive *S. pyogenes* disease occurs at greater rates in New Caledonia than in Western countries and are similar to the rates reported from other countries in the Pacific, such as Fiji, and from indigenous populations of Australia and New Zealand (6, 15, 17, 22, 23). Thus, the incidence of *S. pyogenes* positive blood culture was five times...
higher in New Caledonia than in metropolitan France in 2006 (Report of the French National Institute of health surveillance) but was similar to that of neighboring countries, such as Fiji (22). Invasive GAS disease predominantly affected the elderly, over 64 years with coexisting medical conditions as in most industrialized and developing countries (6). The high incidence rate for children in New Caledonia with 75 cases/100 000 young children aged less than five years was similar to rates reported from other developing countries and even twice higher than from Fiji (22).

NF, other skin or soft tissue infections and bacteremia from cutaneous origin were more frequently reported in patients aged less than 30 years. Interestingly, the indigenous-Melanesian children (under 15 years old) are over-represented (23 out of 26 cases, p=0.03). The high proportion of young male Melanesians hospitalized for invasive *S. pyogenes* disease associated with skin lesions is in accordance with previous study on the strong role of traditional behavior and environmental conditions in the development of impetigo in the tropics (4). In contrast, co-morbidities, bacteremia, admission in ICU and being non-indigenous accounted for an increasing proportion of severe *S. pyogenes* cases as age increased. The low case-fatality rate in our study (3.3%) as compared to the rate of 32% reported in Fiji remains unexplained (22).

The high genetic diversity of our *S. pyogenes* collection (31 different *emm*-types were identified among 90 strains) confirms previous findings that *S. pyogenes* isolates from the tropics show considerable *emm*-type variability. Furthermore *emm1, emm3* and *emm4*, the most prevalent types reported in the Western world, were absent from our findings (14, 19). Moreover, the *emm*-types distribution identified in this study was original and characterized by 6 predominant *emm* types (*emm15, emm92, emm106, emm74, emm89* and *emm109*) accounting for 54% of the 90 strains. This distribution differed significantly from that of neighboring countries, such as Hawaii, Fiji and in North Queensland, Australia (10, 22, 17).
In contrast to these previous studies, in which no previous dominant *emm*-type or clone has been demonstrated, we described the first predominance of the *emm*15 type among indigenous Melanesians. These *emm*-type findings could be used to estimate the potential benefits of the proposed M 26-valent vaccine (which has successfully completed a phase 2 trial) for age groups at the highest risk of developing invasive *S. pyogenes* disease (children aged < 5 years and adults ≥ 65 years), by checking whether the vaccine types M1, 1.2, 2, 3, 5, 6, 11, 12, 14, 18, 19, 22, 24, 28, 29, 33, 43, 59, 75, 76, 77, 89, 92, 94, 101, and 114 would be effective against the isolates reported in this study (16, 19). The number of children aged <5 years diagnosed with invasive GAS disease due to the types represented by the 26-valent vaccine was 5 out of 15 cases (33%) and the number of adults aged ≥65 years diagnosed was 2 out of 9 (22%). Despite the absence of pharyngitis *S. pyogenes* isolates in our study, the absence of known causative rheumatogenic strains in our *S. pyogenes* collection (M1, 3, 5, 6, 14, 18, 19, 24) and the unusual distribution of *emm*-types highlight the difficulties in building a universal M-valence vaccine that is effective within our borders.

This is the first epidemiological study of invasive *Streptococcus pyogenes* disease in New Caledonia, a region with a high incidence of acute rheumatic fever. This study highlights an *emm*-type distribution that is particular to New Caledonia and should be taken into account for the development of an appropriate vaccine. The reported incidence is far greater in indigenous communities than in other communities. Soft tissue infections were the most common source of infection. These findings prompt better prevention of pyoderma and other cutaneous lesions to limit the development of severe invasive disease. Further studies are ongoing to specify the role the predominant *emm*-types in acute rheumatic fever or other post-streptococcal sequelae in the South Pacific.
Acknowledgments

We thank Gislène Collobert and Françoise Charavay for excellent technical assistance. We gratefully acknowledge Paul Martin to lend one’s support to development of molecular epidemiology in New Caledonia. We also thank all of medical department of the Noumea’s Hospital for participating in this project.

This study was presented at the XVII Lancefield International Symposium on Streptococci and Streptococcal Diseases, Porto Heli, Greece 2008).

The authors declare that they have no conflict of interest in relation to this work.
References


superantigen expression in group A streptococcus serotype M1 isolates from patients


41. In D. R. Johnson, E. L. Kaplan, J. Sramek, R. Bicova, J. Havlicek, H. Havlickova,
J. Motlova, and P. Kriz (ed.), Laboratory diagnosis of group A streptococcal
infections. World Health Organization, Geneva, Switzerland.

A streptococcal serotypes associated with severe systemic infections, rheumatic fever,


Creti, K. Ekelund, M. Koliou, P. T. Tassios, M. van der Linden, M. Straut, J.
Vuopio-Varkila, A. Bouvet, A. Efstratiou, C. Schalén, B. Henriques-Normark;
Strep-EURO Study Group, A. Jasir. 2009. Clinical and Microbiological


Figure 1. Age distribution by ethno-cultural group and incidence of invasive
S.pyogenes disease in New Caledonia, in 2006.
Number of non-indigenous cases (European/Polynesian)  
Number of indigenous cases (Melanesian)  
incidence per 100 000 inhabitants
Table 1. Clinical characteristics for 90 cases of invasive *S. pyogenes* disease in New Caledonia

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>By major ethno-cultural group</th>
<th>By age group (years)</th>
<th>By sex group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indigenous Melanesian N=66</td>
<td>Non-indigenous European/Polynesian/others N=25</td>
<td>C&lt;sub&gt;P&lt;/sub&gt; ≤30 OR CI95</td>
</tr>
<tr>
<td>Predominant clinical manifestations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Necrotizing fasciitis</td>
<td>24</td>
<td>17</td>
<td>≤0.01</td>
</tr>
<tr>
<td>Bacteremia</td>
<td>9</td>
<td>3</td>
<td>NS NS</td>
</tr>
<tr>
<td>Myositis</td>
<td>9</td>
<td>1</td>
<td>NS NS</td>
</tr>
<tr>
<td>Arthritis</td>
<td>6</td>
<td>3</td>
<td>NS NS</td>
</tr>
<tr>
<td>Erysipelas</td>
<td>6</td>
<td>2</td>
<td>NS NS</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>2</td>
<td>0</td>
<td>NS NS</td>
</tr>
<tr>
<td>Presence of at least one co-morbidity, except skin lesion*</td>
<td>33</td>
<td>19</td>
<td>≤0.03</td>
</tr>
<tr>
<td>Presence of skin lesion</td>
<td>46</td>
<td>18</td>
<td>NS NS</td>
</tr>
<tr>
<td>Molecular marker <em>emm</em>15</td>
<td>13</td>
<td>1</td>
<td>≤0.06</td>
</tr>
</tbody>
</table>

*Co-morbidities studied: obesity, ethanol abuse, recent delivery, immunosuppression, dialysis, usage of NSAIDs, cardio-pulmonary diseases, diabetes mellitus, recent surgical intervention < 7 days, intravenous drug abuse, corticotherapy >6month and malignancy treatment

**NS: not significant, significant p>0.05. Chi square or Student’s t-test was used depending on the number.
Table 2. Clinical characteristics of invasive *S. pyogenes* disease in New Caledonia, 2006.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No of isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=90 (%)</td>
<td></td>
</tr>
<tr>
<td><strong>Co-morbidities</strong></td>
<td></td>
</tr>
<tr>
<td>Skin lesion</td>
<td>64 (71)</td>
</tr>
<tr>
<td>Obesity</td>
<td>26 (29)</td>
</tr>
<tr>
<td>Cardio-pulmonary diseases</td>
<td>12 (13)</td>
</tr>
<tr>
<td>Ethanol abuse</td>
<td>10 (11)</td>
</tr>
<tr>
<td>Usage of NSAIDs(^a)</td>
<td>7 (8)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>6 (7)</td>
</tr>
<tr>
<td>Recent delivery</td>
<td>6 (7)</td>
</tr>
<tr>
<td>Dialysis</td>
<td>3 (3)</td>
</tr>
<tr>
<td>Malignancy</td>
<td>3 (3)</td>
</tr>
<tr>
<td>Corticotherapy &gt; 6 month</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Surgical intervention &lt; 7 days</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Others(^b)</td>
<td>4 (4)</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td></td>
</tr>
<tr>
<td>Mortality among cases</td>
<td>3 (3)</td>
</tr>
<tr>
<td>Surgery drain</td>
<td>57 (63)</td>
</tr>
<tr>
<td>Assisted ventilation</td>
<td>9 (10)</td>
</tr>
<tr>
<td>Passage in ICU(^c)</td>
<td>13 (14)</td>
</tr>
</tbody>
</table>


\(^b\) NSAID, non steroidal anti-inflammatory drugs;

\(^c\) Other co-morbidities studied: no intravenous drug abuse, 1 varicella infection, 1 immunosuppressive therapy, 2 malignancies, and no HIV infection;

\(^c\) ICU, intensive care unit.
Table 3. Correlation between predominant clinical manifestations and *emm*-type of *Streptococcus pyogenes* invasive strains

<table>
<thead>
<tr>
<th>Clinical manifestation</th>
<th>Total number</th>
<th><em>emm</em>-15</th>
<th><em>emm</em>-92</th>
<th><em>emm</em>-106</th>
<th><em>emm</em>-74</th>
<th><em>emm</em>-89</th>
<th><em>emm</em>-109</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necrotizing fasciitis</td>
<td>41</td>
<td>8</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Bacteremia without identified focus + STSS*</td>
<td>12</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Myositis</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Septic arthritis</td>
<td>9</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Erysipela</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Post-partum infection**</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Osteomyelitis</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pneumonia +STSS*</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Endocarditis</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Myelitis</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>90</strong></td>
<td><strong>14</strong></td>
<td><strong>11</strong></td>
<td><strong>8</strong></td>
<td><strong>6</strong></td>
<td><strong>5</strong></td>
<td><strong>5</strong></td>
<td><strong>41</strong></td>
</tr>
</tbody>
</table>

*STSS, streptococcal toxic shock syndrome associated with death
**Four cases including one mother and baby case due to a *st*6735 strain.
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Clinical and Microbial Characteristics of Invasive Streptococcus pyogenes Disease in New Caledonia, a Region in Oceania with a High Incidence of Acute Rheumatic Fever

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Volume 48, no. 2, p. 526–530, 2010. Page 527, Fig. 1 key, line 2: “Number of isolates emm-type concordant with the M-26 valent vaccine” should read “Number of indigenous cases (Melanesian).”