Invasive Group B Streptococcal Disease in Non-pregnant Adults, Réunion Island, 2011

Guillaume Camuset, Sandrine Picot, Julien Jaubert, Gianandrea Borgherini, Cyril Ferdynus, Aurélie Foucher, Jean-Christophe Maïza, Olivier Fels, Claire Poyart, Patrice Poubeau, et al.

▶ **To cite this version:**

Guillaume Camuset, Sandrine Picot, Julien Jaubert, Gianandrea Borgherini, Cyril Ferdynus, et al.. Invasive Group B Streptococcal Disease in Non-pregnant Adults, Réunion Island, 2011. International Journal of Infectious Diseases, 2015, 35, pp.46–50. 10.1016/j.ijid.2015.04.006 . hal-01274547

HAL Id: hal-01274547
https://hal.univ-reunion.fr/hal-01274547v1

Submitted on 5 Nov 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

International Journal of Infectious Diseases 35 (2015) 46–50

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Original article

Invasive Group B Streptococcal Disease in Non-pregnant Adults, Réunion Island, 2011

Guillaume Camuset [a,1,*], Sandrine Picot [a], Julien Jaubert [a], Gianandrea Borgherini [a], Cyril Ferdynus [a], Aurélie Foucher [a], Jean-Christophe Maïza [a], Olivier Fels [a], Claire Poyart [b,c,d], Patrice Poubeau [a], Patrick Gérardin [a,e,f,1]

[a] Centre Hospitalier Universitaire (CHU), F-97400, SaintPierre/Saint-Denis, La Réunion, France
[b] Centre National de Référence des Streptocoques, Groupe Hospitalier Cochin-Saint Vincent de Paul, Assistance Publique-Hôpitaux de Paris, F- 75679 Paris, France
[c] Institut Cochin-Inserm; U567-UMR CNRS 10, Université Paris Descartes, F-75014 Paris, France
[d] Unité Biologie des Bactéries Pathogènes à Gram-Positif-URA CNRS 2172, Institut Pasteur, F-75724 Paris, France
[e] Centre d'Investigation Clinique 1410 (Inserm/CHU/Université de La Réunion/Union Régionale des Médecins Libéraux de l'Océan Indien), F-97410, Saint Pierre, La Réunion
[f] UMR PIMIT "Processus Infectieux en Milieu Insulaire Tropical" (Inserm 1187, CNRS 9192, IRD 249, Université de La Réunion), plateforme technologique CYROI, F-97490, Sainte Clotilde, La Réunion

ARTICLE INFO

Article history:
Received 24 February 2015
Received in revised form 9 April 2015
Accepted 10 April 2015

Keywords:
Group B streptococcus
Invasive disease
Incidence
Diabetes mellitus
Tropical area

SUMMARY

Objectives: While the prevalence of Group B streptococcus (GBS) colonization is important, little is known about invasive GBS (iGBS) disease in tropical areas. Our objective was to assess the burden of iGBS disease among non-pregnant adults.
Methods: A prospective hospital-based study of all non-pregnant adult patients with iGBS disease was conducted between January and December 2011 in Saint Pierre, Réunion Island, to assess its cumulative incidence rate (CIR). Capsular serotyping and multilocus sequence typing were performed to characterize GBS isolates. Case-control study was done to identify risk factors.
Results: The overall CIR of iGBS disease was 10.1 per 100,000. The CIR in elderly patients (≥ 65 yrs) was estimated at 40.6 per 100.000, and that of adults (15-64 years) at 6.7 per 100.000. Aboriginal origin in the Indian Ocean and overweight were both associated with iGBS disease. The most prominent clinical forms were osteo-articular and skin/soft tissue infections, as a consequence of diabetic foot. The serotypes were classic, type-Ia being the most prevalent. The hyper virulent ST-17 (CC17) was associated with type-III.
Conclusions: The incidence of iGBS disease found in Réunion island is twofold that usually reported. This burden is linked to overweight in aboriginal people from the Indian Ocean.
© 2015 The Authors. Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

Streptococcus agalactiae (Group B streptococcus [GBS]), a pathogen well known to cause significant morbidity and mortality in the neonate and in pregnant women, has become a global concern worldwide among non-pregnant adults, especially in the elderly with underlying conditions.[1] Populations usually considered "at-risk" encompass patients with type-2 diabetes mellitus (T2D), neurologic disease, renal failure, malignancies, cirrhosis, HIV infection or those undergoing intravenous catheterization. In these populations, GBS causes a broad-spectrum disease characterized by various invasive infections including bacteraemia without focus, skin/soft-tissue and osteo-articular infections, pneumonia, urosepsis, endocarditis, peritonitis, meningitis and empyema, streptococcal toxic shock syndrome (STSS).[1]

In the literature, the cumulative incidence rates (CIR) of invasive GBS (iGBS) disease usually range between 2.4 and 9.2 cases per 100,000 non-pregnant adults,[2,3] and most publications come from

* Corresponding author. Department of Infectious disease, CHU La Réunion, Saint-Pierre, BP 350, 97448 Saint-Pierre Cedex, Réunion Island, France.
Tel.: +00 (33) 262 35 91 65
E-mail address: guillaume.camuset@chu-reunion.fr (G. Camuset).
[1] Contributed equally

http://dx.doi.org/10.1016/j.ijid.2015.04.006
1201-9712/© 2015 The Authors. Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

non-tropical areas.[1] In Réunion island, a French overseas department located in the Indian Ocean, severely affected by the pandemic of obesity and T2D,[4] we had previously shown higher incidence rates of early-onset GBS neonatal infections than in metropolitan France.[5] We also documented the prevalence of GBS colonization in pregnant woman and confirmed the role of obesity previously found in the United States, and of ethnicity, evidenced in the USA and the Netherlands, as predictors for GBS carriage during childbearing age.[6–8] In this context, we wished to know whether the high incidence rates found in younger age categories could also encompass non-pregnant adults, and to what extent the host or pathogen factors contribute to the disease burden.

The objectives of this prospective hospital-based cohort study were to characterize the clinical and microbiological features associated with iGBS disease among non-pregnant adults and to assess its disease burden and risk factors in a tropical setting.

2. Methods

After oral consent, in accordance with the recommendations of the local Committee for Clinical Research, we collected data for all consecutive patients over age 18 years admitted consecutively to the Department of Infectious Diseases of the teaching hospital of Saint Pierre, Réunion Island, between 1 January and 31 December, 2011. The subjects with an invasive GBS infection and for whom GBS was isolated from a sterile specimen (blood or urine culture, synovial or peritoneal fluid culture and bone biopsy) were enrolled as invasive GBS disease cases. Clinical data were extracted from chart reviews, and specimens underwent serotyping and genotyping, the latter based on a two-multiplex RT-PCR assay.[9]

Age-appropriate incidence rates were compared to US standards.[1] Case-control study was performed to assess the role of age, gender, place of birth, obesity and T2D in iGBS disease, taking uninfected non-pregnant adults (GBS carriers or not), or uninfected GBS-carrier pregnant women as controls using our Medical Statistics Database. We used Poisson regression models for binary data with a robust variance option[10] to provide incidence rate ratio estimates. Stata (version 13.0®, StataCorp. 2013, Texas, USA) was used for fitting the models. Statistical significance was set at $P = 0.05$.

3. Results

Over the one-year study period, 22 non-pregnant adult cases were diagnosed with an invasive GBS infection out of an adult non-pregnant population of roughly 217,000 persons, which led to an overall CIR of iGBS disease of 10.1 per 100.000 (95% confidence interval: 6.3-13.9 per 100.000). The median age of the patients was 59 years (range: 25-93 years). The CIR in elderly patients (≥ 65 yrs) was thus estimated to be 40.6 per 100.000 (Figure 1). The clinical features at presentation to hospital, the antibiotic treatment and its duration, and the outcomes of the 22 patients are depicted in Table 1.

Osteo-articular infections (12/22) topped the list, as the outcome of primary diabetic foot (9/12), orthopedic prosthesis (2/12) or chronic prostatitis (1/12: for this patient (n°5), urine culture and vertebral biopsy was positive for *Streptococcus agalactiae*). Skin/soft tissue infections were observed in three patients (3/22: cellulitis, 2/3; necrotizing fasciitis, 1/3), two of them being diabetic. Three patients exhibited urosepsis (3/22), these consisting of one acute pyelonephritis (1/3), one acute orchitis (1/3), or the outcome of pelviureteric junction syndrome (1/3). Patient n°3 suffered from peritonitis (1/22) following an episode of acute renal failure, as the result of infection of his peritoneal dialysis catheter. In three patients (3/22), a bacteriemia without focus was diagnosed.

Amoxicillin alone (8/22) or in combination with clavulanate (3/22) was used in half of the patients. It was defeated in a diabetic foot followed by amputation. Other treatments were probabilistic and guided by the clinical presentation and underlying conditions.

The outcome was favourable for 72.7% of iGBS disease (16/22), after removal of the orthopedic implant in one case. In seven patients, the issue was pejorative marked by a relapse in two cases,

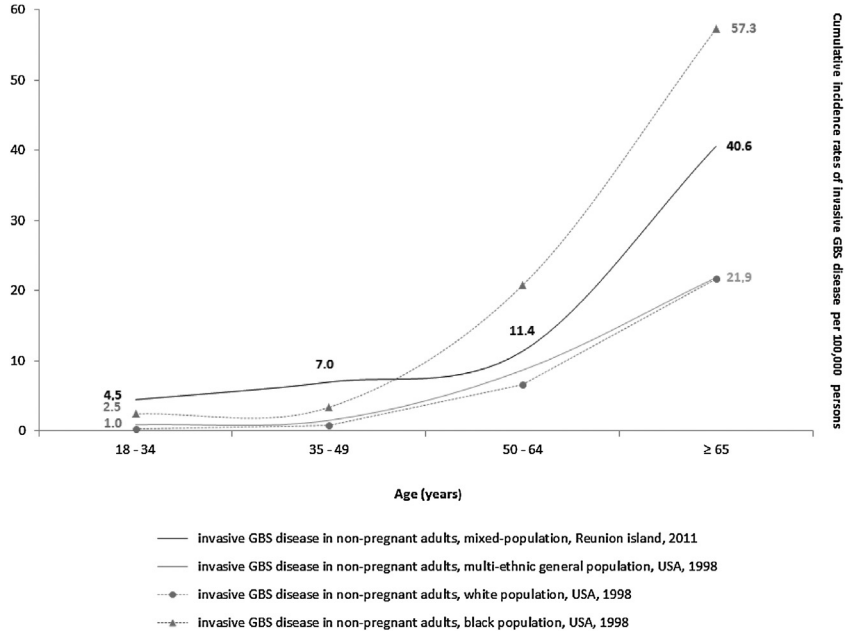

Figure 1. Age-specific incidence rates of invasive GBS diseases among non-pregnant adults in Reunion island and the USA.
Note. US data for non-pregnant adults are extrapolated from pregnant and non-pregnant adults enrolled in the ABCs Active Bacterial Core Surveillance of Emerging Infections program network of the Centers for Disease Control and Prevention.[1] In the USA, the pregnant to non-pregnant ratio in the adult population with GBS invasive is approximately 1:2.[3].

Table 1
Clinical features, treatment and outcome of the 22 patients.

Patient	Age	Clinical presentation	Treatment	Outcome
1	53	Diabetic foot infection with cellulitis*	Clindamycin (4 weeks)	Favourable
2	47	Diabetic foot infection with osteomyelitis*	Piperacillin/tazobactam (6 weeks)	Amputation
3	38	Peritonitis (peritoneal dialysis)	Amoxicillin (4 weeks)	Favourable
4	58	Acute epididymo-orchitis	Amoxicillin (4 weeks)	Favourable
5	27	Vertebral osteomyelitis with chronic prostatitis	Amoxicillin (6 weeks)	Favourable
6	60	Diabetic foot infection with osteomyelitis*	Amoxicillin/clavulanate (6 weeks)	Favourable
7	72	Diabetic foot infection with osteomyelitis*	Amoxicillin (6 weeks)	Favourable
8	70	Diabetic foot infection with osteomyelitis*	Amoxicillin (6 weeks)	Amputation
9	91	Acute pyelonephritis	Cefixime (10 days)	Relapse
10	33	Bacteriemia without focus	Amoxicillin (2 weeks)	Favourable
11	91	Bacteriemia without focus	Amoxicillin/clavulanate (10 days)	Favourable
12	46	Obstructive pyelonephritis	Ceftriaxone (3 weeks)	Favourable
13	65	Diabetic foot infection with osteomyelitis*	Amoxicillin/clavulanate (4 weeks)	Favourable
14	60	Diabetic foot infection with osteomyelitis*	Clindamycin (5 weeks)	Favourable
15	49	Necrotizing fasciitis	Piperacillin/tazobactam (4 weeks)	Amputation
16	25	Orthopedic prosthesis infection	Oxacillin	Favourable after removal of implant
17	67	Diabetic foot infection with osteomyelitis*	Amoxicillin (6 weeks)	Favourable
18	84	Diabetic foot infection with cellulitis*	Ceftriaxone (1 week)	Death
19	93	Diabetic foot infection with osteomyelitis*	Ciprofloxacin + Rifampicin (6 weeks)	Favourable
20	62	Diabetic foot infection with osteomyelitis*	Amoxicillin (6 weeks)	Favourable
21	53	Bacteriemia without focus	Oxacillin (10 days)	Favourable
22	71	Orthopedic prosthesis infection	Oxacillin + Rifampicin (6 weeks)	Relapse

* Diagnosis was made using hemoculture and/or bone biopsy.

amputation in three cases (two diabetic feet), and death in one case.

Underlying conditions were found in 63.6% (14/22), of which T2D ranked first, observed in half of the cases (11/22), ahead of cancer (2/22) and neurogenic bladder (1/22).

Serotyping was performed for 17 of 22 specimens. The most frequent capsular serotypes identified were, in decreasing order: Ia (41.2%), II (29.4%), III (17.6%), V (11.8%). Two strains of the 17 studied were resistant to erythromycin due to the presence of the *ermB* gene (type-V strain), or due to the *mef* gene (type-Ia strain). The hypervirulent ST17 (CC17) factor was found in two type-III isolates. All isolates were sensitive to G penicillin.

The relationships between age, gender, place of birth, obesity or T2D and three different contexts of GBS infections are displayed in Table 2.

4. Discussion

Our study reveals one of the highest incidence rates of iGBS disease ever reported in non-pregnant adults (10.1 per 100,000), for which it almost reaches levels usually observed in "high-risk" populations such as black adults (Figure 1).[1–3,6–8] This high incidence can be explained by the combination of several risk factors highly prevalent on Réunion Island, such as obesity,[4] T2D,[4] black (African) descent[6] or hyper precocious sexuality.[12,13] In our study, T2D is thus associated with half the cases (11/22), which exceeds the range of 20% to 48% previously reported worlwide.[1–3,11,14,15] This finding was expected given the prevalence of T2D in our community (20% of the adults age 30 to 69 years), especially in the elderly (men: 34%, women: 40% of the 60-69 years category).[4] Importantly, invasive GBS disease in non-pregnant adults was associated with overweight and place of birth (Table 2), highlighting Indian Ocean indigenous populations as vulnerable to the most severe forms of GBS infection.

As a consequence, in Réunion Island, the clinical spectrum of iGBS disease is shifted toward the complications of the diabetic foot (*e.g.*, osteo-articular and skin/soft tissue infections, Table 1).[3] This distribution contrasts those observed in the USA or in France, where bacteraemia without focus and pneumonia predominate.[1–3,11,14,15] We explain it by both the high prevalence of T2D and the community origin of 100% of the infections observed in La Réunion, unlike the hospital-acquired origin found in most US or French patients. Indeed, even though living in long-term care facilities (LTCF) is a well-known risk factor for invasive GBS disease,[15] in La Réunion 92% of the elderly dependent persons are community residents, while overall, *a contrario* 80% of these usually live in LTCF in Europe. For these reasons, we believe that the iGBS disease spectrum in Réunion island is more representative of the clinical forms usually encountered in the Indian Ocean than those found in Europe or in the USA.[16]

The distributions of the serotypes and of the resistance genes were classic: type Ia ranked first, as observed for metropolitan France, Portugal, China, Australia, New Zealand and the USA.[11,14,17,18] Erythromycin resistance was linked to the *mef* gene in type-Ia and to *ermB* gene in type-V, the latter also conferring resistance to clindamycin.[17,19] ST17 (CC17) was found exclusively in type-III, as found in east African adults.[20]

Our study has some limitations. It was not population-based, so we may have underestimated the real burden of iGBS disease. Notwithstanding, our estimates were likely conservative and we think they may provide reliable figures for public health stakeholders in our insular population.

In conclusion, in Réunion Island, the burden of invasive GBS disease may be one of the highest ever reported. This burden is linked to the aboriginal origin in the Indian Ocean and to overweight, more than to black descent or type-2 diabetes mellitus *per se*. Further studies are needed to decipher whether these observations illustrate the social disadvantage of indigenous populations or pathogen specific mechanisms.

Authors' contributions: GC drafted the manuscript with the help of PG; SP, JJ and CP performed microbiological analyses; GC, GB, AF, JCM, PP conducted the case study; CF contributed to data analysis; OF provided the case list from our Medical Statistics Database. All authors reviewed and approved the final manuscript.

Table 2
Risk factors associated with invasive GBS disease in non-pregnant adults, La Reunion, 2011

Non-pregnant adult cases with invasive GBS disease (a)			Uninfected non-pregnant adult controls without GBS carriage (b)					Uninfected non-pregnant adult controls with GBS carriage (c)					Uninfected pregnant women controls with GBS carriage (d)				
	N=22		N =83					N = 28					N = 42				
Risk factors	n	(%)	n	(%)	IRR	95% CI	*P* value [a vs b]	n	(%)	IRR	95% CI	*P* value [a vs c]	n	(%)	IRR	95% CI	*P* value [a vs d]
Gender																	
Male	11	(50)	57	(68.7)	0.5	0.2 – 1.1	0.094	2	(7.1)	2.6	1.3 – 4.9	0.004	0	(0)		N.A	N.A
Female	11	(50)	26	(31.3)	1	reference	-	26	(92.9)	1	reference	-	42	(100)		reference	-
Age (years)																	
15 to 44	4	(18.2)	14	(16.9)	1	reference	-	14	(50.0)	1	reference	-	42	(100)		reference	-
45 to 64	9	(40.9)	30	(36.1)	0.9	0.3 – 2.6	0.907	6	(21.4)	2.4	0.7 – 7.0	0.122	0	(0)		N.A	N.A
$\geq$ 65	9	('40.9)	39	(47.0)	0.5	0.1 – 1.7	0.262	8	(28.6)	2.3	1.1 – 4.8	0.026	0	(0)		N.A	N.A
Place of Birth																	
Metropolitan France	0	(0)	7	(8.4)	1	reference	-	2	(7.1)	1	reference	-	4	(9.5)	1	reference	-
Reunion island	21	(95.4)	75	(90.4)	5380777	$1.7\times10e^6$ - $1.7\times10e^7$	$<$ 0.001	24	(85.7)	398400	$7.4\times10e^5$ - $7.4\times10e^7$	$<$ 0.001	34	(80.9)	1973177	$5.5\times10e^5$ - $7.0\times10e^6$	$<$ 0.001
Other Indian Ocean islands	1	(4.6)	1	(1.2)	$1.7\times10e^7$	$3.4\times10e^6$ - $8.1\times10e^7$	$<$ 0.001	2	(7.1)	259004	$3.7\times10e^5$ - $1.8\times10e^7$	$<$ 0.001	4	(9.5)	1301512	$2.2\times10e^5$ - $7.5\times10e^6$	$<$ 0.001
Body mass index (kg/m^2)																	
$<$ 18.5	2	(9.1)	24	(28.9)	0.9	0.1 – 5.3	0.904	4	(14.3)	1.7	0.5 – 5.9	0.370	10	(23.8)	0.8	0.1 – 3.5	0.727
18.5 to 24.9	3	(28.6)	29	(34.9)	1	reference	-	14	(50.0)	1	reference	-	12	(28.6)	1	Reference	-
25 to 29.9	12	(54.6)	15	(18.1)	4.5	1.4 – 14.7	0.012	5	(17.8)	3.5	1.4 – 8.6	0.005	11	(26.2)	1.4	0.4 – 4.2	0.507
$\geq$ 30	5	(22.7)	15	(18.1)	3.0	0.8 – 11.5	0.102	5	(17.8)	2.7	0.9 – 7.6	0.055	9	(21.4)	1.3	0.3 – 4.3	0.707
Comorbidity																	
None	8	(36.4)	35	(42.2)	1	reference	-	13	(46.4)	1	reference	-	34	(80.9)			-
Type-2 diabetes mellitus	11	(50.0)	33	(39.7)	0.8	0.3 – 2.0	0.657	12	(42.9)	0.6	0.2 – 1.4	0.284	8	(19.1)	2.5	1.1 – 5.6	0.019
Other	3	(13.6)	15	(18.1)	0.5	0.1 – 1.6	0.245	3	(10.7)	0.7	0.2 – 2.4	0.624	0	(0)	3.8	1.8 – 7.9	$<$ 0.001

NOTE. Data are numbers, percentages, adjusted incidence risk ratios and 95% confidence intervals estimated using three different Poisson regression models with robust variance option for [a vs b], [a vs c] and [a vs d] comparisons.

Acknowledgments

We thank the staffs of Microbiology laboratories at GHSR and at CNR, Institut Pasteur, for performing molecular diagnosis. We are grateful to Sylvaine Porcherat, from the CIC-EC of La Réunion, for conducting the case-control study.

Potential conflicts of interest: All authors: no conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest.

References

1. Fairley MM, Group B. streptococcal disease in nonpregnant adults. *Clin Infect Dis* 2001;**33**:556–61.
2. Schwartz B, Schuchat A, Oxtoby MJ, Cochi SL, Hightower A, Broome CV. Invasive group B streptococcal disease in adults: a population-based study in metropolitan Atlanta. *JAMA* 1991;**266**:1112–4.
3. Farley MM, Harvey C, Stull T, Smith JD, Schuchat A, Wenger JD, et al. A population-based assessment of invasive disease due to group B Streptococcus in nonpregnant adults. *N Engl J Med* 1993;**328**:1807–11.
4. Favier F, Jaussent I, Moullec NL, Debussche X, Boyer MC, Schwager JC, et al. Prevalence of Type 2 diabetes and central adiposity in La Reunion Island, the REDIA Study. *Diabetes Res Clin Pract* 2005;**67**:234–42.
5. Gérardin P, Fianu A, Choker G, Carbonnier M, Jamal-Bey K, Heisert M, et al. Infection bactérienne néonatale précoce dans le sud de la Réunion: incidence et application des critères de risque Anaes. *Med Mal Infect* 2008;**38**:192–9.
6. Dahan-Saal J, Gérardin P, Robillard PY, Bouveret A, Barau G, Picot S, et al. Déterminants de la colonisation maternelle à Streptocoque B et facteurs associés à sa transmission verticale périnatale: études cas – témoins. *Gynecol Obstet Fertil* 2011;**39**:281–8.
7. Stapelton RD, Kahn JM, Evans LE, Critchlow CW, Gardella CM. Risk factors for group B streptococcal genitourinary tract colonization in pregnant women. *Obstet Gynecol* 2005;**106**:1246–52.
8. Valkenburg-van den Berg AW, Spri AJ, Oostvogel PM, Mutsaers JA, Renes WB, Rosendaal FR, et al. Prevalence of colonisation with group B streptococcus in pregnant women of multi-ethnic population in the Netherlands. *Eur J Clin Microbiol Infect Dis* 2006;**124**:178–83.
9. Poyart C, Tazi A, Reglier-Poupet H, Billoet A, Tavares N, Raymond J, et al. Multiplex PCR assay for rapid and accurate capsular typing of group B streptococci. *J Clin Microbiol* 2007;**45**:1985–8.
10. Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004;**159**:702–6.
11. Skoff TH, Farley MM, Petit S, Craig AS, Schaffner W, Gershman K, et al. Increasing burden of invasive group B streptococcal disease in nonpregnant adults, 1990–2007. *Clin Infect Dis* 2009;**49**:85–92.
12. Manning SD, Tallman P, Baker CJ, Gillepsie B, Marrs CF, Foxman B. Determinants of co-colonization with group B streptococcus among heterosexual college couples. *Epidemiology* 2002;**13**:533–9.
13. Iacobelli S, Robillard PY, Gouyon JB, Nichols M, Boukerrou M, Barau G, et al. Longitudinal health outcome and well-being of mother-infant pairs after adolescent pregnancy in Reunion island, Indian Ocean. *Int J Gynecol Obstet* 2014;**125**:144–8.
14. Tazi A, Morand PC, Réglier-Poupet H, Dmytruk N, Billoet A, Antona D, et al. Invasive group B streptococcal infections in adults, France (2007–2010). *Clin Microbiol Infect* 2011;**17**:1587–92.
15. Kothari NJ, Morin CA, Glennen A, Jackson D, Harper J, Schrag SJ, et al. Invasive group B streptococcal disease in the elderly, Minnesota, USA, 2003–2007. *Emerg Infect Dis* 2009;**15**:1279–81.
16. Louthrenoo W, Kasitanon N, Wangkaew S, Hongsongkiat S, Sukitawut W, Wichainun R. Streptococcus agalactiae: an emerging cause of septic arthritis. *J Clin Rheumatol* 2014;**20**:74–8.
17. Zhao Z, Kong F, Zeng X, Gidding HF, Morgan J, Gilbert GL. Distribution of gentypes and antibiotic resistance genes among invasive Streptococcus agalactiae (group B streptococcus) isolates from Australasian patients belonging to different age groups. *Clin Microbiol Infect* 2008;**14**:260–7.
18. Martins ER, Melo-Cristino J, Ramirez M. Portuguese Group for the Study of Streptococcal Infections. *J Clin Microbiol* 2012;**50**:1219–27.
19. Domelier AS, van der Mee-Marquet N, Arnault L, Meregheti L, Lanotte P, Rosenau A, et al. Molecular characterization of erythromycin-resistant Streptococcus agalactiae strains. *J Antimicrob Chemother* 2008;**62**:1227–33.
20. Huber CA, Odimba F, Pflueger V, Dauenberger CA, Revathi G. Characterization of invasive and colonizing isolates of Streptococcus agalactiae in East African adults. *J Clin Microbiol* 2011;**49**:3652–5.