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MENINGOCOCCAL CARRIAGE AND CEREBROSPINAL MENINGITIS AFTER *MENAFRIVAC* MASS IMMUNIZATION IN BURKINA FASO

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ABSTRACT

The aims of this study were to evaluate the impact of conjugate vaccine A, MenAfriVac, on *Neisseria meningitidis* (Nm) asymptomatic carriage and cerebrospinal meningitis in three health districts (Bogodogo, Kaya, and Dandé) of Burkina Faso. Asymptomatic carriage of Nm was assessed by performing cross-sectional studyrepeated (rounds 1 to 10) before and after introduction of the conjugate vaccine against serogroup A of *N. meningitidis* (NmA), MenAfriVac. In each round at least 1,500 people were enrolled in each district for a month. Data oncases of meningococcal meningitis in the three studied health districts were collected through meningitides epidemiological surveillance of Burkina Faso.Nm was identified in680 of 23,885 throat swabs before vaccination (2. 84%)withNmYasthe dominant serogroup(1.87%). During the same period (2009 and 2010), 891 cases of suspected meningitis were reported in the three health districts among whom 42 were due toNm (4.71%) withNmX (3.70%) asthe most frequently identified serogroup. After vaccination, Nm was identified in 1117 of 27,245 pharyngeal samples (6.42%); NmX (4.42%) wasthe dominantserogroup. From 2011 to 2013, 965 cases of suspected meningitis were reported in all health facilities in the three studied health districts located in the geographical study area; 91 was due toNm (9.43%) andNmWasthe most commonserogroup(52 cases= 5.38%).After introduction of conjugate vaccine A (MenAfriVac), the NmAserogroup almost disappeared both in asymptomatic carriers and in patients with cerebrospinal meningitis. However the presence of the NmW and NmXserogroups, which appear to have replaced serogroup A, is very worrying with regard to meningitis prevention and control in Burkina Faso. It appears necessary to strengthen surveillance and laboratory diagnosis of the different meningococcal serogroups circulating in Africa.

Keywords: meningococcal meningitis, serogroups W and X, meningococcal carriage, MenAfriVac.

PORTAGE DU MENINGOCOQUE ET MENINGITES CEREBROSPINALES APRES IMMUNISATION DE MASSE PAR LE *MENAFRIVAC* AU BURKINA FASO

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RÉSUMÉ

Objectifs: Evaluer l'impact du vaccin conjugué A, MenAfriVac, sur le portage asymptomatique du *Neisseriameningitidis* (Nm) et sur la méningite cérébrospinale dans trois districts sanitaires (Bogodogo, Kaya, et Dandé) du Burkina Faso.

Matériel et Méthodes: Le portage asymptomatique de Nm a été évalué à travers une étude transversale avec plusieurs passages (round 1 à 10) avant et après l'introduction du vaccin conjugué contre le *N. meningitidis*sérogroupe A (NmA), MenAfriVac. À chaque round, au moins 1.500 personnes ont été enrôlées dans chaque district pendant un mois. Les données sur les cas de méningites à méningocoque dans les trois districts sanitaires ont été recueillies à travers la surveillance épidémiologique des méningites du Burkina Faso.

Résultats: Le Nm a été identifié dans 680 des 23 885 prélèvements de gorge avant la vaccination (2. 84%) et le NmY était le sérogroupe dominant (1,87%). Au cours de la même période (2009 et 2010), 891 cas suspects de méningites ont été notifiés dans les trois districts sanitaires, 42 cas étaient dus au Nm (4,71%) et NmX (3,70%) était le sérogroupe le plus fréquemment identifié. Après la vaccination, 1117 Nm (6,42%) ont été identifiés des 27 245 prélèvements pharyngés, le NmX (4,42%) était le sérogroupe dominant. De 2011 à 2013, 965 cas suspects de méningites ont été enregistrés dans toutes les formations sanitaires des trois districts sanitaires étudiés; 91 étaient liés au Nm (9,43%), le sérogroupeNmW était le plus fréquent (52 cas, 5,38%).

Conclusion: Après l'introduction du vaccin conjugué A (MenAfriVac), le sérogroupe A (NmA) a presque disparu à la fois chez les porteurs asymptomatiques et chez les malades atteints de méningites cérébro-spinale. Toutefois, la présence des sérogroupesNmW et NmX, qui semblent avoir remplacé le sérogroupe A, est un très inquiétante en ce qui concerne la

prévention et le contrôle de la méningite au Burkina Faso. Il apparaît nécessaire de renforcer la surveillance et le diagnostic en laboratoire des différents sérogroupes de méningocoques qui circulent
Mots clé: méningite cérébrospinale; serogroupes W et X, portage du méningocoque, MenAfriVac.

INTRODUCTION

Meningococcal meningitis is a serious public health problem, especially in the part of sub-Saharan Africa called the meningitis belt of Lapeyssonnie. This area stretches from Senegal to Ethiopia and has an estimated population about 500 million people. This belt has become a ramp that includes other African countries (1). Every year, an upsurge in cases of meningitis occurs during the dry season in countries located in this area, which thus have a high endemic background (1, 2, 3).

According to the World Health Organization (WHO), there have been 700,000 cases of meningococcal meningitis globally over the last 15 years,with an estimated lethality rate of more than 10% and a considerable proportion of sequelae, sometimes reaching 20%(4).

During epidemics, about 90% of cases are attributable to *Neisseria meningitides* serogroup A, W, X (3). Since records began, meningococcal serogroup A has been the dominant cause of epidemics of meningococcal meningitis in this region; however, NmW and NmX have also been responsible for epidemics (5, 6, 7, 8).

Burkina Faso, a landlocked West African country with a population of roughly 18 million, is one of the few countries entirely located within the meningitis belt and has hyperendemic rates of meningitis (3, 9, 10). From 2003 to 2009, there were 78,518 reported cases of meningococcal meningitis with 8,568 deaths (11%) in Burkina Faso. Among the fatal cases, 5.569 (65%) were caused by group A *N. meningitides* (11).

From 2010 to 2012, NmX has been responsible for meningitis epidemics in Burkina Faso, causing 59% of the confirmed cases of meningococcal meningitis in this country in 2011(12).The lethality rates of meningitis caused by this serogroup were as high as those reported for NmA(12); children aged 1–9 years being the most frequently affected age group (12).

The mechanisms leading to the spread of infections linked to meningococcal infections and to epidemics of meningococcal meningitis remain unknown. The rate of asymptomatic carriage may reach 15% in Africa during epidemics (13, 14, 15). The environmental conditions present in the meningitis belt of sub-Saharan Africa during the dry season, particularly the high temperatures, very low humidity, and the Harmattan (dusty wind that blows from the Sahara), and respiratory co-infections related to degradation of mucosal barriers defenses are considered to contribute to the increase in sensitivity to meningococcal disease (16,17,18, 19). Several studies have shown the importance of the dynamics of asymptomatic carriage in individuals and communities and the effect of the season on colonization by meningococci (20, 21, 22, 23).

Over the past three decades, control of meningitis epidemics in the African meningitis belt has been confined to reactive vaccination with polysaccharide vaccine when the incidence in a given administrative area has reached a critical incidence (4). Implementing reactive vaccination with polysaccharide vaccine at the beginning of an epidemic has saved many lives; however, it does not decrease the frequency of outbreaks because polysaccharide vaccines confer protection for a limited time, especially in children, and have little or no impact on asymptomatic carriage (20). Conjugate vaccines, in which polysaccharidesare linked to a supportprotein, are likely to be more effective in preventing epidemics because they induce immunological memory and decrease pharyngeal carriage (21).

As a prelude to the introduction of the conjugate vaccine A, Burkina Faso initiated a study of nasopharyngeal carriage of meningococcus in three health districts (Bogodogo, Dandé, and Kaya). After the introduction of immunization, other carriage studies have been conducted, mainly to evaluatethe impact of the vaccine on serogroup A and on the carriage of the other two main *N. meningitides* serogroups: X and W.

In December 2010, the meningococcal A vaccine, MenAfriVac, was introduced in Burkina Faso through a mass vaccination program aimed at reducing the frequency of occurrence of cases and outbreaks related to serogroup A, which is the usual causative agent in the African cerebrospinal meningitis belt. Considering the results obtained elsewhere byadministering anti-meningococcal conjugate vaccines (24,25, 26), MenAfriVacwas expected to impact the rate of both carriage and the occurrence of meningitis due to NmA in Burkina.

The aim of this study was to evaluate the impact of conjugate vaccine A, MenAfriVac, on the frequency of occurrence of clinical cases of cerebrospinal meningitides and NmA carriage, and possibly cases associated with other common serogroups in Burkina Faso.

MATERIALS AND METHODS

Ethical Considerations

This study was approved by the Ethics Committees of Health Research in Burkina Faso, the Regional Committee for Research insouthern Norway, and the Commission of Internal Revision of the Centers for Disease Control in Atlanta, GA, USA.Written informed consent was obtained from all study participants or their parents or guardians.

Study Sites

The study was conducted in three health districts of Burkina Faso (Bogodogo, Kaya, and Dandé). Villages or sectors in each district were chosen randomly. In BogodogoDistrict, an urban district located in the capital of Burkina Faso, oropharyngeal samples and cerebrospinal fluid wereprocessed by the laboratory of Charles De Gaulle pediatric hospital. In Kaya District, which is a rural district located in north-eastern Burkina Faso, samples were sent to and processed by the laboratory of the Regional Hospital of Kaya (CHR) and the bacteriology laboratory of the university teaching hospital of Yalgado Ouedraogo. Finally, in the rural district of Dandé, which is located in the western part of the country, the Bacteriology Laboratory of the university teaching Hospital of Bobo Dioulasso, Souro Sanou Hospital, was in charge of bacteriological analysis of samples.

Type and period of the study

This descriptive cross-sectionalstudy was performed foranalytical purposes and comprisedfive separate rounds 3 monthsbefore and after vaccination. The study was conducted from January 2009 to November 2011.During this period, specimens were collected to obtain data on asymptomatic carriage of *N. meningitidis*. However, data related to cerebrospinal meningitis cases was collected continuously between 2009 and2013 in the three health districts studied.

Sampling for meningococcal carriage

A sample representing persons aged 1 to 29 years was obtained by cluster sampling at several levels as follows:

Eight villages were selected randomly in each of the two rural districts studied (Dandé and Kaya). For each campaign, 42 concessions per village were selected by simple random sampling from maps showing the Global Positioning System (GPS) coordinates of all concessions in the selected villages, these maps having been prepared before the start of the study. All persons in the target group who lived in one of the randomly selected concessionswere invited to participate in the study.

In the urban district studied (Bogodogo), all residential blocks were identified on a geographical map of the district. Sixteen blocks per campaign were selected by simple random sampling and mapped with GPS coordinates. During each campaign, all households in the selected blocks were visited and eligible subjects invited to participate in the study.

Sampling for cases of cerebrospinal meningitis

The sample of cases of cerebrospinal meningitis comprised all cases registered in the Ministry of Health database (National Epidemiological Surveillance System) during the period of the study.The cases of cerebrospinal meningitisin the three health districts studied (Bogodogo, Dandé, and Kaya) were selected according to the WHO definition of acute bacterial meningitis, which classifies cases as 'suspected'or'laboratoryconfirmed'.

Data collection for meningococcal carriage

The residents of the study sites were first informed of the project by local health workers and community leaders. Each randomly selected household was visited by the study staff and questionnaires administered to all target family members after they had signed individual writteninformed consent forms. The consent of a parent or guardian was obtained for children aged less than 18 years. Oropharyngeal specimens were obtained by swabbing the posterior wall of the pharynx with a sterile cotton swab, these samples being collected by technicians who had previously been trained to take such swabs.Each participant received a paper bracelet with a bar code corresponding to a unique identification number linked to the questionnaire.

Data collectionfor cases of meningococcal meningitis

Data was collected on an especially designed form for each case. The primary tools for collecting these data were clinical records, recordsofnotification of cases, the documents that accompanied the samples, and results of laboratory analysis of cerebrospinal fluid (CSF).

RESULTS

Rate of carriage of meningococcus in the selected three health districts of Burkina Faso before the introduction of meningococcal A conjugate vaccine MenAfriVac

The overall carrier rate of serogroup Nm before vaccination was 2.84% (680/23885) (Table I). In the Bogodogo health district, the overall carriage rate was 1.08% (93/8596) and the carriage rates of NmA0.11%, of NmX0.32%, of NmY0.51%, and of NmW0.12%. In the Dandé health district, the overall carriage rate was 3.14% (270/8582) and the carriage rates of NmA0.18%, ofNmX0.27%, of NmY2.49%, and of NmW 0.20%. Finally, in the Kaya health

district, the overall carriage rate was 4.72% (317/6707) and the carriage rates of NmA 0.83%, of NmX 0.79%, of NmY 2.81%, and of NmW 0.28%.

Notably, the prevalence of NmY (65.7%) prior to vaccination was 4-fold that ofNmX (15.3%), 5-fold that ofNmA (12.1%) and more than 9-fold greater than that ofNmW (6.9%)(Table II).

Types of meningococcus responsible for cerebrospinal meningitis in the three studied health districts before introduction of the anti-meningococcal A conjugate vaccine

From 2009 to 2010 (before the vaccination campaign), 891 cases of suspected bacterial meningitis were reported in the three studied health districts; 97 of these cases (10.88%) having been confirmed by laboratory analysis. Among the 92 confirmed cases, 42 (43.2%) were caused by*N. meningitidis*, 51 (52.57%) by *Streptococcus pneumonia* and four (4.12%) by *Haemophilus influenzae*. The distribution of serogroups of *N. meningitidis* was as follows: five cases (5.15%) of NmA, 33 (34.02%) of NmX, and four (4.12%) of NmW. All the NmA strains isolated were from theDandé district, whereas NmX was isolated in 16 cases (16.49%) in Kaya, nine (9.27%) in Bogodogo, and eight (8.24%) in Dandé health districts. Finally, NmW was isolated in two cases in Kaya (2.06%) and two in Dandé (2.06%).

TABLE I: CARRIAGE RATE OF MENINGOCOCCAL IN THE THREE HEALTH DISTRICTS BEFORE VACCINATION

Sites	Rounds	Number of participants	Sérogroup A	Sérogroup X	Sérogroup Y	Sérogroup W
Bogodogo district	R1	1710	2	0	4	0
	R2	1716	4	1	15	1
	R3	1717	3	0	6	3
	R4	1720	1	4	12	4
	R5	1733	0	23	7	3
	Total 1	8596	10	28	44	11
Dandé district	R1	1663	4	0	47	6
	R2	1709	5	2	55	3
	R3	1763	2	0	37	1
	R4	1742	2	0	42	2
	R5	1705	3	21	33	5
	Total 2	8582	16	23	214	17
Kaya district	R1	1663	19	1	40	8
	R2	1714	18	29	70	7
	R3	1643	7	18	38	1
	R4	1687	12	5	41	3
	Total 3	6707	56	53	189	19

TABLE II: MENINGOCOCCAL CARRIAGE RATE IN THE THREE HEALTH DISTRICTS AFTER VACCINATION

Sites	Rounds	Number of participants	Sérogroup A	Sérogroup X	Sérogroup Y	Sérogroup W
Bogodogo	R6	1750	0	11	1	1
District	R7	1713	0	9	0	14
	R8	1736	0	9	5	7
	R19	1724	0	4	2	3
	R10	1645	1	3	0	25
	Total1	8568	1	36	8	50
Dandé	R6	1748	0	20	50	6
District	R7	1728	0	12	30	11
	R8	1725	0	10	31	31
	R19	1704	0	4	24	14
	R10	1656	0	6	2	282
	Total2	8561	0	52	137	344
Kaya	R5	1706	0	365	12	2
District	R6	1697	0	244	17	0
	R7	1678	0	214	8	0
	R8	1668	0	106	5	7
	R9	1683	0	86	6	2
	R10	1684	0	14	5	28
	Total3	10116	0	1029	53	39

Meningococcal carriage rate in the three studied health districts of Burkina Faso after vaccination with MenAfriVac

The overall carriage rate Nm after vaccination was 6.42% (1749/27245)(Table II). In the health district of Bogodogo, the overall carriage rate was 1.10% (95/8568), comprising one case (0.01%) of NmA, 36 (0.42%) of NmX, eight (0.09%) of NmY, and 50 (0.58%) of NmW.In the health district of Dandé, the global carriage rate was 533/8561 (6.2%), comprising52 (0.60%) of NmX, 137 (1.60%) of NmY, and 344 (4.01%) of NmW. No NmA serogroup was isolated in this district. In the health district of Kaya, the carriage rate was 11.08% (1121/10 116), comprising1029 (10.17%) of NmX, 53 (0.52%) of NmY, and 39 (0.38%) NmW. No NmAserogroup was isolated in this district.

After immunization, the prevalence of NmX was almost three-fold (63.9%) that of NmW (24.8%) and five-fold that ofNmY (11.3%). However, NmA was isolated in only 0.1% of participants.

Meningococcus responsible for cerebrospinal meningitidis in the three studied health districts after vaccination with MenAfriVac

The MenAfriVac vaccine was introduced in Burkina Faso December 2010; thus, the period from 2011 to 2013 was considered the post-vaccination period. During this period, 965 suspected cases of meningitis were reported in the three studied health districts, 179 (18.54%) of these cases being laboratory-confirmed. Among the confirmed cases, 91 (50.83%) were caused by*N. meningitidis*, 83 (46.36%) by *S. pneumoniae*, and five (2.79%) by *H. influenzae*. The distribution of *N. meningitides* serogroups was as follows: 58 cases (32.40%) of NmX, 52 (29.05%) of NmW, one (0.55%) of NmY, and none of NmA (Table III).

TABLE III: SUMMARY TABLE OF THE MENINGITIS DATA OF 2009, 2010, 2011, 2012 AND 2013 IN THE HEALTH DISTRICTS OF BOGODOGO, DANDÉ AND KAYA

Districts		Year				
		2009	2010	2011	2012	2013
Bogodogo	Hib	2	1	1	0	0
	Negative	99	120	105	55	39
	NmA	0	0	0	0	0
	NmW	0	0	4	7	5
	NmX	0	9	1	2	0
	NmY	0	0	1	0	0
	Sp	10	17	16	1	4
	Total	111	147	128	65	39
Dandé	Hib	0	0	1	0	0
	Negative	15	140	121	163	29
	NmA	0	5	0	0	0
	NmW	0	2	2	15	10
	NmX	0	8	0	3	0
	NmY	0	0	0	0	0
	Sp	3	5	9	1	12
	Total	18	160	133	182	41
Kaya	Hib	1	0	1	1	1
	Negative	137	289	44	102	165
	NmA	0	0	0	0	0
	NmW	0	2	3	5	1
	NmX	6	10	15	12	5
	NmY	0	0	0	0	0
	Sp	7	9	16	11	13
	Total	145	310	61	131	185

As to sites, the single NmY strain was from Bogodogo health district. NmX and NmY strains were identified in all three study sites.In Kaya, 32 cases (17.87%) of NmX and nine (5.02%) of NmW were identified; in the Dandé district, 27 cases (29.67%) of NmWandthree (3.29%) of NmX, and in the Bogodogo district, 16 cases (17.58%) of NmW and three (3.29%) of NmX.

DISCUSSION

Cerebrospinal meningitis is a major public health problem in countries of the meningitidis belt such as Burkina Faso. With the aim of reducing the negative impact of this disease, there havebeen vaccination campaigns in Burkina Faso and many other African countries that are subject to outbreaks of this disease.

TheMenAfriVac vaccine wasspecifically developed to targettheNmAserogroup. Prior to the vaccination campaign, the prevalence of asymptomatic carriage of this serogroup was 0.11% in the Bogodogo district, 0.18% in the Dandé district, and 0.83% in the Kaya district. Post-vaccination, a single NmA carrier was identified intheBogodogo district; this carrier had not received the MenAfriVac vaccine. Thus, this study showed that NmA carriage had almost total disappeared from the three study sites, confirming that the conjugate vaccine MenAfriVac greatly reduces the prevalence of NmA carriage (23, 27, 28, 29, 30). A study conducted in Brazil in 2010 also showed that the conjugate vaccine reduces the prevalence of rhinopharyngeal colonization by Nm (31). Our findings are similar to those of a study conducted in Chad from 2009 to 2012, which also showed that the MenAfriVac vaccine led to a

reduction in the prevalence of rhinopharyngeal colonization byNmA (30).

Before the 2009–2010 MenAfriVacvaccination campaign, the NmAserogroup was only isolated from CSF of patients with cerebrospinal meningitis in the Dandé district (5.15% of laboratory-confirmed cases). Despite the presence of asymptomatic carriage of NmA in the Bogodogo (0.11%) and Kaya districts (0.83%), NmAwas not isolated from the CSF of any patients from these two health districts before the vaccination campaign. This may be attributable to the effect of the reactive mass vaccination (polysaccharide vaccine A/C and A/W/Y/C) performed in Kaya in 2007 and 2008 and in Bogodogo in 2008 (9). Of note, people in the Dandédistrict had not received vaccination in 2009 with the polysaccharide vaccine, which provides short-lived immunity (2–3 years) against the serogroups that it contains and is less active in children aged less than 2 years (32).

However, post-vaccination, NmA was not isolated from the CSF of any patients with cerebrospinal meningitis in any if the studydistricts. This disappearance of NmA may be associated with the effect of the MenAfriVac conjugate vaccine on this serogroup. This finding is similar to those of several other studies (33, 34).

Of note, we found an increase in prevalence of NmX carriage post-vaccination in the Bogodogo and Kaya districts, from 0.32% to 0.42% and from 0.79% to 10.17%, respectively. In contrast with patients with meningitis in Bogodogo, the prevalence of NmXwas higher in the CSF of patients with meningitis in the Kaya district post-vaccination, doubling from 16 to 32 cases compared with the pre-vaccination era. The particularly high prevalence of asymptomatic carriers of NmX in theBogodogo and Kaya districts and of laboratory-proven NmX cerebrospinal meningitis in theKaya health district could be related to the close proximity of these districts to Niger, where outbreaks caused by this serogrouphaveoccurred since 2006 (7, 35, 36).

Also of note, the post-vaccination NmW carriage rate in the Dandé health district was 20-fold that before introduction of the vaccine (0.20% vs. 4.01%). Similarly, the post-vaccination prevalence of laboratory-confirmed NmW meningitis in this district was 9-foldthat found in the pre-vaccination era.This very significant presence of the NmW serogroup in the Dandé district post-vaccination is likely related to the proximity of this city to Mali,in which cases of laboratory-confirmed NmW meningitis were reported in 2007 and 2009 (34, 37).
A post-vaccination increase in the prevalence of asymptomatic carriers of NmWwas also seen in the health district of Bogodogo, the rate there increased from 0.12% to 0.58%. Also, whereas this serogroup had not been isolated from patients with meningitis in this district pre-vaccination, post-vaccination there were 16 such cases (17.58%). Of note, the capital of Burkina Faso (Ouagadougou), in which theBogodogo district is located, is a crossroads through which many people continuously move into the country for diverse reasons. The significant presence of the NmW serogroup in this town could be attributable to thisinflux of people, including some from areas to the west thathave borders withMali.

Studies by Paul and colleagues have shown that the NmW observed in Burkina Faso post-vaccination belong to the NmW clone ST-11, which hadlast been seen in the country in 2006 but reappeared after the MenAfriVac nationwide mass vaccination campaign (38). This clone has been identified both in carriers of NmW non-invasive strains and in patients with meningitis (23, 34,39). Thus far, the ability of NmW to cause large epidemics has been associated with the hyper-virulent ST-11 clone (34, 40,41, 42). In our study, we identified persistence of the NmW serogroup in 2013 in patients in the Bogodogo and Dandé districts. This may imply that a new strain of hyper-virulent NmW emerged after the mass vaccination with MenAfriVac, which resulted in the disappearance of NmA carriers and patients with laboratory-confirmed NmA meningitis in the three studied health districts.

In general, we believe it is important to note that the unusual emergence of NmX and NmW serogroups post-vaccination was associated with the virtual absence of NmA. This finding is particularly relevant in light ofthe observed increase in overall prevalence of meningococcus after vaccination with MenAfriVac conjugate vaccine in the sites of our study among asymptomatic carriers (from 2.84% to 6.42%) and patients with meningitis (from 43.2% to 50.83%). Of note, there was also an increase in the global meningococcal carriage rate in the threestudied districts. Indeed, in the Bogodogo district it increased from 1.08% to 1.10%, in Dandéfrom 3.14% to 6.2%, and in Kaya from 4.72% to 11.08%. This increase in prevalence of asymptomatic carriers of meningococcuspost-vaccination was linked with a very low rate of carriage of NmA. Paul et al. reported similar findings (43).

In contrast with these two serogroups, we identified a significant decrease in the rate of carriage of NmY within the three studied districts post-vaccination. The prevalence of this serogroup dropped from 0.51 % to 0.09% in Bogodogo, from 2.49% to 1.60% in Dandé, and from 2.81% to 0.52% in Kaya. This reduction may reflect the effects of group immunity, including immunity against NmA. Despite the very high prevalence of carriage of this serogroup in all the health districts, analysis of CSF from patients

with meningitis in all three studied districts post-vaccination revealed a single patient from whom NmYwas isolated, this patient being in the Bogodogo health district. Serogroup Y meningococcal meningitis does not appear to be associated with outbreaks, but rather occurs sporadically (44).

CONCLUSION

In this study, we identified the disappearance of both NmA carriage andserogroup A meningococcal meningitis since the introduction in Burkina Faso of the MenAfriVac anti meningococcal A conjugate vaccine in December 2010. Despite the introduction of this vaccine, Burkina Faso remains vulnerable to outbreaks related to serogroup X, for which no vaccine is currently available, and to re-emergence of serogroup W, because the prevalence of these two serogroups both in asymptomatic carriers and in patients with meningitis has increased post-vaccination in the three studied health districts. It is therefore essential to review strategies against acute bacterial meningitis. Strengthening surveillance is essential to monitoring these changes, detectingepidemics in a timely manner and remaining reactive to those caused by any Nm serogroup.

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