

# Summary of Meningitis Outbreaks across the World from 1905 to 2016

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## Introduction

The review of the literature of meningitis outbreaks recorded throughout the world shows us that meningitis is present on all 5 continents. Meningococcal meningitis is a global public health problem. Its incidence is variable: low in Europe and North America (1 case for 100,000), but high in Africa (800 to 1000 cases per 100,000) during epidemic outbreaks [1]. The history of meningitis dates back to 1805 in Geneva, then to the nineteenth century through Europe and North America, reaching Africa in 1840. Since then, the African continent remains the most affected by epidemics of bacterial meningitis. It is probably by the military garrisons from Europe that the bacteria have arrived on the African continent [2]. French troops based in Algeria experienced two major outbreaks in 1840 and 1847, as British troops in Egypt in 1889 and in Sudan in 1899 [3]. The first widespread manifestations of East-West from 1905 (Sudan), 1906 (Ghana), from 1914 (Sudan), 1919 (Ghana), affecting Nigeria and Niger. The progression is towards the north, then to the west Kordofan is reached in 1934, Darfur in 1936, Chad in 1936, as many cases of meningitis on both sides of the (theoretical) border in 1936. Then it was the turn of Upper Volta and Ghana in 1939, Mali in 1940 and Dakar in 1941 [4]. Epidemics occur almost as annually, according to the WHO definition of an epidemic year. A cumulative incidence greater than 100 cases per 100,000 populations, nationally [5]. The chronology outbreaks of bacterial meningitis having occurred in the world in general and in particular in the African meningitis belt from 1905 to 2016 are summarized in Table 1 [4,6-10]. Between 1995 and 1997, epidemics were the most important epidemics that Africa has ever experienced: more than 250,000 cases have been reported. Due to meningococcal A ST-5 of clone complex 5 (cc5), they start in 1995 in Niger (26,738 cases). In 1996, an epidemic peak of exceptional amplitude, with more than 150,000 reported cases, affected Burkina Faso (42,129 cases), Mali (7,244 cases), Niger (16,050 cases) and Nigeria (75,069 cases). This epidemic will continue in 1997, Burkina Faso (21,504 cases) and Mali (10,960 cases), followed by Ghana (18,551 cases), Togo (2,845 cases) and The Gambia 913 cases), while in Niger the number of cases is clearly decreased (3,922 cases). Year after year, all countries in the belt will be affected by A meningococci belonging to this clone [4]. The bacteria involved in meningococcal meningitis are *Neisseria meningitidis*. It is recognized as the most responsible bacterium for meningitis epidemics in Africa. There are 13 serogroups of *Neisseria meningitidis* and most invasive infections are due to 6 serogroups: A, B, C, X, Y and W135. Serogroup A was considered until 2010 to be hyperendemic in the meningitis belt. It is now sharply reduced by the introduction of conjugate vaccine A [11]. Serogroup W135 is present in all countries in the meningitis belt and has been on the increase since vaccination against serogroup A [12]. Serogroup X was mainly responsible for the epidemics in Niger, Kenya and Uganda [13]. In 2015, an epidemic of serogroup C meningitis is observed in Niger and other countries in the meningitis belt [6].

The evolution of meningococcal serogroups through the epidemics recorded from 1950 to 2016 is summarized in Table 2 [4,6-10,13]. These data show that meningitis occurs almost everywhere in the world, but to varying degrees depending on the climate and period.

The American, Asian, European and Oceanic continents are less affected compared to the African continent [2,14,15]. In Africa, this is the so-called "African meningitis belt" where the majority of cases of meningitis are recorded. It extends from Senegal to Ethiopia and covers 26 countries [16]. Meningitis is one of the pathologies that have caused human suffering for centuries [14,15]. Since 1905, meningitis has become a public health problem in the world, especially epidemics of meningococcal meningitis A (*Neisseria meningitidis* A) until the introduction of conjugate vaccine A "MenAfriVac" in 2010 in the African meningitis belt [2,17]. In 1970 there was the appearance of new strains: The first was *Neisseria meningitidis* B in some countries of America, Europe, Asia and an African country, namely Algeria [2,14,15]; Second was the *Neisseria meningitidis* C in Africa, America, Asia and Europe [2,14]. It has been the cause of the recent epidemic in Niger [17,18]. The NmW135 appeared in 2000 in France, the United Kingdom and Saudi Arabia. Africa in turn was affected in 2002 through Burkina Faso during the return of the pilgrims [4,8,17]. NmX was detected in 2006 in Niger [9], in 2008 in Togo, in 2009 in Ghana, in 2010 in Burkina Faso, in 2014 in Mali [4,8,17]. Since 2010, the gradual introduction of "MenAfriVac" into the epidemic-prone areas of the 26 countries of the African meningitis belt has led to a dramatic decline in the number of cases of NmA meningitis and the elimination of NmA epidemics. At the same time, the relative proportion of cases due to other serogroups (W, X and C) and *Streptococcus pneumoniae* (Spn) increased [17,19]. Our results have been confirmed by other studies in Africa and around the world. The study of Guindo in 2013 in Mali [20], KENZA in 2010 in Morocco [21], Isabelle in 2012 in France [22] and that of Jessica in 2015 in the United States [23].

## Conclusion

These results show the dynamics of the epidemiological monitoring in Mali in all its components with a major observation, the reduction of epidemics on a large scale substituted by sporadic or endemic forms at the pediatric level. The introduction of A-conjugate vaccine could be an alternative to Mali because NmA has almost disappeared but replaced by other serogroups including NmW135, NmC and NmX. We believe that the use of vaccines against *S. pneumoniae* and *Hib* under the Expanded Program for Immunization (EPI) would prevent significant endemic morbidity and many deaths due to meningitis. However, it would be necessary to improve some points: Control of emerging meningococcal serogroups; case-by-case monitoring at all levels of the health pyramid; the number of serotypes covered by vaccines.

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Year	Country
1905	Sudan
1906	Sudan, Ghana
1907	Sudan
1914	Sudan
1919	Ghana,
1921	High-Volta (Burkina Faso), Niger, Nigeria
1924-1931	Sudan
1932	Sudan, Chad
1933	Sudan
1934	Sudan
1935	Sudan, Chad
1936	Chad, Sudan
1937	Nigeria, Niger, High- Volta, Chad, Sudan
1938	Nigeria, Niger, High- Volta, Chad, Soudan
1939	Ghana, Nigeria, Niger, High-Volta, Chad, Sudan
1940	Algeria, Mali, Nigeria, Niger, High-Volta, Chad, Sudan
1941	Mali, Nigeria, Niger, High-Volta, Chad, Senegal, Sudan
1942-1949	Nigeria, Niger, High-Volta, Chad, Sudan
1950	North America, Europe, Ghana, High -Volta, Niger, Nigeria, Chad, Sudan
1951-1957	Nigeria, Niger, High-Volta, Chad, Sudan
1958	Brasil, Nigeria, Niger, High-Volta, Chad, Sudan
1959	France, Nigeria, Niger, High-Volta, Chad, Sudan, Zaire
1960-1962	Nigeria, Niger, High-Volta, Chad, Sudan
1965	Senegal
1968	Chad
1969	Senegal
1970	Norveg, Espagne, Italy, Portugal, Yougoslavie, Belgium, Senegal
1971	Brasil, Espagne, Italy, Portugal, Yougoslavie, Belgium, Senegal, Ivory Coast, Egypt, Chad
1972	Brasil, Senegal, Zaire
1973	France, Finland, Mongoly, Senegal
1974	Argentina, Brasil, Finlande, Mongoly, Royaume-Uni, Senegal
1975	Mongoly, Nigeria, Norvege, Royaume-Uni, Russia, Senegal, Ivory Coast, Egypt
1976	Islande, Senegal
1977	Vietnam, Nigeria, Senegal
1978	Algeria, France, Rwanda, Norvege, Iles Feroe, Senegal
1979	Algeria, Burkina Faso, Chili, Mali, Senegal
1980	Cuba, India, MongolY, Nepal, Russia
1981	Iles Feroe
1982	New Delhi, Cuba
1983	Nepal, Ivory Coast
1984	Cuba, Nepal
1985	Burkina Faso, Ivory Coast, Mali, New Delhi, Niger, Nigeria, Tanzania
1986	Afghanistan, Saudi Arabia, Chili, Djibouti, Egypt, Emirats, France, Iran, Iraq, Jordania, Maroc, Pakistan, Syria, Sudan, Tunisia, Yemen
1987	Afghanistan, Saudi Arabia, Djibouti, Egypte, Emirats, France, Iran, Iraq, Jordania, Koweït, Maroc, Oman, Pakistan, Syria, Soudan, Tunisia
1988	Afghanistan, Algeria, Saudi Arabia, Egypt, Emirats, Iran, Iraq, Jordania, Maroc, Pakistan, Syria, Sudan, Chad, Tunisia, Yemen, Ethiopia
1989	Afghanistan, Saudi Arabia, Brasil, Egypt, Iran, Iraq, Jordania, Maroc, Pakistan, Syria, Sudan, Tunisia, Yemen, Kenya, Uganda, Burundi
1990	Saudi Arabia, Egypt, Iran, Pakistan, Syria, Sudan, Tunisia
1991	Egypt, Iran, Iraq, Maroc, Pakistan, Syria, Sudan, Tunisia
1992	Burundi, Egypt, Iran, Iraq, Maroc, Niger, Pakistan, Syria, Sudan, Tunisia, Yemen
1993	Algeria, Chili, Egypt, Iran, Iraq, Maroc, Syria, Sudan, Tunisia, Yemen
1994	Egypt, Iran, Iraq, Maroc, Syria, Sudan, Tunisia, USA
1995	Cameroun, Egypt, Ghana, Iran, Iraq, Maroc, Niger, Pakistan, Syria, Sudan, Chad, Tunisia
1996	Burkina Faso, Cameroun, Ghana, Mali, Niger, Nigeria, Iran, Iraq, Sudan, Chad
1997	Burkina Faso, Mali
1998	Algeria, Burkina Faso, Mali, Niger, Chad
1999	Burkina Faso, Cameroun, Kenya, Ethiopia, Niger, Sudan, Chad
2000	Saudi Arabia, French, Niger, Nigeria, Chad

2001	Burkina Faso, Saudi Arabia, Niger, Chad, RDC
2002	Burkina Faso, Benin, Niger, Nigeria, Senegal, Chad, RDC
2003	Burkina Faso, Benin, Centrafrique, Ghana, Niger, Nigeria, Mali, Ethiopia, Tchad
2004	Burkina Faso; Central African, Ethiopia, Ghana, Kenya, Niger, Nigeria, Uganda, Cameroun, Chad
2005	Burkina Faso, Benin, Cameroun, Kenya, Uganda, Mali, Niger, Sudan, Chad, Togo, Ivory Coast, Eritrea, Ethiopia
2006	Burkina Faso, Benin, Ivory Coast, French, Guinea, Kenya, Mali, Niger, Nigeria, Sudan, Uganda, Chad, Togo
2007	Burkina Faso, Benin, Cameroun, Central African, Kenya, Ghana, Uganda, Niger, Nigeria, Sudan, Chad, Togo, Ivory Coast, Ghana, Guinea, Mali, Uganda, RDC
2008	Burkina Faso, Benin, Central African, Ivory Coast, Guinea, Mali, Niger, Nigeria, Uganda, RDC, Chad, Togo
2009	Cameroun, Burkina Faso, Benin, Central African, Ivory Coast, Ethiopia, Ghana, Mali, Niger, Nigeria, Chad, Togo, RDC
2010	Burkina Faso, Benin, Central African, Ivory Coast, Cameroun, Ghana, Mali, Niger, Nigeria, Chad, Togo, RDC
2011	Burkina Faso, Benin, Cameroun, Ethiopia, Ghana, Guinea, Mali, Niger, Nigeria, Chad, Togo, RDC
2012	Burkina Faso
2015	Niger
2016	Burkina Faso, Ghana, Mali, Niger, Togo, RDC

Table 1: Epidemics of meningitis in the world from 1905 to 2016 [4,6-10].

Year	Country	Serogroup	Year	Country	Serogroup
<b>Neisseria meningitidis A</b>			<b>Neisseria meningitidis B</b>		
1950	North America, Europe	A	1970	Norvege	B
1974	Brasil, Finland	A	1982-84	Cuba	B
1978	Rwanda	A	1986	Chili	B
1983-84	Nepal	A	1993	Chili	B
1987	Saudi Arabia	A	1989	Brasil	B
1988-89	Ethiopia, Sudan	A	1994	USA	B
1989-92	Burundi, Kenya, Uganda	A	1975-78	Norvege	B
1995-97	Burkina Faso, Mali, Niger, Nigeria, Tanzania	A	1976	Island	B
1982-84	New Delhi	A	1978-81	Iles Feroe	B
1980	India, Nepal	A	1986	Chili	B
1985	New Delhi	A	1980-84	Cuba	B
1972-74	Brasil	A	1988	Algeria, Brasil	B
1977-78	Vietnam	A	1993	Chili	B
1975	North Nigeria	A	2000	France	B
1979	Burkina Faso, Mali	A	<b>Neisseria meningitidis C</b>		
1973-74	Finland	A	1970	Nigeria, Niger	C
1974	Brasil	A	1985	France	C
1973-74	Mongoly	A	1972-74	Brasil	C
1983	Nepal	A	1977-78	Vietnam	C
1977	Nigeria	A	1975	North Nigeria	C
1978	Algeria, Rwanda	A	1979	Burkina Faso	C
1983	Ivory coast	A	1979	Mali	C
1985	Ivory coast	A	1975	Nigeria	C
1987	Saudi Arabia	A	1979	Burkina Faso	C
1988	Algeria, Ethiopia, Chad, Sudan	A	1979	Mali	C
1989	Ethiopia, Kenya, Sudan, Uganda	A	1992	Niger	C
1992	Burundi, Kenya, Uganda	A	1971-72	Brasil	C
1995	Niger	A	1977	Vietnam	C
1996	Burkina Faso, Mali, Niger, Nigeria	A	1979	Algeria, Burkina Faso, Mali	C
1997	Burkina Faso, Mali	A	2011	Ghana	C
1998	Burkina Faso, Mali	A	2002	France	C
1999	Burkina Faso	A	2015	Niger	C
2000	Saudi Arabia	A	2016	Mali	C
2001	Burkina Faso	A	<b>Neisseria meningitidis W135</b>		
2003	Burkina Faso, Benin, Ghana, Niger	A		France, Royaume-Uni,	W135
2004	Burkina Faso, Central African, Ethiopia, Ghana, Mali, Niger	A	2000	Saudi Arabia	
2005	Burkina Faso, Niger	A	2001	Saudi Arabia	W135
2006	Burkina Faso, Guinea, Mali, Nigeria, Chad	A	2002	Burkina Faso, Niger	W135

2007	Burkina Faso, Benin, Niger, Nigeria, Togo	A	2003	Burkina Faso, Niger	W135
2008	Benin, Burkina Faso, Central African, Ivory coast, Guinea, Mali, Niger	A	2004	Niger	W135
2009	Burkina Faso, Niger, Nigeria, Chad	A	2005	Niger	W135
2010	Burkina Faso, Niger, Nigeria, Chad	A	2006	Niger	W135
2011	Cameroun, Nigeria, Chad	A	2007	Togo	W135
2014	Guinea	A	2009	Niger, Chad	W135
2015	Guinea	A	2010	Ghana, Niger, Nigeria, Chad	W135
Neisseria meningitidis X			2011		
2004	Niger	X	2015	Togo	W135
2006	Niger	X	2016	Togo	W135
2008	Niger, Togo	X			
2009	Ghana	X			
2010	Burkina Faso	X			
2011	Burkina Faso, Niger	X			

**Table 2:** Meningococcal serogroups circulating around the world from 1950 to 2016 [4,6-10,13].

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