J Glob Health 2019; 9: 010411

Online Supplementary Document

Table S1. Peer-reviewed literature and grey literature search strategy

PubMed search terms	#1. Meningococcal disease "Meningococcal Infections"[Mesh] OR "Meningitis, Meningococcal"[Mesh] OR meningococc*[tiab] AND #2. Outbreaks "Disease Outbreaks"[Mesh] OR outbreak*[tiab] OR epidemic*[tiab] OR pandemic*[tiab]
	Publication date January 1966 to July 2017
EMBASE search terms	#1. Meningococcal disease 'meningococcosis'/exp OR 'epidemic meningitis'/exp OR meningococc*:tiab AND #2. Outbreaks 'epidemic'/exp OR outbreak*:tiab OR epidemic*:tiab OR pandemic*:tiab
	Publication date January 1966 to July 2017
Grey literature	Websites were searched for information on meningococcal outbreaks using the terms 'meningococcal' and 'outbreak' • ProMED mail (www.promedmail.org, search date 8 September 2017) • World Health Organization (WHO) (www.who.int, search date 11 September 2017) • Centers for Disease Prevention and Control (CDC) (www.cdc.gov, search date 11 September 2017) • European Centre for Disease prevention and Control (ECDC) (www.ecdc.europa.eu, search date 11 September 2017) Hits from ProMED mail were first screened based on title and abstract, followed by full-text screening. All search results on the CDC webpage, including all publications on the page of surveillance, epidemiology and outbreaks of meningococcal were screened, just as all possible relevant pages on the ECDC website that were identified using the search terms. For the WHO website, the first page of the search results and all hits on an overview page with meningococcal outbreaks worldwide.

Table S2. Characteristics of the included studies

Studies from the peer-reviewed literature

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
Region of the Americas						
Banerji, 1995 [1] Canada (Eastern Ontario/Western Quebec)	Outbreak investigation	MCD cases identified during outbreak in a region December 1991–January 1992 (6 weeks)	NR	n=10 Age NR Gender NR	Serogroup C (assumed all cases had serogroup C[1]) (type/subtype NR)	Chemoprophylaxis NR Vaccination NR
Tyrrell, 2002 [2] Canada (Edmonton, Alberta)	Outbreak investigation	MCD cases identified during outbreak in a region December 1999–April 2001	Laboratory or clinically confirmed	Lab. conf.: n=57 Clin. conf.: n=4 Age range: 5 wks–77 yrs Male: 47%	Serogroup C in 56/57 serogrouped isolates Serogroup B in 1/57 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampin): - Close contacts Vaccination (polysaccharide quadrivalent meningococcal vaccine): - Persons aged 2–19 yrs - Extended in next round to all previously unimmunized 2–24 yrs
Quan, 2007 [3] Canada (Abbotsford, British Columbia)	Follow-up study	MCD cases identified during outbreak in a village (Abbotsford) and outbreak among MSM (city NR) Outbreak Ia: December 2000–March 2001 Outbreak Ib: October 2001–December 2001 Outbreak II: September–December 2004	Laboratory confirmed	Outbreak Ia: n=5 Outbreak Ib: n=4 Outbreak III: n=7 Outbreak Ia: Teenagers and young adults Outbreak Ib: Older cases Outbreak II: age NR Outbreak Ia/Ib: Gender NR Outbreak II: male 100%	Outbreak Ia: Serogroup C in 3/3 serogrouped isolates Outbreak Ib: Serogroup C in 4/4 serogrouped isolates Outbreak II: Serogroup C in 5/5 serogrouped isolates Outbreak I, II, III (type/subtype NR)	Chemoprophylaxis NR Vaccination NR
Tsang, 2003 [4] Canada (Toronto, Ontario)	Outbreak investigation	MCD cases identified during outbreak among MSM in a city Early May–mid July 2001	Laboratory confirmed	n=6 Age range: 23–39 yrs Male: 100%	Serogroup C:NT:P1.2 in 6/6 serotyped cases	Chemoprophylaxis (type NR): - Close contacts (household and potential bathhouse contacts) Vaccination (quadrivalent polysaccharide vaccine): - Homosexual or bisexual men having ≥1 risk factors
Langley, 2016 [5] Canada (Nova Scotia)	Follow-up study	MCD cases identified during outbreak at a university	Laboratory confirmed	n=2 Age NR	Serogroup B in 2/2 serogrouped isolates (type/subtype NR)	Chemoprophylaxis NR Vaccination (4CMenB):

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
		1–11 February 2015		Gender NR		- Students, staff, faculty
No author, 1998 [6] USA (Florida)	Outbreak investigation	MCD cases identified during 2 outbreaks in a hotel resort and a nursing home <u>Outbreak I</u>: 8 July–August 1995 <u>Outbreak II</u>: 2–10 December 1997	<u>Outbreak I</u> Laboratory and clinically confirmed <u>Outbreak II</u> Laboratory confirmed	<u>Outbreak I</u> Lab. conf.: n=4 Clin. conf.: n=1 Age range: up to 17 yrs Gender NR <u>Outbreak II</u> n=3 Age range: 56-90 yrs Gender NR	<u>Outbreak I</u> Serogroup C in 4/4 serogrouped isolates (type/subtype NR) <u>Outbreak II</u> Serogroup C in 3/3 serogrouped isolates (type/subtype NR)	<u>Outbreak I</u> Chemoprophylaxis (rifampin): - After case 1-3, all guests and employees at both hotels - After 5th case, all guests and employees at hotel A Vaccination NR <u>Outbreak II</u> Chemoprophylaxis (ciprofloxacin): - All persons who had visited the facility during the previous 14 days (staff members, patients, visitors) Vaccination NR
Guttler, 1972 [7] USA (United States Army Infantry Training Center, Fort Lewis, Washington)	Follow-up study	MCD cases identified during outbreak in military base 14 December 1970–June 1971	Laboratory confirmed	n=15 Age NR Gender NR (assumed all cases were male[2])	Serogroup C in 15/15 serogrouped isolates (type/subtype)	Chemoprophylaxis (minocycline): - Basic combat trainees - Training cadre Chemoprophylaxis (minocycline): - Untreated recruits Vaccination (group C polysaccharide vaccine): - All recruits in the first 6 weeks of basic training and to all inductees entering Fort Lewis
Oill, 1978 [8] USA (Los Angeles area, San Francisco area)	Outbreak investigation	MCD cases identified in intercity outbreak among immigrants recently arrived from Mexico 1–13 April 1974	Laboratory confirmed	n=5 Age range: 17–39 yrs Male: 100%	Serogroup B in 5/5 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (type NR): - Household contacts of cases 1–3 Chemoprophylaxis (rifampin): - Persons who lived in the residence of case 4 or who had had close contact with the patient Vaccination NR
Brook, 1980 [9] USA (Washington DC)	Outbreak investigation	All MCD cases identified during outbreak in a family 9 May–16 May 1979	Laboratory confirmed	n=3 Age range: 7 mo–10 yrs Male: 33%	Serogroup B in 2/2 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampin for prophylaxis): - All household contacts Vaccination NR
Hudson, 1986 [10] USA (Vermont)	Case-control study	MCD cases identified during outbreak in 2 contiguous rural counties	Laboratory confirmed	n=13 Median age: 7 yrs (range: 1–18)	Serogroup C, serogroup 4 in 1/13 serogrouped isolates Serogroup C:2b in 12/13	Chemoprophylaxis (sulfamethoxazole): - School children and their household contacts Vaccination (meningococcal A–C vaccine):

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
		15 February 1984		Male: 62%	serotyped isolates	- School students
Harrison, 1991 [11] USA (Rockbridge County, north-western Virginia)	Case-control study	MCD cases during outbreak among school bus passenger 15–16 February 1986	Laboratory confirmed	n=5 Age range: 9–13 yrs Gender NR	Serogroup C (number NR) (type/subtype NR)	Chemoprophylaxis (rifampin): - All persons who rode the school bus Vaccination (tetravalent A, C, W135, or Y meningococcal polysaccharide): - Children of the 4 schools that had children who routinely rode the school bus
Houck, 1995 [12] USA (Benton, Chelan, Douglas, Grant, Klickitat, and Yakima)	Outbreak investigation	MCD cases identified during outbreak in counties Outbreak I: 12 January–August 1989 Outbreak II: September 1989–August 1990 Outbreak III: September 1990–August 1991	Laboratory and clinically confirmed	Outbreak I: Lab. conf.: n=23. Clin. conf.: n=5 Outbreak II: Lab. conf.: n=12 Outbreak III: Lab. conf.: n=5 Median age: 3 yrs (range: 2 mo–77 yrs) Gender NR	Serogroup C in 50/50 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampin): - All case contacts Vaccination (serogroup C meningococcal vaccination): - Persons 1–24 yrs, residents of selected parts of the upper and lower valley
Morrow, 1990 [13] USA (Santa Clara County, California)	Outbreak investigation	MCD cases identified during outbreak in a class of an intermediate school 27 January–7 February 1989	Laboratory confirmed	n=5 Age: 4/5 were students, 1/5 was a younger sibling Gender NR	Serogroup C in 4/5 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampin): - Entire student body and staff members of the school Vaccination (quadrivalent (A, C, Y and W135) meningococcal vaccine): - Entire student body and staff members of the school - Siblings of the students
Imrey 1996 [14] USA (region NR)	Case-control study	MCD cases identified during outbreak in a large residential university 8 February 1991–20 April 1992	Laboratory confirmed	n=9 Age range: 18–20 yrs Male: 56%	Serogroup C in 9/9 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampin): - Close contacts Vaccination (quadrivalent meningococcal polysaccharide vaccine): - Undergraduates and entering undergraduates
Edmond, 1995 [15] USA (Iowa City, Iowa)	Outbreak investigation	MCD cases identified during outbreak in a university community 23 October–15 December 1992	Laboratory confirmed	n=5 Age range: 18–22 yrs Gender NR	Serogroup C in 5/5 serogrouped isolates (type/subtype NR)	Chemoprophylaxis NR Vaccination (tetravalent meningococcal vaccine): - Student of the university
Tappero, 1996 [16]	Outbreak	MCD cases identified during	Laboratory	n=11	Serogroup C in 8/11	Chemoprophylaxis (ciprofloxacin):

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
USA (Los Angeles County Men's Jail system, California)	investigation	outbreak in jail 1 January–31 March 1993	confirmed	Age NR Male: 100%	serogrouped isolates (type/subtype NR) Serogroup B in 1/11 serogrouped isolates (type/subtype NR)	- Inmates and workers at the jail Vaccination NR
Wenger, 1994 [17] USA (Grayson County, North Texas)	Outbreak investigation	MCD cases identified during outbreak in 2 neighbouring towns 24 February–21 March 1993	Laboratory confirmed	n=7 Age range: 4–32 yrs Male: 57%	Serogroup C in 7/7 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (type NR): - Contacts Vaccination (type NR): - Residents aged 2–29 yrs
Jackson, 1996 [18] USA (region NR)	Follow-up study	MCD cases identified during outbreak at a middle school 11–18 February 1995	Laboratory and clinically[3] confirmed	Lab. conf.: n=5 Clin. conf.: n=1 Age: students Male: 33%	Serogroup B in 5/5 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampin): - School students and staff Vaccination not provided
Krause, 2002 [19] USA (Putnam County, Florida)	Outbreak investigation	MCD cases identified during community outbreak in a county 12 December 1998–28 December 1999	Laboratory confirmed	n=12 Age range: 3 mo–25 yrs Male: 50%	Serogroup C in 12/12 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampin, ciprofloxacin, or ceftriaxone): - Close contacts Mass vaccination (quadrivalent polysaccharide meningococcal vaccine): - All residents aged 2–22 years of the 2 neighbouring towns - Additional vaccinations to the target group but did not receive the vaccine
Schmink, 2007 [20] USA (Chicago)	Outbreak investigation	MCD cases in MSM identified during outbreak in a city 6–15 October 2003	Laboratory confirmed	n=6 Age range: 27–42 yrs Male: 100%	Serogroup B in 6/6 serogrouped isolates Serogroup B:P1.5-1,10-8 in 5/5 serotyped isolates	Chemoprophylaxis (type NR): - Patrons of MSM-oriented venues in the city Vaccination (quadrivalent meningococcal polysaccharide vaccine): - Patrons of MSM-oriented venues in the city
Weiss, 2009 [21] USA (central Brooklyn, New York)	Follow-up study	MCD cases identified during outbreak among primarily illicit drug users and their contacts 1 November 2005–30 November 2006	Laboratory and clinically confirmed	Lab. conf.: n=22 Clin. conf.: n=1 Median age: 41 yrs (range: 4–68) Male: 43%	Serogroup C in 22/22 serotyped isolates (type/subtype NR)	Chemoprophylaxis (type NR): - Individuals who were found to be at an increased risk of infection Vaccination (meningococcal conjugate vaccine): - Adults with a history of illicit drug use or methadone use in the previous 3 months - Household contacts of persons with a history of illicit drug use, living in 1 of 4 central Brooklyn zip codes

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
Bradley, 2012 [22] USA (north-eastern Oklahoma)	Outbreak investigation	All suspected MCD cases during outbreak in a school district 10 March–31 March 2010	Laboratory and clinically[5] confirmed	Lab. conf.: n=5 Clin. conf.: n=2 *Lab. conf. and clin. conf. without suspected cases:* Age range: 5–18 yrs Gender NR	Serogroup C in 4/4 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampin, intramuscular ceftriaxone injection): - Students and faculty members in the lower elementary school - Close contacts of the patients - Extended to older students with direct contact with younger children in classrooms where cases were identified and to persons who rode on buses with the patient Vaccination (quadrivalent meningococcal conjugate vaccine, quadrivalent meningococcal polysaccharide vaccine): - All students, faculty, and staff members in the affected school district
Duffy, 2017 [23] USA (California)	Follow-up study	MCD cases identified during outbreak at a university March–November 2013	NR	n=5 Age: student/young adults Gender NR	Serogroup B (numbers NR)	Chemoprophylaxis (type NR): - Close contacts Vaccination (4CMenB): - Persons who were determined to be at increased risk of meningococcal serogroup B disease due to the outbreaks
McNamara, 2015 [24] USA (New Jersey)	Follow-up study	MCD cases identified during outbreak in a university 25 March 2013–10 March 2014	Laboratory confirmed	n=9 Median age: 19 yrs (range: 17–21) Gender: 56%	Serogroup B in 9/9 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (type NR): - Close contacts Vaccination (4CMenB vaccine): - Undergraduate students, graduate students living in undergraduate and graduate student dormitories, graduate students, faculty, and staff with a medical condition that increases risk of meningococcal disease, and spouses and caregivers of undergraduate and graduate students living in a dormitory with the students
Soeters, 2015 [25] USA (Providence College, Rhode Island)	Outbreak investigation	MCD cases identified during outbreak at a college 2–5 February 2015	Laboratory confirmed	n=2 Age: both undergraduate students Male: 100%	Serogroup B in 2/2 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (ciprofloxacin): - Potential contacts Mass vaccination (MenB): - Potential contacts
Biswas, 2016 [26] USA (Santa Clara University, California)	Outbreak investigation	All MCD cases identified during outbreak at a university 31 January–2 February 2016	Laboratory and clinically[3] confirmed	Lab. conf.: n=2 Clin. conf.: n=1 Age: undergraduate	Serogroup B in 2/2 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (ciprofloxacin): - Students in social networks Vaccination (4CMenB vaccine):

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
				students Gender NR		- All undergraduate students, graduate students and faculty and staff members at increased risk
Iser, 2012 [27] Brazil (Rio Verde city)	Case-control study	MCD cases identified during outbreak among large food processing plant workers June–August 2008	Laboratory or clinically[4] confirmed	Lab. conf.: n=10 Clin. conf.: n=12 *Lab. conf. and clin. conf. without suspected cases:* Median age: 16 yrs (range: 2 mo–45 yrs) *Lab. conf. and clin. conf. without suspected cases:* Male: 63%	Serogroup C in 10/10 confirmed isolates Serogroup C:23:P1.14–6 in 5/5 serotyped isolates	Chemoprophylaxis (type NR): - Household contacts Vaccination (polysaccharide meningococcal AC vaccine): - Plant workers
Gorla, 2012 [28] Brazil (Trancoso, Seguro, Bahia State)	Outbreak investigation	MCD cases identified during outbreak in a village 21–26 October 2009	Laboratory confirmed	n=9 Age range: 14–39 yrs Male: 78%	Serogroup C:23:P1.5 in 5/5 serotyped isolates	Chemoprophylaxis (rifampin): - Close contacts of cases Vaccination NR
Safadi, 2014 [29] Brazil (Cosmópolis and São José dos Campos, São Paulo State)	Cross-sectional study	MCD cases identified during 2 outbreaks in 2 oil refineries Refinery A: 29 March–30 June 2010 Refinery B: 10 July–8 August 2010	Refinery A Laboratory confirmed Refinery B NR	Refinery A: n=18 Refinery B: n=13 Refinery A: Age range: 8 mo – >18 yrs Refinery B: <4 – >18 yrs Gender NR	Refinery A: Serogroup C:23:P1.14-6 in 18/18 serotyped isolates Refinery B: Serogroup C in 1/1 serogrouped isolate (assumed all cases had serogroup C[1]) (type/subtype NR)	Refinery A Chemoprophylaxis (rifampin): - Close contacts Vaccination (meningococcal A/C polysaccharide): - All refinery workers Mass vaccination (MCC vaccine, meningococcal A/C polysaccharide vaccine): - Inhabitants of Cosmópolis, infants, toddlers, persons 2–19 yrs Refinery B Chemoprophylaxis (type NR): - Close contacts Vaccination NR
Chacon-Cruz [30] Mexico (Tijuana)	Outbreak investigation	MCD identified during outbreak in a city 30 January–30 March 2013	Laboratory confirmed	n=19 Median age: 16 yrs (range: 2–47) Male: 58%	Serogroup C in 19/19 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (>18 yrs: ciprofloxacin; <18 yrs: rifampin): - Household contacts - people who had suspected direct exposure to any confirmed case's secretion through kissing, sharing eating/drinking utensils at any time during the 7 days before onset of illness Vaccination not provided
Chadee, 2006[31]	Outbreak	All MCD cases identified	Laboratory and	Lab. conf.: n=14	Serogroup B in 13/14	Chemoprophylaxis (rifampicin):

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
Trinidad and Tobago (El Socorroi, San Juan and Claxton Bay)	investigation	during outbreak in a city 26 September–10 October 1998	clinically[3] confirmed	Clin. conf.: n=7 *Lab. conf.*: Age range: <5 - >65 yrs Gender NR	serogrouped isolates (type/subtype NR) Serogroup A in 1/14 serogrouped isolates (type/subtype NR)	- Contacts and surveillance workers Vaccination NR
European region						
Reintjes, 2002 [32] Belgium, Denmark, Germany, The Netherlands	Outbreak investigation	MCD cases from 4 countries identified during outbreak following with a youth football tournament 9 May–24 December 1997	Laboratory confirmed	n=11 Age range: 12–39 yrs Male: 73%	Serogroup C:2a: P1.5 in 11/11 serotyped isolates	Chemoprophylaxis (type NR): - Belgium, The Netherlands, Germany: close contacts - Denmark: everyone who travelled by bus Vaccination (type NR): - Belgium, Germany NR - The Netherlands: town residents <20 yrs - Denmark: everyone who travelled by bus
Kriz, 1995 [33] Czech Republic (Olomouc and Bruntal)	Outbreak investigation	MCD cases identified during 2 outbreaks in 2 neighbouring districts Olomouc: 2 February–8 May 1993 Bruntal: 14 February–2 June 1993	Laboratory confirmed	Olomouc: n=8 Bruntal: n=6 Olomouc: Age range: 2–16 yrs Bruntal: Age range: 2–18 yrs Olomouc & Bruntal: Gender NR	Olomouc & Bruntal (only reported for both outbreaks combined) Serogroup C:2a:P1.2 in 7/8 serotyped isolates	Chemoprophylaxis NR Olomouc: Mass vaccination (type NR): - Students Bruntal: Vaccination (type NR): - Contacts and those requesting vaccination
Ronne, 1993 [34] Denmark (Randers)	Follow-up study	MCD cases identified during outbreak in a city November 1983–May 1984	Laboratory or clinically confirmed	Lab. conf.: n=19 Clin. conf.: n=1 Age range: 0–22 yrs Male: 65%	Serogroup C in 19/19 serogrouped isolates Serogroup C: 2a:P1.2 in 11/17 serotyped cases Serogroup C:2a:NST in 5/17 cases Serogroup C:NT:P1.2 in 1/17 case	Chemoprophylaxis (rifampicin): - Classmates of second case Vaccination after first cluster (polysaccharide vaccine A+C): - All students and staff Vaccination after 3rd cluster (type NR): - All individuals attending schools or living in the area aged 10–19 yrs
Samuelsson, 1992 [35] Denmark (Hillerød municipality, Karlebo: Hørsholm and Hillerød, Frederiksborg county)	Outbreak investigation	MCD cases identified during 4 outbreaks in various cities and communities Outbreak I: January–April 1987 Outbreak II: August–	Laboratory or clinically confirmed	Outbreak I: Lab. conf.: n=5; clin. conf.: n=1 Outbreak II: Lab. conf.: n=5; clin. conf.: n=1 Outbreak III: clin. conf.: n=8 Outbreak IV: Lab. conf.:	Outbreak I: Serogroup B: 15: P1.16 in 5/5 serotyped isolates Outbreak II: Serogroup B: 15: P1.16 in 4/5 serotyped isolates Serogroup B:NT:P1.16 in 1/5	Outbreak I, II, III: Chemoprophylaxis NR Outbreak IV: Chemoprophylaxis (rifampicin): - All pupils and adults at schools >1 case; siblings of pupils Outbreak I, II, III, IV: Vaccination NR

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
		December 1987 Outbreak III: 1988 Outbreak IV: January–March 1989		n=5; clin. con.: n=1 Outbreak I, II, III, IV: Cases were teenagers Outbreak I, II, III, IV: Gender NR	serotyped isolates Outbreak III: Serogroup B:15:P1.16 in 7/8 serotyped isolates Serogroup C:4:P1.1 in serotyped 1/8 isolates Outbreak IV: Serogroup B:15:P1.16 in 5/5 serotyped isolates	
Grodet, 2004 [36] France (Indre-et-Loire)	Outbreak investigation	MCD cases identified during outbreak in a department November 2000–February 2002	Laboratory confirmed	n=8 Median age: 21.7 yrs (range: 14–28) Male: 75%	Serogroup B:15:P1.12 in 8/8 serotyped isolates	Chemoprophylaxis (type NR): - Family members, colleagues, friend or other people in close contact Vaccination NR
Delisle, 2005 [37] France (Dax, Landes)	Outbreak investigation	MCD cases identified during outbreak in a village December 2008–September 2009	Laboratory confirmed	n=11 Median age: 18 yrs (range 7 mo–7 yrs) Male: 55%	Serogroup B in 11/11 serogrouped isolates Serogroup B:NT:NST in 10/10 serotyped isolates	Chemoprophylaxis (type NR): - Close contacts Chemoprophylaxis (rifampicin): - Nightclub members Vaccination NR
Parent du Châtelet, 2012 [38] France (Pays de la Loire and Rhone-Alpes)	Outbreak investigation	MCD cases, recently returned from Senegal, identified during outbreak in 2 areas 12 February–1 April 2012	Laboratory confirmed	n=16 Median age: 45 yrs (range: 2 mo–89 yrs) Male: 56%	Serogroup W135 in 16/16 serogrouped isolates Serogroup W135:2a:P1–5,2 in 8/16 serotyped cases	Chemoprophylaxis NR Vaccination NR
Hauri, 2000 [39] Germany (Rottal-Inn County)	Case-control study	MCD cases identified during outbreak in a county 10 December 1997–2 March 1998	Laboratory confirmed	n=9 Age range: 2–62 yrs (1 case NR) Gender NR	Serogroup C:2a:P1.2,5 in 9/9 serotyped isolates	Chemoprophylaxis (type NR): - Close contacts Vaccination not provided
Hellenbrand, 2016 [40] Germany (Berlin)	Outbreak investigation	MSM cases with MCD during outbreak in a city October 2012–May 2013	Laboratory confirmed	n=5 Age range: 20–34 yrs Male: 100%	Serogroup C:P1.5-1,10-8:F3-6 in 5/5 serotyped isolates	Chemoprophylaxis NR Vaccination (MenACWY): - MSM
Makras, 2001 [41] Greece (Hellenic Air Force recruit center and training base, southern	Outbreak investigation	MCD cases identified during outbreak in a military centre 19–24 January 1996	Laboratory and clinically confirmed	Lab. conf.: n=7 Clin. conf.: n=3 Age NR	Serogroup C in 7/7 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampin): - Close contacts Vaccination NR

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
Greece)				Gender NR		
Ferro, 2008 [42] Italy (Treviso area, Veneto region, north-eastern Italy)	Outbreak investigation	MCD cases identified during outbreak in an area 13 December 2007–4 January 2008	Laboratory confirmed	n=9 Mean age: 23 yrs (range: 15–33) (2 cases NR) Gender NR	Serogroup C in 6/6 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (type NR): - Contacts (same places as cases) Vaccination (type NR): - 1-yr-olds and 15-yr-olds Vaccination (meningococcal C conjugated): - People aged 15–29 yrs
Van der Ende, 2003 [43] The Netherlands (Zevenbergen, Klundert, Standdaarbuiten, Etten-Leur)	Outbreak investigation	MCD cases identified during outbreak in 4 small villages in a confined area 26 July–1 August 2001	Laboratory confirmed	n=7 Age range: 2–23 yrs Male: 29%	Serogroup C:2a:nt in 5/7 serotyped isolates Serogroup C:2a:P1.5 in 2/7 serotyped isolates	Chemoprophylaxis NR Vaccination NR
Kristiansen, 1985 [44] Norway (Tromsø, Northern-Norway)	Follow-up study	MCD cases identified during outbreak in a military camp September–November 1981	Laboratory confirmed	n=3 Age NR Gender NR (assumed all cases were male[2])	Serogroup B:15 in 3/3 serotyped isolates (subtype NR)	Chemoprophylaxis NR Vaccination NR
Kristiansen, 1986 [45] Norway (northern Norway)	Cross-sectional study	MCD cases identified during outbreak in a small community 6-week period in 1983	Laboratory confirmed	n=3 Age range: 11–12 yrs Gender NR	Serogroup B:15 in 3/3 serotyped isolate (subtype NR)	Chemoprophylaxis NR Vaccination NR
Grecki, 2006 [46] Poland (Skwierzyna, Lubuskie, a western province of Poland)	Outbreak investigation	MCD cases identified during outbreak among soldiers in an army sub-unit 22–24 March 2006	Laboratory confirmed	n=4 Age NR Gender NR (assumed all cases were male[2])	Serogroup C in 4/4 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (ciprofloxacin): - All soldiers of sub-unit - Extended to all residents of unit, including civil personnel Chemoprophylaxis (rifampicin): - All staff member in intensive care unit Vaccination not provided
Skoczynska, 2010 [47] Poland (Goleniów and Załom in commune Goleniów and Łoźnica in commune Przybiernów, Goleniów County)	Outbreak investigation	MCD cases identified during outbreak in two communes 10–30 March 2009	Laboratory confirmed	n=6 Age range: 7–25 yrs Male: 50%	Serogroup C:2a:P1.5,2 in 6/6 serotyped isolates	Chemoprophylaxis (rifampicin, cefotaxime, ciprofloxacin or azithromycin): - All close contacts Vaccination (type NR): - Children aged 6–19 yrs living in affected communes, children in the same age group from other communes who attended schools in the

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
						affected region, police, border guards and airport ground staff up to 24 yrs old in affected county
Saez-Nieto, 1984 [48] Spain (Logrofio, Rioja)	Outbreak investigation	MCD cases identified during outbreak in a nursery 13 November 1981–22 February 1982	Laboratory confirmed	n=11 Age range: 2.5–12 yrs Male: 73%	Serogroup C:2 in 3/7 serotyped isolates	Chemoprophylaxis (rifampicin): - Children and all nursery staff - Carriers of virulent strain after carriage study Vaccination (polysaccharide C vaccine): - Children from nursery, family contacts, adults connected to nursery
Camps, 1998 [49] Spain (Lloret de Mar, Catalonia, northeast Spain)	Outbreak investigation	All MCD cases identified during outbreak in an indoor swimming pool 29 January–2 May 1996	Laboratory confirmed	n=5 Age range: 1–4 yrs Male: 60%	Serogroup B in 5/5 serogrouped isolates Serogroup B:4:P1.4 in 3/3 serotyped isolates	Chemoprophylaxis (rifampin): - General chemoprophylaxis at swimming pool (not further specified) Vaccination NR
Smith-Palmer, 2016 [50] Scotland and Sweden	Outbreak investigation	MCD cases returning from an international event identified during outbreak 12–17 August 2015	Laboratory and clinically[5] confirmed	Lab. conf.: n=7 Clin. conf.: n=6 Age NR Gender NR	Serogroup W: P1.5,2,36-2 in 6/6 serotyped isolates	<u>Scotland</u> Chemoprophylaxis (ciprofloxacin): - All scouts and leaders North of Scotland unit in addition to other close contacts of the 2 confirmed cases Vaccination (type NR): - All scouts and leaders North of Scotland unit in addition to other close contacts of the 2 confirmed cases <u>Sweden</u> Chemoprophylaxis (ciprofloxacin): - All scouts across Sweden Vaccination NR
Easton, 1974 [51] UK (Devon)	Outbreak investigation	MCD cases identified during outbreak in an area October 1972–May 1973	Laboratory or clinically confirmed	Lab. conf.: n=18 Clin. conf.: n=13 Age range: <1 – ≥50 yrs Male: 55%	Serogroup B (assumed all cases had serogroup B[1])	Chemoprophylaxis (soluble sulphonamides): - All contacts Vaccination not provided
Round, 2001 [52] UK (region NR)	Follow-up study	MCD cases identified during outbreak in university campus residents 16 October–2 December 1996	Laboratory or clinically confirmed	Lab. conf.: n=5 Clin. conf.: n=2 Age range: 18–20 yrs Male: 43%	Serogroup C in 4/5 serogrouped cases Serogroup B in 1/5 serogrouped cases Serogroup C:2a: P1.5 in 2/2	Chemoprophylaxis (ciprofloxacin): - All students and staff at the hall - All guests who had stayed overnight in the previous 2 weeks Vaccination (A+C meningococcal):

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
					serotyped cases	- All students and staff at the hall
Irwin, 1997 [53] UK (Rotherham and North Nottinghamshire health districts)	Follow-up study	MCD cases identified during community outbreak in 2 health districts 8 December 1995–16 January 1996	Laboratory or clinically confirmed	Lab. conf.: n=7 Clin. conf.: n=1 Age range: 1–17 yrs Gender NR	Serogroup C in 7/7 serogrouped isolates Serogroup C:2b:P1.5, P1.2 in 5/7 serotyped isolates (C:2b in 1/7 isolate)	Chemoprophylaxis (rifampicin): - Primary school and younger children (<11 yrs) Chemoprophylaxis (ciprofloxacin): - Secondary school age children and young adults (aged 11–18 yrs) Vaccination (polysaccharide): - Children and young people between 2–18 years of age inclusive, living in or attending schools in the target areas
Gilmore, 1999 [54] UK (University of Southampton)	Outbreak investigation	MCD cases identified during outbreak at a university October, 1997	Laboratory or clinically confirmed	Lab. conf.: n=5 Clin. conf.: n=1 Age range: 18-19 yrs Male: 50%	Serogroup C in 5/5 serogrouped isolates	Chemoprophylaxis (ciprofloxacin): - All first-year students - Extent to all first-year undergraduates and all students and staff living or working in halls of residence Vaccination NR
Stewart, 2013 [55] UK (West Midlands, England)	Outbreak investigation	MCD cases identified during outbreak in a nursery 23 August–23 September 2010	Laboratory confirmed	n=2 Age: 3 yrs Gender NR	Serogroup B in 2/2 serogrouped isolates (type/subtype NR)	Chemoprophylaxis (rifampicin, ciprofloxacin): - Household contacts - Contacts at the nursery Vaccination not provided
Chatt, 2014 [56] UK (Warwickshire area)	Outbreak investigation	MCD cases identified during outbreak in a nursery February–June 2013	Laboratory confirmed	n=5 Age range: 2 – >60 yrs Gender NR	Serogroup B: P1.18–4,25: F1–5 in 5/5 serotyped isolates	Chemoprophylaxis (type NR): - Close contacts children and staff associated with 2 of the 4 classes Chemoprophylaxis (ciprofloxacin): - All staff and children Vaccination not provided
South-East Asian region						
Duggal, 2007 [57] India (Delhi)	Outbreak investigation	MCD cases identified during outbreak in a city December 2005–June 2006	Laboratory or clinically[3] confirmed	Lab. conf.: n=257 Clin. conf.: n=274 *Lab. conf.:* Age range: 3 mo–65 yrs *Lab. conf.:* Male: 82%	Serogroup A in 42/195 serogrouped isolates Agglutination with combined ACYW135 antigen in 65/195 isolates	Chemoprophylaxis NR Vaccination NR
Kushwaha, 2010 [58]	Outbreak investigation	MCD cases identified during outbreak among soldiers	Laboratory confirmed	n=17	Serogroup A in 3/3 serogrouped isolates	Chemoprophylaxis (rifampicin): - Close contacts

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
India (Kashmir)		1 February–26 May 2006		Age range: 21-26 yrs (2 cases NR) Gender NR (assumed all cases were male[2])		Vaccination not provided
Nair, 2009 [59] No author, 2005 [60] India (Delhi)	Outbreak investigation	MCD cases identified during outbreak in a city April–July 2005	Laboratory and clinically confirmed	Lab. conf. and clin. conf: n=444 (not reported per case definition) Age NR Gender NR	C in 35 serogrouped isolates (total number of serogrouped isolates NR) (type/subtype NR)	Chemoprophylaxis NR Vaccination NR
Eastern Mediterranean region, including Israel						
Almog, 1994 [61] Israel (Israel Defence Force, not further specified)	Outbreak investigation	MCD cases identified during 3 outbreaks among military Outbreak I: 18–23 January 1992 Outbreak II: 23–24 January 1992 Outbreak III: 6–20 February 1993	Laboratory confirmed	Outbreak I: n=3 Outbreak II: n=2 Outbreak III: n=3 Outbreak I, II, III: Age NR Outbreak I, II, III: Gender NR	Outbreak I: Serogroup C:NT:- in 3/3 serogrouped isolates Outbreak II: Serogroup C:NT:- in 2/2 serogrouped isolates Outbreak III: Serogroup C:NT:P1.2 in 3/3 serogrouped isolates	Outbreak I: Chemoprophylaxis (rifampicin): - All platoon mates who shared sleeping accommodation with the case and instructors - Extended to all soldiers and personnel of the company Vaccination not provided Outbreak II: Chemoprophylaxis (rifampicin): - Cadets and teachers of 2 classes Vaccination not provided Outbreak III: Chemoprophylaxis (rifampicin): - All recruits and personnel of the platoon and 2 medical staff personnel who treated him Chemoprophylaxis (ceftriaxone) - Close contacts Vaccination not provided
Al-Gahtani, 1995 [62] Saudi Arabia (Makkah)	Outbreak investigation	All MCD cases identified during outbreak, 3 months before the Hajj in a village 19 March–15 June 1992	Laboratory and clinically[3] confirmed	Lab. conf.: n=102 Clin. conf.: n=80 *Lab. conf.:* Mean age: 35.3 yrs *Clin. conf.:* Mean age: 30.7 yrs Lab. conf.: Male: 67%	Serogroup A (assumed all lab. conf. cases had serogroup A[1]) (type/subtype NR)	Chemoprophylaxis NR Mass vaccination (AC bivalent meningococcal): - Residents and religious visitors who for some reason were not vaccinated in their home countries

Author, year; country (region)	Study design	Study population and setting; outbreak period	Case definition	Number of cases; age; gender	*N. meningitidis* serogroup; type; subtype	Control intervention
				Clin. conf.: Male: 91%		
Western Pacific region						
Pearce, 1995 [63] Australia (Doomadgee, northern Queensland)	Follow–up study	MCD cases identified during outbreak in an isolated Aboriginal community 24 September 1990–11 April 1991	Laboratory and clinically confirmed	Lab. conf. and clin. conf: n=11 (not reported per case definition) Age range: 1–10 yrs Male: 36%	Serogroup C in 11/11 serogrouped isolates Serogroup C:2b:p1.2 in 5/5 serotyped isolates	Chemoprophylaxis (rifampicin): - Household contacts Mass chemoprophylaxis (rifampicin): - Community Vaccination (bivalent meningococcal polysaccharide vaccine): - Children (1–15 yrs)
Jelfs, 1998 [64] Australia (western Sydney, Penrith local government area)	Outbreak investigation	MCD cases identified during outbreak in an urban region, associated with a nightclub 1 August–10 September 1996	Laboratory and clinically[3] confirmed	Lab. conf.: n=11 Clin. conf.: n=3 Mean age: 23.8 yrs (range: 2–66) Male 57%	Serogroup C:2a:P1.5 in 10/11 serotyped isolates Serogroup C:2b:P1.5.2 in 1/11 serotyped isolate	Chemoprophylaxis (type NR): - Households, close contacts, staff of nightclub and their families Vaccination not provided
Zhang, 2013 [65] China (Jinan City)	Follow-up study	MCD cases identified during outbreak in a jail May 2010	Laboratory confirmed	n=3 Age range: 18–24 yrs Male: 100%	Serogroup C in 3/3 serogrouped isolates (type/subtype NR)	Chemoprophylaxis NR Mass vaccination (polysaccharide A+C): - Close contacts
Mills, 2013 [66] New Zealand (Northland)	Outbreak investigation	MCD cases identified during outbreak in area 10 July–21 December 2011	Laboratory confirmed	n=13 <20 yrs: 89% Gender NR	Serogroup C:2a:1.5-1,10-8 in 9/13 serotyped isolates Serogroup B in 4/13 serogrouped isolates (type/subtype NR)	Chemoprophylaxis NR Vaccination NR

4CMenB: multicomponent meningococcal serogroup B; Clin. conf.: clinically confirmed; Lab. conf.: laboratory confirmed; MCD: meningococcal disease; MMC: meningococcal serogroup C; mo: months; MSM: men who have sex with men; nmA: *N. meningitidis* serogroup A; NR: not reported; NST: non-sub-typeable; NT: non-typeable; UK: United Kingdom; USA: United States of America; wks: weeks; yrs: years

[1] We assumed that all cases were affected by the same serogroup (as mentioned in the article) but this was not proven by identification of the serogroup in all cases

[2] Based on the setting (e.g. military camp, MSM) it was highly likely that all cases were male

[3] All clinically confirmed cases were suspected cases as defined in the article.

[4] 6 of the 12 clinically confirmed cases were suspected cases as defined in the article

[5] All clinically confirmed cases were suspected cases as defined in the article. Although the authors decide to omit the suspected cases, this was not in line with our approach and therefore we included this cases in the table

Studies from the grey literature

Source, year; country (region)	Study population and setting; outbreak period	Number of cases; age	*N. meningitidis* serogroup[1]	Control intervention
Region of the Americas				
ProMED, 1998 [67] Canada (Kitchener-Waterloo, Ontario)	MCD cases identified during outbreak in a district 3 December 1997–4 January 1998	n=7 Age range: 16–23 yrs	Serogroup C (type/subtype NR)	Chemoprophylaxis NR Vaccination (type NR): - All those 2–22 yrs of age
ProMED, 1998 [68] USA (Connecticut)	Students identified during MCD outbreak at a university May 1993	n=3 Age: young adults	Serogroup A (type/subtype NR)	Chemoprophylaxis (type NR) - University of Connecticut students/staff/faculty Vaccination NR
ProMED, 2015 [69] USA (Eugene, Oregon)	Students identified during MCD outbreak at the university campus 13 January–19 May 2015	n=7 Age: young adults	Serogroup B (type/subtype NR)	Chemoprophylaxis (type NR): - 7th case's close contacts (other cases NR) Vaccination (meningococcal serogroup B) - Students
ProMED, 2012 [70] Chile (Metropolitan Region, includes Santiago)	MCD cases identified during outbreak in a region January–November 2013	n=46 cases (n=37 from the Santiago Metropolitan Region) Age NR	Serogroup W135 (type/subtype NR)	Chemoprophylaxis NR Vaccination (type NR) - People (not further specified)
European region				
ProMED, 2012 [71] Italy (region NR)	Crew members identified during MCD outbreak on a cruise ship October 2012	n=4 Age: adults	Serogroup C (type/subtype)	Chemoprophylaxis (rifampicin, ciprofloxacin): - All crew members and passengers Vaccination NR
Western Pacific region				
ProMED, 2017 [72] Taiwan (northern Taiwan)	Military personnel identified during MCD outbreak at military base[2] 23–24 July 2017	n=3 Age: adults	NR	Chemoprophylaxis (type NR) - All contacts Vaccination NR

MCD: meningococcal disease; NR: not reported; USA: United States of America; yrs: years

1 We assumed that all cases were affected by the same serogroup (as mentioned in the report) but the approach of the identification of the serogroup was not clear

2 Based on the setting (e.g. military camp) it was highly likely that all cases were male

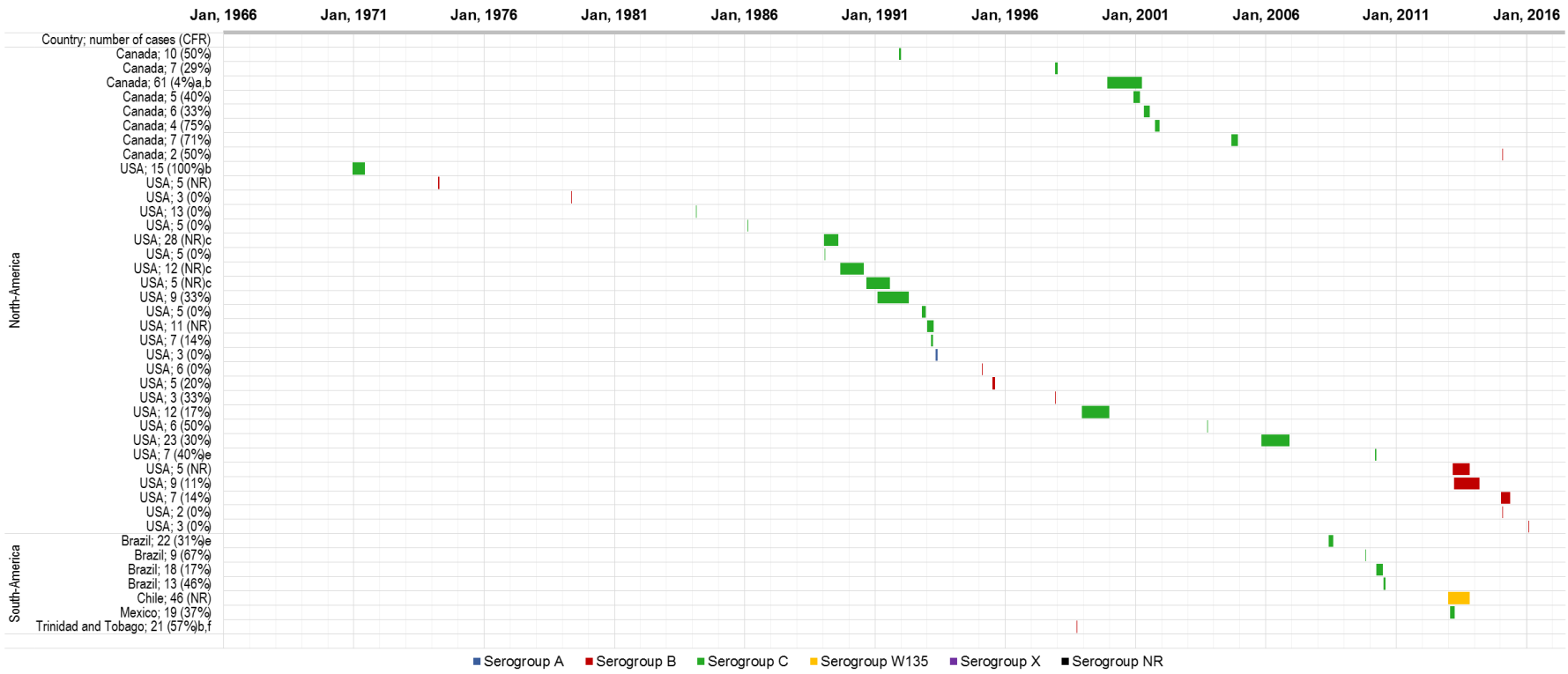
Table S3. CFR rates stratified by WHO region

Region	**CFR range (%)**
Region of the Americas (N=29) [1-6,9-15,17-22,24,25,27-31,67,68,73]	0.0–75.0
European region (N=23) [26,32,34,36-42,44-54,56,71]	0.0–80.0
South-East Asian region (N=3) [57-59]	5.8–14.0
Eastern Mediterranean region (N=1) [62]	14.7
Western Pacific region (N=3) [63,64,66]	0.0–33.3

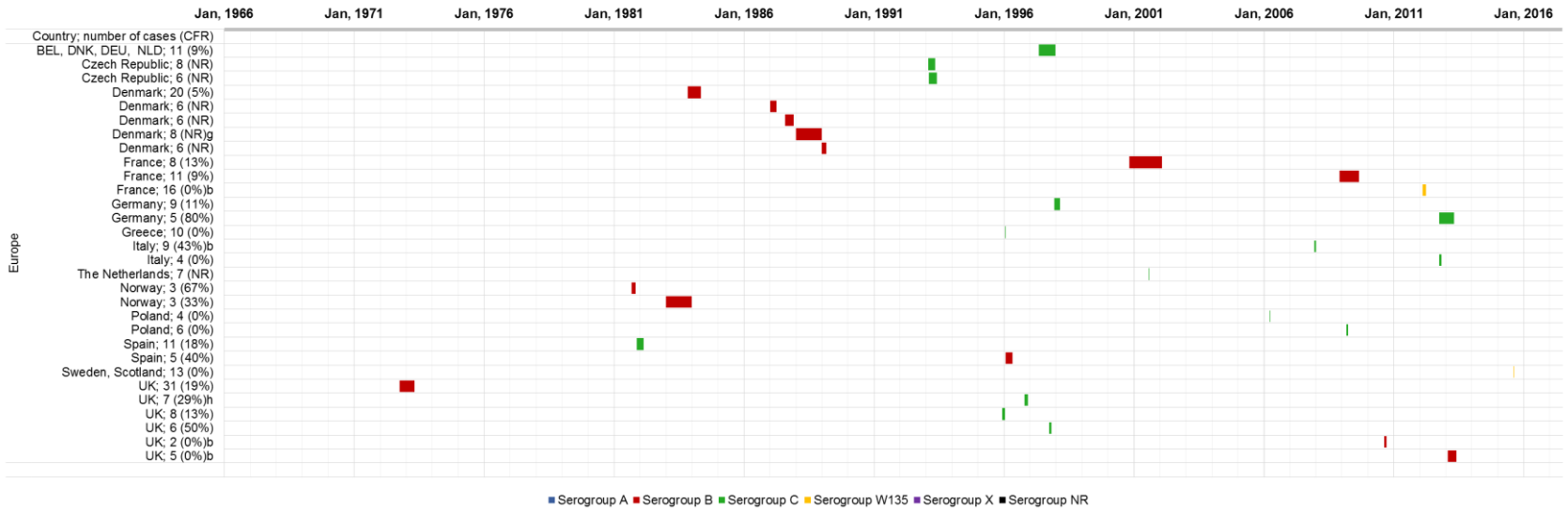
CFR, case fatality rate

Figure S1. Timeline of meningococcal outbreaks in (A) the Americas region (B) the European region (C) the Western Pacific, Eastern Mediterranean, and South-East Asian region

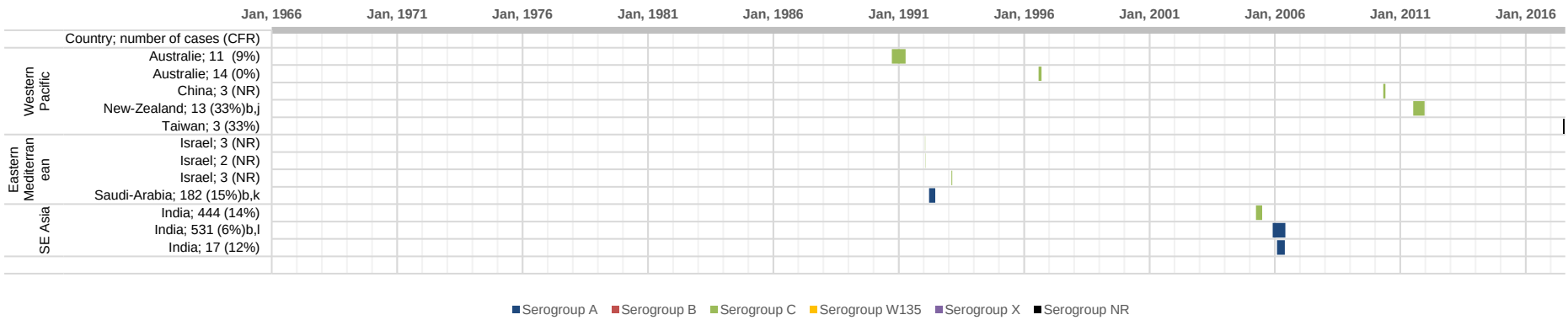
A.



B.


Jan, 1966
Jan, 1971
Jan, 1976
Jan, 1981
Jan, 1986
Jan, 1991
Jan, 1996
Jan, 2001
Jan, 2006
Jan, 2011
Jan, 2016
Country; number of cases (CFR)
Europe
BEL, DNK, DEU, NLD; 11 (9%)
Czech Republic; 8 (NR)
Czech Republic; 6 (NR)
Denmark; 20 (5%)
Denmark; 6 (NR)
Denmark; 6 (NR)
Denmark; 8 (NR)g
Denmark; 6 (NR)
France; 8 (13%)
France; 11 (9%)
France; 16 (0%)b
Germany; 9 (11%)
Germany; 5 (80%)
Greece; 10 (0%)
Italy; 9 (43%)b
Italy; 4 (0%)
The Netherlands; 7 (NR)
Norway; 3 (67%)
Norway; 3 (33%)
Poland; 4 (0%)
Poland; 6 (0%)
Spain; 11 (18%)
Spain; 5 (40%)
Sweden, Scotland; 13 (0%)
UK; 31 (19%)
UK; 7 (29%)h
UK; 8 (13%)
UK; 6 (50%)
UK; 2 (0%)b
UK; 5 (0%)b
Serogroup A
Serogroup B
Serogroup C
Serogroup W135
Serogroup X
Serogroup NR

C.



BEL: Belgium; DEU: Germany; DNK: Denmark; NLD: The Netherlands

a. Of serogrouped isolates 56/57 were serogroup C, 1/57 was serogroup B, CFR calculated over 56 cases with serogroup C; b. Fatal outcome not reported for all outbreak cases, CFR calculated over cases with known fatal outcome; c. Total number of deaths for three outbreaks combined was reported, 9 cases died; d. Of serogrouped isolates 8/11 were serogroup C, 1/11 was serogroup B; e. Mortality reported for laboratory and clinically confirmed cases; f. Of serogrouped isolates 13/14 were serogroup B, 1/14 was serogroup A, CFR calculated over 14 confirmed cases (serogroup B and A); g. Of serogrouped isolates 7/8 were serogroup B, 1/8 was serogroup C; h. Of serogrouped isolates 4/5 were serogroup C, 1/5 was serogroup B; i. Although all 6/6 serogrouped isolates were serogroup A, we want to mention the minimal number of analyses done; j. Of serogrouped isolates 9/13 were serogroup C, 4/13 were serogroup B, CFR calculated over serogroup C cases; k. Mortality reported for confirmed cases; l. Of serogrouped isolates 42/195 were serogroup A, 65/195 had agglutination with combined ACYW135 antigen, CFR calculated for confirmed cases.

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