The Treatment Of Meningitis By Meningococcal Vaccine

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Abstract

Meningitis is an infection of the protective membrane (meninges) that covers the brain and spinal cord. Although it can affect anyone, it is most common in infants, toddlers, teenagers, and young adults. Meningitis can be a very serious condition if not treated quickly, and can lead to life-threatening sepsis and permanent brain and nerve damage.Meningitis symptoms begin suddenly. High fever (fever), nausea, headache, a rash that doesn't go away when you roll glass (but the rash doesn't always occur), stiff neck, aversion to bright lights, drowsiness or lethargy, and seizures. These symptoms can occur in any order. There are several vaccines that provide some protection against meningitis. Although various vaccines against meningococcal disease have been available for over 30 years, currently no vaccine protects against all five pathogenic serotypes. . (**Ferri FF.,2022).**

Introduction

Pharmacological information

Two meningococcal vaccines are available in the United States:

Polysaccharides and Conjugates. Meningococcal polysaccharide vaccine (MPSV) is available worldwide in bivalent (A and C) and tetravalent (A, C, W-135 and Y) formulations, but the tetravalent MPSV4 Menomune-A/C/Y/W-135 (Sanofi Pasteur) is approved in the USA. Menomune contains 50 mcg each of lyophilized powders and unit dosage forms are reconstituted in sterile, pyrogen-free, unpreserved distilled water. Dosing in a multiple dose presentation (**Zahlanie YC et al.,2014).**

Two tetravalent conjugate vaccines are licensed in the United States: Menectra (Sanofi Pasteur) and Membeo (Novartis

Vaccines and Diagnostics). Menectra, licensed in 2005, contains 4 µg each of his 4 serogroups capsular polysaccharide combined with 48 µg diphtheria toxoid. Supplied in single-dose vials and contains no preservatives or excipients. Menveo was approved in 2011 and consists of 10 µg A and 5 µg C, Y, and W-135 oligosaccharides covalently attached to CRM197 protein. The vaccine is supplied in two single-dose vials (A and C-Y-W-135) and contains no preservatives or adjuvants. (**Assaf-Casals A et al.,2016).**

The Advisory Committee on Immunization now provides routine immunizations for people aged 11 to 12 and those at high risk for meningococcal disease, such as college freshmen living in dormitories, military recruits, and people with asplenia. recommended vaccinations. MCV4 He is preferred by individuals aged 11-55. However, MPSV4 is recommended for anyone from her 2 to her 10 and he over 55. In 2009, the National Immunization Survey estimated that his 53.6% of adolescents aged 13 to 17 had received at least one dose of her MCV4 vaccine. (**Mbaeyi SA et al.,2020)**

Medication sources and routes

Sources of drugs

The first vaccine, the meningococcal polysaccharide vaccine (MPSV4), was licensed in 1978. It is made up of antigens contained in the outer polysaccharide or sugar capsule that surrounds the bacterium. A meningococcal conjugate vaccine (MCV4) was approved in 2005. (**Gasparini R et al.,2011).**

Routes of drugs

Administer meningococcal conjugate (MenACWY) and serogroup B meningococcal (MenB) vaccines intramuscularly. The preferred location for infants is the vastus lateralis muscle on the anterolateral thigh. The preferred injection site for older children and adults is the deltoid muscle (**Harrison LH.,2006).**

Injectable Administration

Visually inspect for particulate matter or discoloration before administering parenteral products. After reconstitution, the meningococcal vaccine is clear and colorless.Do not mix meningococcal vaccine with other vaccines or products in the same syringe (**CDC.,2022).**

Subcutaneous Administration

Restoration (Menomune):(Wodi AP et al., 2023)

- Withdraw the supplied diluent (0.6 mL for single-dose vials, 6 mL for multi-dose vials) using a sterile syringe suitable for accurate measurements. Inject the dilution into the vial containing the lyophilized vaccine.

- Rotate the vial until the vaccine is completely dissolved. The resulting solution should be clear and colorless.

- Storage of reconstituted vaccine:

Single dose vial:

Administer immediately after reconstitution.

Multi-dose vials:

Store at 2-8°C (35-46°F) for up to 35 days after reconstitution. Do not freeze.

Subcutaneous injection:

Clean the skin at the injection site with an appropriate cleanser prior to administration. The preferred injection site is the deltoid muscle of the upper arm. Do not inject into areas that have been or will be used for other injections.Remove 0.5 mL of the reconstituted solution from the vial using a sterile syringe and a 23 or 25 gauge (5/8 inch long) needle.Administer 0.5 ml of vaccine by injecting the needle subcutaneously at a 45 degree angle. A separate syringe and needle should be used for each patient. (**Wodi AP et al.,2023)**

DOSAGE & INDICATIONS (Łyczko K et al.,2023)

For prophylaxis of meningococcal infections caused by Neisseria meningitidis serogroups A, C, Y, and W-135.

Subcutaneous administration (Menomune)

Adults, adolescents, children >= 2 years old

The primary immunization consists of a single subcutaneous injection of 0.5 ml. The deltoid region is preferred. A second booster dose can be given in patients at high risk of meningococcal disease.

MAXIMUM DOSAGE (Łyczko K et al.,2023)
Adults

0.5 ml/dose SC.

Geriatric

0.5 ml/dose SC.

Adolescents

0.5 ml/dose SC.

Children

>= 2 years: 0.5 ml/dose SC.
< 2 years: Safety and efficacy have not been established.

Infants

Safety and efficacy have not been established.

Neonates

Safety and efficacy have not been established.

DOSING CONSIDERATIONS

Liver dysfunction

No specific guidelines for dose adjustment in hepatic impairment are available. No dose adjustment appears to be necessary (**Doogue MP et al., 2011).**

Renal dysfunction

No specific guidelines for dose adjustment in renal impairment are available. Dosage adjustment does not appear to be necessary . (**Doogue MP et al.,2011).**

MenACWY Vaccines

MenACWY vaccine (Menactra®, Menveo® [one or two vials], or MenQuadfi®) is given as the first priming dose to adolescents aged 11-12 years. 1 booster at 16 years of age. The minimum interval between doses is at least 8 weeks. Patients aged 2 years or older, in this case, should be given 2 primary series (Menactra®, Menveo® [2-vial formulation only], or MenQuadfi®) at 2-month intervals (**Conti A et al ., 2023**)

• Compensate for component deficiencies

• Use of complement inhibitors (including Soliris® or Ultomiris®)

• Functional or anatomic asplenia

• HIV

The number and schedule of doses for patients under 2 years of age depend on the vaccine product. Please refer to the package insert for specific instructions. For patients at persistently high risk of meningococcal disease, CDC recommends her MenACWY booster dose after completion of the primary series. Patients who received their last dose before age 7 years will receive a booster dose after 3 years. Patients aged 7 years or older who received the last dose will receive a booster dose after 5 years. After that, boosters should be given every 5 years for the rest of your life as long as you remain at high risk for meningococcal disease. (**Conti A et al.,2023)**

MenB Vaccines

Both MenB vaccine products require more than one dose for maximum protection. Patients should receive the same vaccine product at all doses **(Nwogu IB et al., 2021).**

• Vexelo:

® Give 2 doses. The second vaccination should be given at least one month after the first vaccination.

Tormean:

® Give 2 or 3 doses. o Two doses of serogroup B in healthy adolescents who are not at increased risk for meningococcal

disease. The second dose is given to him 6 months after the first.

o He gives 3 doses to her 10+ who are at high risk for meningococcal disease. This also applies during an outbreak of meningococcal disease in serogroup B. The second dose should be given 1-2 months after her first dose. The third dose is given 6 months after the first dose.

For patients at persistently high risk of meningococcal disease, CDC recommends her MenB booster dose after completion of the primary series. One year after the end of the series he gets her MenB booster vaccine every 2-3 years thereafter.

Phases of medication administration

Pharmacological stage

Meningococcal vaccines induce the production of bactericidal antibodies specific for capsular polysaccharides of meningococcal serogroups A, C, Y, and W-135. Bacterial anticapsular antibodies are associated with protection against invasive meningococcal disease (**McCarthy PC et al., 2018).**

Pharmacokinetic stage

Meningococcal polysaccharide vaccine (MPSV4) is administered subcutaneously. Vaccination does not guarantee immunity. During clinical trials, vaccine efficacy was determined by measuring the proportion of patients with a 4-fold or greater increase in antibody concentration from baseline. Twenty-eight days after 1 dose of vaccine in 1098 adults aged 18 to 55 years, 84.6%, 89.7%, 79.4%, and 94.4% had at least a 4-fold increase in antibody titers to N. Meningococci of serogroups A, C, Y and W-135, respectively. We found that seroconversion rates (>= 4-fold increase) were higher in vaccinees with undetectable titers at baseline (that is, <8 at day 0). 99% serogroup A (n=143/144), 98% serogroup C (n=297/304), 97% serogroup Y (n=221/228) and 99% serogroup W-135 (n=325 /328). Vaccine distribution, metabolism, and excretion have not been defined (**Quiambao B et al., 2020).**

Pharmacodynamic phase

Meningococcal (groups A, C, Y, and W-135) The oligosaccharide diphtheria CRM197 conjugate vaccine provides immunity to meningococcal serotypes A, C, Y, and W-135 in vaccinated individuals. enhances response **(Pace D et al., 2007**).

Nervous system

Meningitis In more severe cases, the disease causes hearing and/or speech loss, blindness, permanent brain and nerve damage, behavioral changes, cognitive impairment, lack of muscle control, seizures, and memory loss. It is possible. These people may require long-term treatment, medication, and supportive care. The vaccine consists of a portion of meningococcus that cannot cause infection. After vaccination, the body produces antibodies against meningococcus. These antibodies help protect the body from meningococcal infections (**CDC.,2022**).

DRUG INTERACTIONS

Duclavacitinib:

(Moderate) Vaccine response may be reduced in patients receiving immunosuppressants. If possible, get the indicated vaccines at least 2 weeks before starting immunosuppressants. If vaccination is necessary, revaccination should be considered after immunity has been restored. Patients taking immunosuppressive medications should be consulted regarding the potential for reduced vaccine response, and precautions to avoid exposure should be continued after vaccination.

Ocrelizumab:

(Moderate) If possible, receive all non-live vaccines at least 2 weeks before starting ocrelizumab treatment. Ocrelizumab may affect the efficacy of non-live vaccines. Attenuated antibody responses to tetanus toxoid-containing, pneumococcal polysaccharide, pneumococcal conjugate, and seasonal influenza vaccines have been observed in patients exposed to ocrelizumab at the time of vaccination during open-label trials. Infants born to mothers exposed to ocrelizumab during pregnancy may receive an inactivated vaccine prior to her B-cell recovery as directed. However, consider evaluating the immune response to the vaccine. ACIP recommends that a

patient who has been vaccinated during immunosuppressive therapy or two weeks before her treatment initiation should be considered unvaccinated and should be re-vaccinated at least three months after her cessation of therapy. . Passive immunoprophylaxis with immunoglobulin may be indicated for immunocompromised patients instead of or in addition to vaccination. Ofatumumab:

(Important) Administer all required non-live vaccines at least 2 weeks prior to starting atumumab treatment according to vaccination guidelines. Ofatumumab may interfere with the efficacy of inactivated vaccines due to its effect of causing B cell depletion.

satralizumab:

(Important) Administer all non-live vaccines according to vaccination guidelines at least 2 weeks before starting satralizumab treatment.

Siponimod:

(Moderate) If possible, all non-live vaccines should be given at least 2 weeks before starting treatment with siponimod. Getting the vaccine while being treated with siponimod may make it less effective. Patients should be considered unvaccinated if they have been vaccinated within 14 days prior to initiation of immunosuppressive therapy or during immunosuppressive therapy and, when immunocompetence is restored, at least 3 days after cessation of therapy. should be revaccinated months later. (**Shetty AK et al.,2012).**

ADVERSE REACTIONS (CDC.,2022)
Severe

Guillain-Barre syndrome / Delayed / Incidence not known
angioedema / Rapid / Incidence not known

Moderate

erythema / Early / 5.7-16.0
dyspnea / Early / Incidence not known

Mild

injection site reaction / Rapid / 2.8-48.1
headache / Early / 20.3-41.8
fatigue / Early / 25.1-32.3
malaise / Early / 16.8-22.3
arthralgia / Delayed / 5.3-16.0
diarrhea / Early / 10.2-14.0
irritability / Delayed / 0-12.2
drowsiness / Early / 0-11.2
anorexia / Delayed / 7.7-9.9
chills / Rapid / 3.5-5.6
fever / Early
vomiting / Early
rash / Early
paresthesias / Delayed
asthenia / Delayed
urticaria / Rapid
nausea / Early
dizziness / Early
pruritus / Rapid

PREGNANCY AND LACTATION
Pregnancy

The meningococcal polysaccharide vaccine has been classified as pregnancy risk category C by the FDA. No adequate and well-controlled studies in pregnant women have been conducted, and the ability of vaccines to harm the fetus or affect the reproductive system is unknown.Immunization Advisory Committee According to the ACIP, administration of inactivated vaccines to pregnant women had no adverse effects on the fetus. The ACIP recommends vaccination during pregnancy, when exposure to disease is more likely, infection is more likely to harm the mother or fetus, and vaccines are less likely to harm. recommends vaccination only if the potential benefit to the mother justifies the potential risk to the fetus. (**Etti M et al., 2022**).

Data on the use of the meningococcal polysaccharide vaccine during breastfeeding are limited and excretion into breast milk is unknown. The manufacturer recommends caution when administering to nursing mothers. However, according to the Advisory Committee on Immunization (ACIP), inactivated polysaccharide vaccines pose no risk to mothers or infants. Limited data suggest that breastfeeding may enhance immune responses to specific vaccine antigens. Consider the benefits of

breastfeeding, the risks your infant may be exposed to drugs, and the risks of untreated or undertreated disease. If a breastfed infant experiences side effects related to mother-administered medications, health care providers are encouraged to report the side effects to the FDA. (**Etti M et al.,2022).**

CONTRAINDICATIONS / PRECAUTIONS

Latex hypersensitivity, thimerosal hypersensitivity

Use of the meningococcal polysaccharide vaccine is contraindicated in patients with previous allergic reactions to the vaccine or any of its components. The diluent of the multi-dose formulation contains thimerosal and should not be used by patients with thimerosal hypersensitivity. Patients with latex sensitivity may not be suitable for vaccination. Freeze-dried vaccine vial stoppers contain dried natural rubber, which can cause allergic reactions. When using biological products, prescribing physicians or health care professionals should take precautions to prevent allergic reactions. Healthcare workers should have adrenaline readily available (1:1000) Injections and other means of treating severe anaphylaxis in the event of a severe allergic reaction to vaccines. Before administering any vaccine, healthcare professionals should inform patients, parents, guardians, or responsible adults of the benefits and risks to the patient. This should include providing the manufacturer's vaccine information statement. Patients or responsible adults should report side effects to their physician after administration of the vaccine **(Kimmel SR.,2008).**

Fever, infection

The decision to administer or postpone meningococcal polysaccharide vaccination for current or recent febrile illness depends on the severity of symptoms and disease etiology. The Advisory Committee on Immunization Practices recommends delaying vaccination during the course of moderate or severe acute febrile illness. All vaccines can be given to people with mild illnesses such as diarrhea, mild upper respiratory tract infections with or without low-grade fever, or other mild febrile illnesses. People with moderate or severe febrile illness should be vaccinated as soon as they recover from the acute phase of the illness (**Nguyen N et al.,2023).**

Agammaglobulinemia, corticosteroid therapy, human immunodeficiency virus (HIV) infection, mhypogammaglobulinemia, immunosuppression, neoplastic disease, radiation therapy, severe combined immunodeficiency (SCID)

Patients with severe immunosuppression may not have adequate antibody responses to vaccination. Immunocompromised individuals may include patients with asymptomatic or symptomatic human immunodeficiency virus (HIV) infection. **(Aytekin G et al.,2023).**

Severe Combined Immunodeficiency (SCID); Hypogammaglobulinemia; immune system compromised by , antimetabolites, or radiation therapy. Short-term (<2 weeks) corticosteroid therapy or intra-articular, bursal, or tendon injections of corticosteroids should not be immunosuppressive. Patients who were vaccinated within 2 weeks prior to starting immunosuppressive therapy or during immunosuppressive therapy with the meningococcal polysaccharide vaccine are considered unvaccinated. should be revaccinated at least 3 months after cessation of therapy if immunity is restored. **(Aytekin G et al.,2023).**

Intramuscular administration, intravenous administration

The meningococcal polysaccharide vaccine is only indicated for subcutaneous administration. Do not administer intravenously or intramuscularly.

Children, infants, newborns

The meningococcal polysaccharide vaccine is only licensed for patients 2 years of age and older. Safety and effectiveness in neonates, infants, and children have not been established. 2 years (**Zahlanie YC et al.,2014).**

Guillain-Barre syndrome

Guillain-Barré syndrome has been reported with postmarketing use of the meningococcal polysaccharide vaccine (Menomune), but causality has not been established. The FDA-approved product labels for the meningococcal conjugate vaccines (Menactra and Menveo) contain a warning

about the possible risk of Guillain-Barré syndrome (GBS) after vaccination. (**CDC.,2006)**

Conclusion

Meningococcal disease is one of the leading causes of morbidity and mortality worldwide. This activity will teach you how to treat this disease as a serious problem. It also explains the importance of meningococcal vaccination and how it improves immunological memory, reduces nasopharyngeal carriers (the main cause of meningococcal infections), and leads to herd immunity. To do. Vaccines help prevent meningococcal disease. Meningococcal disease is any type of disease caused by meningococcal bacteria. There are two types of meningococcal vaccines: All children between the ages of 11 and 12 should be vaccinated with MenACWY vaccine. Booster dose at age 16. Adolescents and young adults (ages 16-23) can also receive the MenB vaccine. CDC also recommends meningococcal vaccine for other children and adults at increased risk of meningococcal disease.

References

Assaf-Casals A, Dbaibo G. Meningococcal quadrivalent tetanus toxoid conjugate vaccine (MenACWY-TT, Nimenrix™): A review of its immunogenicity, safety, co-administration, and antibody persistence. Hum Vaccin Immunother. 2016 Jul 2;12(7):1825-37. doi: 10.1080/21645515.2016.1143157. Epub 2016 Feb 22. PMID: 26900984; PMCID: PMC4964831.

Aytekin G, Vaqar S. X-Linked Immunodeficiency. [Updated 2023 Jan 2]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK562182/

CDC. Centers for Disease Control and Prevention (CDC). Update: Guillain-Barré syndrome among recipients of Menactra meningococcal conjugate vaccine--United States, June 2005-September 2006. MMWR Morb Mortal Wkly Rep. 2006 Oct 20;55(41):1120-4. Erratum in: MMWR Morb Mortal Wkly Rep. 2006 Nov 3;55(43):1177. PMID: 17060898.

CDC. Viral meningitis. Centers for Disease Control and Prevention. https://www.cdc.gov/meningitis/viral.html. Accessed Oct. 10, 2022

Conti A, Broglia G, Sacchi C, Risi F, Barone-Adesi F, Panella M. Efficacy and Safety of Quadrivalent Conjugate Meningococcal Vaccines: A Systematic Review and Meta-Analysis. Vaccines (Basel). 2023 Jan 13;11(1):178. doi: 10.3390/vaccines11010178. PMID: 36680022; PMCID: PMC9866575.

Doogue MP, Polasek TM. Drug dosing in renal disease. Clin Biochem Rev. 2011 May;32(2):69-73. PMID: 21611079; PMCID: PMC3100283.

Etti M, Calvert A, Galiza E, Lim S, Khalil A, Le Doare K, Heath PT. Maternal vaccination: a review of current evidence and recommendations. Am J Obstet Gynecol. 2022 Apr;226(4):459-474. doi: 10.1016/j.ajog.2021.10.041. Epub 2021 Nov 11. PMID: 34774821; PMCID: PMC8582099.

Etti M, Calvert A, Galiza E, Lim S, Khalil A, Le Doare K, Heath PT. Maternal vaccination: a review of current evidence and recommendations. Am J Obstet Gynecol. 2022 Apr;226(4):459-474. doi: 10.1016/j.ajog.2021.10.041. Epub 2021 Nov 11. PMID: 34774821; PMCID: PMC8582099.

Ferri FF. Meningitis, bacterial. In: Ferri's Clinical Advisor 2023. Elsevier; 2023. https://www.clinicalkey.com. Accessed Oct. 21, 2022

Gasparini R, Panatto D. Meningococcal glycoconjugate vaccines. Hum Vaccin. 2011 Feb;7(2):170-82. doi: 10.4161/hv.7.2.13717. Epub 2011 Feb 1. PMID: 21178398; PMCID: PMC3166476.

Harrison LH. Prospects for vaccine prevention of meningococcal infection. Clin Microbiol Rev. 2006 Jan;19(1):142-64. doi: 10.1128/CMR.19.1.142-164.2006. PMID: 16418528; PMCID: PMC1360272.

Jakuszko K, Kościelska-Kasprzak K, Żabińska M, Bartoszek D, Poznański P, Rukasz D, Kłak R, Królak-Olejnik B, Krajewska M. Immune Response to Vaccination against COVID-19 in Breastfeeding Health Workers. Vaccines. 2021; 9(6):663. https://doi.org/10.3390/vaccines9060663

Kimmel SR. Using the tetravalent meningococcal polysaccharide-protein conjugate vaccine in the prevention of meningococcal disease. Ther Clin Risk Manag. 2008 Aug;4(4):739-45. doi: 10.2147/tcrm.s962. PMID: 19209256; PMCID: PMC2621387.

Łyczko K, Borger J. Meningococcal Prophylaxis. [Updated 2023 Mar 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK537338/

Mbaeyi SA, Bozio CH, Duffy J, Rubin LG, Hariri S, Stephens DS, MacNeil JR. Meningococcal Vaccination: Recommendations of the Advisory Committee on Immunization Practices, United States, 2020. MMWR Recomm Rep. 2020 Sep 25;69(9):1-41. doi: 10.15585/mmwr.rr6909a1. PMID: 33417592; PMCID: PMC7527029.

McCarthy PC, Sharyan A, Sheikhi Moghaddam L. Meningococcal Vaccines: Current Status and Emerging Strategies. Vaccines. 2018; 6(1):12. https://doi.org/10.3390/vaccines6010012

Nguyen N, Ashong D. Neisseria Meningitidis. [Updated 2022 Sep 26]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK549849/

Nwogu IB, Jones M, Langley T. Economic evaluation of meningococcal serogroup B (MenB) vaccines: A systematic review. Vaccine. 2021 Apr 15;39(16):2201-2213. doi:

10.1016/j.vaccine.2021.02.049. Epub 2021 Mar 18. PMID: 33744052.

Pace D, Pollard A. Meningococcal A, C, Y and W-135 polysaccharide-protein conjugate vaccines. Archives of disease in childhood.2007; 92. 909-15. 10.1136/adc.2006.111500.

Quiambao B, Peyrani P, Li P, Cutler MW, Van Der Wielen M, Perez JL, Webber C. Efficacy and safety of a booster dose of the meningococcal A, C, W, Y-tetanus toxoid conjugate vaccine administered 10 years after primary vaccination and long-term persistence of tetanus toxoid conjugate or polysaccharide vaccine. Hum Vaccin Immunother. 2020 Jun 2;16(6):1272-1279. doi: 10.1080/21645515.2020.1744363. Epub 2020 May 13. PMID: 32401600; PMCID: PMC7482828.

Shetty AK, Winter MA. Immunization of children receiving immunosuppressive therapy for cancer or hematopoietic stem cell transplantation. Ochsner J. 2012 Fall;12(3):228-43. PMID: 23049460; PMCID: PMC3448245.

Wodi AP, Murthy N, McNally V, Cineas S, Ault K. Advisory Committee on Immunization Practices Recommended Immunization Schedule for Children and Adolescents Aged 18 Years or Younger - United States, 2023. MMWR Morb Mortal Wkly Rep. 2023 Feb 10;72(6):137-140. doi: 10.15585/mmwr.mm7206a1. PMID: 36757872; PMCID: PMC9925138.

Zahlanie YC, Hammadi MM, Ghanem ST, Dbaibo GS. Review of meningococcal vaccines with updates on immunization in adults. Hum Vaccin Immunother. 2014;10(4):995-1007. doi: 10.4161/hv.27739. Epub 2014 Feb 5. PMID: 24500529; PMCID: PMC4896590.

Zahlanie YC, Hammadi MM, Ghanem ST, Dbaibo GS. Review of meningococcal vaccines with updates on immunization in adults. Hum Vaccin Immunother. 2014;10(4):995-1007. doi: 10.4161/hv.27739. Epub 2014 Feb 5. PMID: 24500529; PMCID: PMC4896590.