POST-SPLENECTOMY VACCINE PROPHYLAXIS

SUMMARY

The splenectomized patient should be vaccinated to decrease the risk of overwhelming post-splenectomy sepsis (OPSS) by organisms such as *Streptococcus pneumoniae, Haemophilus influenzae* type B, and *Neisseria meningitidis.* Patients should be educated prior to discharge on the risk of OPSS, their immunocompromised state and the need to follow up for booster vaccinations. An understanding of the need for prompt medical attention if fevers or concerning symptoms develop should be instilled in patients to reduce the morbidity and mortality of post-splenectomy infection.

RECOMMENDATIONS

- **Level 1**
  - None
- **Level 2**
  - Non-elective splenectomy patients should be vaccinated at least 14 days post-splenectomy or at time of discharge from the hospital.
  - Asplenic patients should be revaccinated at the appropriate time interval for each vaccine.
  - Patients with <50% splenic mass remaining after injury or embolization should be vaccinated.
- **Level 3**
  - Elective splenectomy patients should be vaccinated at least 14 days prior to the operation.
  - Asplenic or immunocompromised patients (with an intact but nonfunctional spleen) should be vaccinated as soon as the diagnosis is made.
  - When adult vaccination is indicated, the following FIVE vaccinations should be administered:
    - Pneumococcal vaccine naïve: Conjugate pneumococcal vaccine (PCV13) followed by polyvalent pneumococcal vaccine (PPSV23) ≥ 8 weeks later
    - Previous PPSV23 vaccination: PCV13 ≥ 1 year after PPSV23
    - MenACWY (Menactra®), two doses, given at least two months apart
    - MenB-FHbp (three-dose series) at 0, 2, and 6 months OR MenB-04C (two dose series) at least one month apart
    - *Haemophilus influenzae* b vaccine (HibTITER)
  - Pediatric vaccination should be performed according to the recommended pediatric dosage and vaccine types with special consideration made for children less than 2 years of age

Vaccine	Dose	Route*	Revaccination
13-valent pneumococcal (PCV13, Prevnar 13)	0.5 mL	IM	None
23-valent pneumococcal (PPSV23, Pneumovax® 23)	0.5 mL	IM or SC	Once at 5 yrs
Meningococcal/diphtheria conjugate (MenACWY, Menactra®)	0.5 mL	IM	At 2 months & every 5 yrs
Serogroup B meningococcal (MenB-FHbp, Trumenba™)	0.5 mL	IM	At 2 and 6 mo
Serogroup B meningococcal (MenB-4C, Bexsero®)	0.5 mL	IM	Once at ≥1 mo
Haemophilus b conjugate	0.5 mL	IM	None
Influenza	0.5 ml	IM	One dose annually

EVIDENCE DEFINITIONS

- **Class I:** Prospective randomized controlled trial.
- **Class II:** Prospective clinical study or retrospective analysis of reliable data. Includes observational, cohort, prevalence, or case control studies.
- **Class III:** Retrospective study. Includes database or registry reviews, large series of case reports, expert opinion.
- **Technology assessment:** A technology study which does not lend itself to classification in the above-mentioned format. Devices are evaluated in terms of their accuracy, reliability, therapeutic potential, or cost effectiveness.

LEVEL OF RECOMMENDATION DEFINITIONS

- **Level 1:** Convincingly justifiable based on available scientific information alone. Usually based on Class I data or strong Class II evidence if randomized testing is inappropriate. Conversely, low quality or contradictory Class I data may be insufficient to support a Level I recommendation.
- **Level 2:** Reasonably justifiable based on available scientific evidence and strongly supported by expert opinion. Usually supported by Class II data or a preponderance of Class III evidence.
- **Level 3:** Supported by available data, but scientific evidence is lacking. Generally supported by Class III data. Useful for educational purposes and in guiding future clinical research.

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INTRODUCTION

Blunt abdominal trauma commonly injures the spleen resulting in either irreparable parenchymal disruption (necessitating removal of the injured organ) or devascularization of varying degrees. Non-operative management may avoid splenectomy, but can also result in functional asplenia if the devascularization is extensive. Splenic injury can also be managed by splenic embolization. Elective splenectomy may be indicated for specific primary disease of the spleen or symptomatic splenomegaly.

Loss of functional splenic tissue places such individuals at high risk for infection by encapsulated organisms such as *Haemophilus influenzae* type b, *Neisseria meningitidis* and *Streptococcus pneumoniae.* Although the risk of fulminant septicemia or meningitis as a result of infection by such organisms appears to be less in the adult population (by virtue of prior exposure to these bacteria), overwhelming post-splenectomy sepsis (OPSS) remains a significant concern in the asplenic patient (1).

The incidence of OPSS is estimated to occur in 0.05% to 2% of splenectomized patients (2). It may develop immediately or as late as 65 years post-splenectomy (2-4). Although most OPSI occurs the first two years after splenectomy. Mortality is significant and reported to be as high as 50% (4,5). OPSS incidence reduction is dependent upon education of both the patient and physician as to the risks, prevention and rapid recognition of the asplenic individual when infection may be present (2,5-7).

Reduced post-splenectomy levels of opsonins, splenic tuftsin, and immunoglobulin (IgM) (which promote phagocytosis of particulate matter and bacteria), hinder the body's ability to clear encapsulated organisms (4,6,7). Vaccination, to impart immunity against such infections, is commonly performed despite the absence of Class I or Class II data to support its efficacy. As 50 to 90% of OPSS infections are secondary to *Streptococcus pneumoniae* infection, the polyvalent pneumococcal vaccine has been the most commonly administered post-splenectomy vaccine. In recent years, the meningococcal and *Haemophilus influenzae* type b vaccines have also been advocated (2-17).

Timing of vaccine administration following splenectomy has been a topic of longstanding debate. Two major concerns include the patients' immunogenicity in the perioperative period and the impaired immune function of the critically ill (2,13,16,17). The patient's present state of health should be considered prior to the administration of post-splenectomy vaccines. In patients with moderate to severe acute illness, vaccination should be delayed until the illness has resolved. This minimizes adverse effects of the vaccine which could be more severe in the presence of illness or could confuse the patient's clinical picture (such as a post-vaccine fever) (16).

With the increase use of splenic emobilization to manage splenic injuries nonoperatively, there has been growing interest in which patients need vaccinations and has enough preserved splenic parenchyma to not require vaccination. The Advisory Committee on Immunization Practices (ACIP) recommend that asplenic patients with 50% or more of the splenic mass lost should be treated as if they are asplenic and receive vaccinations (18).

There are two pneumococcal vaccines currently approved for use in adult patients. PPSV23 is a polyvalent vaccine of purified capsular polysaccharides from 23 strains of *Streptococcus pneumoniae* (19). PCV13 is composed of capsular antigen polysaccharides from 13 *S. pneumoniae* serotypes linked to a non-toxic diphtheria protein (20). Current ACIP recommendations are that asplenic patients receive PCV13 during their next pneumococcal vaccination opportunity. Patients given PCV13 have demonstrated comparable or greater mean antibody titers compared to patients who received PPSV23 in two randomized, multicenter immunogenicity studies. In addition, patients who received PPSV23 prior to PCV13 had lower opsonophagocytic antibody response compared to those who received PCV13 as the initial dose (21).

In light of two recent serogroup B meningococcal (MenB) disease outbreaks on college campuses in 2013, the FDA granted Breakthrough Therapy designations to two MenB vaccines, MenB-FHbp (Trumenba™) and MenB-4C (Bexsero®). Both were approved for ages 10-25 years and are recommended by the ACIP for prevention of serogroup B meningococcal disesase in all asplenic patients ≥10 years (22). The MenB-FHbp vaccine composed of two recombinant factor H binding proteins from *N. meningitides* serogroup B. It is administered as a three dose series at 0, 2, and 6 months (23). MenB-4C is composed of three

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recombinant proteins and outer membrane vesicles. It is administered as a two dose series given at least one month apart (23). Due to the low incidence of serogroup B meningococcal disease, the efficacy of both vaccines was evaluated in immunogenicity studies and determined based on the proportion of patients who achieved ≥4-fold increase in complement activity against serogroup B strains (22).

All of the vaccines can cause adverse reactions which are generally self-limiting and resolve 24-72 hours after vaccine administration. Both pneumococcal vaccines may cause a transient and self-limited fever in up to 5% of vaccinated patients, as well as pain and redness at the site for 1-2 days. A hypersensitivity reaction can occur at the injection site of the *Haemophilus influenzae* type b vaccine along with occasional fever, aches, and malaise. The meningococcal vaccines can all cause headaches, fatigue, malaise and injection site reactions.

Another important aspect to consider when managing patients post splenectomy or with evidence of asplenia is long term follow up and need for revaccination. Several studies have shown that patients have poor information recall on inpatient vaccination and low revaccination rates (24). At the end of this guideline is a sample form for patients and clinicians to monitor vaccination and revaccination status.

LITERATURE REVIEW

Two Class I studies have demonstrated that the polyvalent pneumococcal vaccine results in the highest antibody titers, for the most common serotypes, when administered at least 14 days post-splenectomy (16,17). These prospective, randomized trials evaluated the efficacy of the vaccine when administered at 1, 7, 14, and 28 days post-splenectomy. As these trials were designed to demonstrate the immunogenicity of the vaccines and not the prevention of OPSS, they can only be used to advocate *timing* of vaccination.

In 2004, Landgren et al. published a prospective study on antibody response to repeated vaccination. This study included 28 (out of 311) post-trauma splenectomized patients. Their results showed that time between splenectomy and first pneumococcal vaccine was not associated with pre-vaccination, peak or follow-up antibody levels. 25 of the 28 trauma patients received their first vaccine post-splenectomy. A major limitation of this study is that the time from splenectomy to first vaccine was only documented in 24% of the cases, yet they claimed that timing had no effect (25-26). Similarly, Grimfors et al. conducted a longitudinal study of 173 patients (33 trauma) for three years. Pneumococcal antibody responses declined to pre-treatment values at three years in all groups. They also found no correlation between the interval from splenectomy to vaccination and response to vaccination. The data to support this conclusion was not published (27).

Schreiber et al. published a study in rats in 1998 looking at timing of vaccination and the rats subsequent ability to survive pneumococcal challenge. There was no difference between the groups of rats if they were vaccinated on post-operative day 1, 7, or 42 and their ability to survive a pneumococcal challenge (26). In another study, Werner et al. looked at the effect of perioperative hypovolemic shock and response to vaccination and found no difference if the splenectomized rats were vaccinated on post-operative day 1, 7, or #28. Both of these studies raise the question of whether delaying vaccination for fourteen days as suggested in the Shatz et al. studies is necessary (29). Further human studies are needed to address timing of post-splenectomy vaccines.

Class II data supports the vaccination of asplenic patients based on studies of the spleen's role in immune function and its ability to provide defense against encapsulated organisms (5). Current Center for Disease Control (CDC) recommendations for post-splenectomy vaccinations include PCV13 followed by PPSV23, the meningococcal MenACWY and either MenB-FHbp or MenB-4C, and the *Haemophilus influenzae* type b vaccine (HibTITER) (12-14,26-3)7. All four of the initial vaccines may be administered simultaneously (15,22).

The ACIP suggests patients with <50% splenic function should be vaccinated to prevent OPSS. However, how to manage patients who undergo splenic arterial embolization (SAE) is not well known. For SAE, patients can have a partial or total embolization depending upon the degree of injury. Often, the practice of clinicians who to vaccinate those who had total SAE only. A systematic review from the Netherlands by Schimmer et al, found that 11 out of 12 studies evaluating the long-term effects of SAE found that there

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was preserved splenic function (38). However, there is not one specific test available which can demonstrate if splenic function is preserved.

Foley et al, published a study examining the differences in IgM Memory B cells after splenectomy, distal SAE and proximal SAE. This study found no difference in IgM Memory B cell production between distal vs proximal SAE but did find after SAE there is a larger amount of Ig Memory B cells presents compared to splenectomy. (39)

Revaccinations needs have been established by Class II studies of immune antibody levels and efficacy after initial vaccination (3). Patients receiving PPSV23 should be revaccinated 5 years later (31). Based on the current literature, patients who receive the MenACWY polysaccharide diphtheria toxoid conjugate vaccine (Menactra®) should be revaccinated every 5 years. However, long-term studies with Menactra® are currently on-going which may change this recommendation in the future. The *Haemophilus influenzae* type b vaccine does not require revaccination (12-14).

There is no Class I data identifying the appropriate timing for pre-splenectomy Haemophilus, Pneumococcal or Meningococcal vaccination for patients with nonfunctional or diseased spleens. Vaccination two weeks prior to surgery is commonly practiced, but this is supported only by Class III data (16,17). Pre-splenectomy vaccination has been demonstrated to induce antibody formation in both adults and children (24). The types of antibody produced and time to antibody formation (generally 1 to 4 weeks) does vary from patient to patient. (24-26). The antibody titer required to prevent either pneumococcal carriage or disease is unknown and has been extrapolated from data obtained from the literature on *Haemophilus influenzae* titers (27). In the elective splenectomy patient, therefore, vaccination as soon as splenic disease is diagnosed appears prudent to allow time for antibody production (13). The CDC has outlined recommendations for both initial vaccination in the pediatric population as well as booster (revaccination) requirements in patients with an anatomically present, but non-functional spleen (35).

The CDC recommends that asplenic travelers contact an international health clinic or the CDC (www.cdc.gov) to obtain information on disease risks within the intended country of travel. Asplenic travelers should be advised of the increased risk for Meningococcal meningitis and recommendation of the A and C vaccine for all asplenic individuals traveling to sub-Saharan Africa, India, and Nepal.

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POST-SPLENECTOMY PATIENT INFORMATION SHEET

Name: _____

Splenectomy (splee-nek-tuh-mee) is the name of the operation that was done to remove your spleen. The spleen is a fist-sized organ located in the upper left side of your abdomen (belly). The spleen helps you fight infections, get rid of old or damaged red blood cells, and store blood for your body. Because of either disease or damage to your spleen, it had to be removed. You can live without a spleen, but you may be at a higher risk for certain types of blood infection. To help you fight these infections in the future, you have been given the following immunizations (shots):

Vaccine	Initial Date Given	Repeat Doses	Next Due Date
13-valent pneumococcal vaccine (Prevnar 13)			
23-valent pneumococcal vaccine (Pneumovax® 23)	≥8 weeks after Prevnar 13	Yes, once 5 years after initial dose	
Meningococcal polysaccharide/diphtheria toxoid conjugate vaccine (Menactra®)*		Yes, ≥2 months after initial and every 5 years	
Meningococcal serogroup B (Bexsero® or Trumenba™)*		Yes, timing and number based on vaccine given	
Haemophilus influenza type B (HibTITER)			
Influenza		Yes, annually	

*For Meningococcal vaccination it is either or and not both

It is important that you go and see a doctor IMMEDIATELY if you have any of the following symptoms:

- Fever
- Chills
- Abdominal pain
- Skin rash, swelling, redness, or infection
- Diarrhea
- Achy or weak feeling
- Cough
- Vomiting

These are signs that you may have an infection. Without your spleen, a small or minor infection may become very serious and your doctor needs to examine you and possibly start antibiotics to help your body fight the infection. Always check with your doctor before any dental or invasive procedures, as you may need to take antibiotics before the procedure.

The effect of the vaccines in preventing infection varies from patient to patient and depends on the strength of your immune system when the vaccines were given. You will need to be re-immunized (have the shots again) approximately every 5 years for the rest of your life. You should make sure that your doctor has a copy of this information sheet so that they can help remind you when it is time to be re-immunized.

If you or your doctor has questions about the above information, please contact your surgeon:

Surgeon's Name: _____

Surgeon's Phone Number: _____