INCREASING PNEUMOCOCCAL VACCINATION FOR PATIENTS WITH LUNG CANCER

by

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Abstract

Pneumococcal vaccinations are recommended for patients with lung cancer either before or during treatment to prevent pneumonia. During oncology care, infectious complications contribute to treatment interruptions, poor outcomes, and increased hospitalizations and healthcare expenditures. Pneumococcal vaccination rates remain well below the benchmarks set by *Healthy People 2020* despite support from the Centers for Disease Control and Prevention (CDC) and the National Comprehensive Cancer Network (NCCN). A quality improvement (QI) project was implemented within a thoracic medical oncology practice utilizing the *4Pillars™ Practice Transformation Program* to increase both the frequency of immunization assessment and the pneumococcal vaccination rate. Intervention implementation and prospective data collection occurred over an 8-week timeframe applying the Plan-Do-Study-Act (PDSA) model and the Diffusion of Innovations (DOI) theoretical framework. Thoracic oncologists were given educational resources on pneumococcal vaccinations and the electronic medical record’s (EMR) immunization workflow. Informational posters were displayed at the check-in desk and clinic rooms for patients to read. An EMR alert was proposed by this author and denied by the information technology (IT) staff; without an alert to prompt immunization assessment during clinic visits, the onus was on the oncologists or patients to initiate discussion about pneumococcal vaccinations. Despite the educational resources and reminders, there was no appreciable increase in vaccination rates during the brief QI project. Some providers noted improved awareness of the EMR immunization workflow, however, sustained behavior change takes time and requires ongoing support and reinforcement. Likewise, implementing an EMR alert during oncology visits would ensure consistent vaccination assessment and immunization.

*Keywords: lung cancer, pneumococcal vaccination, pneumonia, quality improvement*
Increasing Pneumococcal Vaccination for Patients with Lung Cancer

Patients with lung cancer are vulnerable to infectious diseases such as pneumonia. Pneumococcal disease is a substantial cause of morbidity and mortality worldwide, with vaccination being the only effective intervention to reduce the rate of infection (Chiou, Hung, Lai, Lin, Su, Chen…Li, 2015). Due to risk factors such as immune compromise and smoking, patients with cancer can be 20 times as likely to contract an invasive pneumococcal disease (IPD) or community-acquired pneumonia (CAP) when compared with their healthy peers (Chiou et al., 2015). A diagnosis of pneumonia will delay or interrupt cancer treatment and contribute to the high mortality rate among patients with lung cancer. The safety and efficacy of administering pneumococcal vaccinations to patients with compromised immune systems have been well established and endorsed by the Centers for Disease Control and Prevention (CDC) and National Comprehensive Cancer Network (NCCN) for many years. However, a study by Hayes et al. (2017) of pneumonia associated hospitalizations in the United States showed an increasing number of admissions for immunocompromised persons diagnosed with pneumonia from 18.7% in 2001 to 29.9% in 2014. Regardless of the proven benefits, a significant percentage of eligible patients go unvaccinated. Oncology practices must incorporate processes within the providers’ workflow to ensure patients receive the necessary immunizations to safeguard them from IPD and CAP. The purpose of this quality improvement (QI) project was to test if providing educational resources on pneumococcal immunization, utilizing a standing order set for vaccinations, and implementing an electronic medical record (EMR) alert for immunization assessment would increase the frequency of pneumococcal vaccination within a thoracic medical oncology practice over a 2-month period.
In 2012, the Advisory Committee on Immunization Practices (ACIP), a group within the CDC, recommended that all immunocompromised patients naïve to the pneumococcal vaccine receive the 13-valent pneumococcal conjugate vaccine (PCV13) first, followed by a dose of 23-valent pneumococcal polysaccharide vaccine (PPSV23) 8 weeks later; after five years, patients should receive a second dose of PPSV23 (CDC, 2012). Despite the recommendations, vaccination rates in 2015 for immunocompromised patients remained well below the benchmarks set by Healthy People 2020 at 23% (Williams, Lu, O’Hollaran, Kim, Grohskopf, Pilishvili…Fiebelkorn, 2017). The objectives for Healthy People 2020 call for an increase in pneumococcal vaccination rates to 60% of at-risk persons aged 18-64 and 90% for adults aged 65 and older (ODPHP, 2018: Williams, et al., 2017). Evidenced-based strategies to increase vaccination rates for patients have been described in the literature and by various healthcare authorities. The Community Preventative Services Task Force (CPSTF) is a nonfederal independent panel of public health and disease prevention experts who concluded that implementing standing order sets for immunization assessment and vaccination administration successfully improved vaccination rates by up to 29% (CPSTF, 2016a). Likewise, monitoring providers’ adherence to vaccination protocols and providing performance feedback was also useful and showed an increase in vaccination rates up to 18% (CPSTF, 2016b). The CPSTF concluded that both interventions have merit within multiple healthcare settings when used alone or in conjunction with other strategies.

This paper describes a QI project completed within a medical oncology practice at an academic medical center aimed at increasing the frequency in which thoracic medical oncology providers assess patients for vaccination needs and prescribe PCV13 and PPSV23 vaccinations when indicated. Similar initiatives have been described in the literature. During cancer treatment,
patients are seen frequently by their oncology team, thus providing multiple opportunities to vaccinate patients against preventable diseases. While primary care offices typically offer preventative care services, oncology practices are assuming this responsibility more and more to safeguard their patients from infections such as pneumonia, influenza, and shingles. Delacruz et al. (2017) describe a QI project within a military-based medical oncology practice to add pneumococcal vaccination assessment and administration as a standard of care practice via provider education and creation of a standing order set. The new process mandated that both physicians and advanced practice providers (APPs) assess patients’ vaccination needs during the first appointment. By implementing a standing order, clinic nurses could administer a pneumococcal vaccination without a physician’s prescription. The project was successful in increasing compliance with the standard of care for pneumococcal vaccination from 6.3% to 50% (Delacruz et al., 2017).

**Problem Description**

At the project site, a random chart audit was performed on 50 patients undergoing treatment or active surveillance for lung cancer to review the frequency of immunization assessment and pneumococcal vaccination at any point in their care. The selected site is an academic medical center accredited by the National Cancer Institute (NCI) and National Comprehensive Cancer Network (NCCN) located in a major United States’ city. Using the EMR, office notes and telephone encounters by thoracic medical oncology providers, medical history lists, medication lists, and the immunization tab were reviewed. All patients included in the audit received care by the thoracic medical oncology practice between 2015-2018. The baseline data revealed that immunization assessments were not routinely performed. Therefore, vaccinations were not provided through the medical oncology practice. One vaccination assessment was
documented, and the patient was referred to their primary care provider (PCP) to receive influenza and pneumococcal vaccinations. Seventeen patients developed pneumonia while receiving cancer care, for which the oncology providers prescribed the diagnostic testing and antibiotics. Ten patients received one or more pneumococcal immunizations through their PCP office, three patients received the vaccine during a hospital admission, and two patients refused to be vaccinated when offered by their PCP. Many patients see PCPs outside of the health system; therefore, some immunization documentation was not available for review. Of note, all but four patients had significant smoking histories ranging from 6-50 pack-years; nine patients were current smokers.

The chart audit identified an opportunity to increase the frequency of immunization assessment as well as pneumococcal vaccine administration for the thoracic oncology patients. A pneumonia diagnosis was noted in 37% of the patients under treatment. The observed practice gap led to a QI initiative for the selected site’s thoracic medical oncology group to routinely assess patients for and prescribe PCV13 and PPSV23 to protect patients from developing pneumonia. As part of a Doctor of Nursing Practice (DNP) capstone, this author led a QI project to increase the frequency in which providers assessed for and prescribed pneumococcal vaccinations to their patients with lung cancer. The project interventions included providing educational materials on current vaccination recommendations from the CDC and NCCN, providing tip sheets on vaccination guidelines and in-person demonstration on EMR immunization documentation to the APPs, and displaying educational posters within the clinic space for patients and families to read. The goal was to incorporate immunization assessment and pneumococcal vaccination administration as a consistent part of the providers’ workflow.

**Available Knowledge**
The current literature was reviewed concerning pneumococcal vaccinations, pneumonia burden on lung cancer patients, immunizing cancer patients, improving vaccination rates, and nurse-driven quality improvement projects. Databases searched included CINNAHL, Google, Google Scholar, and health system’s biomedical library. Keywords and phrases searched included lung cancer + vaccinations, pneumonia + lung cancer, immunizing lung cancer patients, pneumococcal vaccine standing orders, quality improvement + oncology nurse, evidenced-based guidelines + vaccination, and immunization guidelines + lung cancer. Additionally, websites for the Centers for Disease Control and Prevention (CDC), National Comprehensive Cancer Network (NCCN), World Health Organization (WHO), the Community Preventative Services Task Force (CPSTF), Immunization Action Coalition (IAC), and Healthy People 2020 were also reviewed for current evidence-based recommendations and national data.

Approximately 50 articles were located collectively about pneumococcal vaccinations, the prevalence of pneumonia among immunocompromised patients, improving the frequency of pneumococcal vaccinations, the benefits of vaccinations, and the efficacy of the 4Pillars™ Transformation Program. Articles published before 2015 were excluded, with few exceptions. The reference list includes 29 articles, 14 websites from healthcare authorities, and one reference for the 4Pillars™ toolkit website.

The literature and guidelines identified were overwhelmingly supportive of vaccinating patients with lung cancer against pneumonia before or during anti-cancer treatment. Research opposing immunizations for oncology patients was not found during the extensive search. Articles were located on how to improve vaccination rates, the incidence of pneumonia in older adults and lung cancer patients, the use of EMRs and standing order sets to improve vaccination rates, and the financial implications of preventing pneumonia in older adults. Routine
immunization assessment and administration of pneumococcal vaccinations, when indicated, are the most clinically and financially effective strategies to prevent pneumonia and improve patient outcomes.

In the United States, lung cancer is the second most prevalent malignancy in both women and men, as well as the leading cause of cancer death (CDC, 2019). Approximately 200,000 people are diagnosed with lung cancer, and an estimated 150,000 people will die of lung cancer annually (CDC, 2018a). Smoking is responsible for up to 80% of lung cancer cases (CDC, 2018a). Patients undergoing anti-cancer treatment are at a 40-50-fold increased risk of acquiring IPD with mortality rates close to 35% (Shah & Kamboj, 2018). Risk factors for CAP include smoking cigarettes or cigars, receiving chemotherapy or steroids, obstruction of a bronchus (i.e. tumor), and chronic obstructive pulmonary disease (Franco, 2017). Streptococcus pneumonia causes more deaths compared with other vaccine-preventable diseases, particularly among older adults with chronic illnesses (Tuberville, Conner, Johnson, & McGough, 2018). A study by Di Pasquale et al. (2018), revealed the most common risk factors associated with pneumococcal pneumonia include advanced age and immune compromise related to chronic steroid use and chemotherapy. Approximately 17-37% of all IPD cases are attributable to immunocompromised patients (Lee et al., 2018). According to Liu et al. (2017), postoperative pneumonia (POP) is a common complication of cancer-related thoracic surgery and linked to higher mortality rates. Immunocompromised patients are 20 times as likely to develop pneumonia; approximately 72% of cancer-related pneumonia cases are caused by the serotypes covered by PPSV23 (Chiou et al., 2015).

Symptoms of pneumonia can escalate quickly; common symptoms include fever, shortness of breath, and cough (Franco, 2017). Unplanned hospital admissions among patients
with lung cancer are most frequently attributable to respiratory complaints followed by pain, infection, and generalized weakness (Cuppens et al., 2016). According to a retrospective study on cancer patients’ emergency department (ED) visits, lung cancer, respiratory distress, and non-white race were independent predictors of hospital admission and increased mortality (Elsayem et al., 2016). Pneumonia associated hospital admissions for patients with compromised immune systems nearly doubled from 2001 to 2014, possibly due to improved long-term survival of this patient population (Hayes et al., 2017). A nationwide population-based cohort study in Taiwan followed 157 newly diagnosed lung cancer patients aged 75 or more for four years and found that patients who received PPSV23 were less likely to be admitted for CAP and had improved survival rates (Chiou et al., 2015).

Oncology care is complex and continually evolving. The cost of care is rising as new treatment regimens are developed, both because treatments are costly, and patients are living longer, thus requiring long term management. In the United States, oncology care cost an estimated $104 billion in 2006 and will increase to about $173 billion in 2020 (Elsayem et al., 2016). The Centers for Medicare and Medicaid Services (CMS) developed an Oncology Care Model (OCM) of payment which incentivizes oncology providers to improve quality of cancer care in cost-conscious ways whereby providers omit services that do not improve patient outcomes and prioritize services which add value (Kline et al., 2015). The pilot for this new model demonstrated a cost savings of 30% while simultaneously improving the coordination and delivery of care. Incorporating routine immunization assessments and vaccination administration aligns well with the OCM payment structure and may be included as part of the criteria in the future.
According to the World Health Organization (WHO), immunizing patients against preventable infectious diseases is one of the most significant public health interventions of our time that has saved millions of lives (WHO, 2018). Vaccinating lung cancer patients before initiating treatment is a cost-effective method of preventing pneumonia during and after treatment. The Advisory Committee on Immunization Practices (ACIP) initially recommended pneumococcal vaccinations for patients 19 years and older with immunocompromising diagnoses, asplenia, cerebrospinal fluid (CSF) leaks, or cochlear implants on June 20, 2012 (CDC, 2012). Numerous studies were conducted on the safety and efficacy of pneumococcal vaccinations in both immunocompetent and immunocompromised persons of various ages. The ACIP concluded the benefits of immunization outweigh the potential harms and provided specific recommendations based on age and health status. Immunocompromised individuals naïve to the pneumococcal vaccine are recommended to have PCV13 first followed by a dose of PPSV23 8 weeks later and then a second dose of PPSV23 5 years later. Patients newly diagnosed with an immunocompromising condition who have received PPSV23 previously should be immunized with PCV13 at least one year or more from the last PPSV23 dose. The use of both vaccinations is recommended to provide widespread protection from many pneumonia serotypes (CDC, 2012). Whenever possible, vaccines should be given before surgery or anti-cancer treatment; PCV13 and PPSV23 should never be administered at the same time (CDC, 2016a). Patients over the age of 65 only require one dose of PPSV23 (CDC, 2016a). The National Comprehensive Cancer Network (NCCN) endorses the use of PCV13 and PPSV23 following the CDC and ACIP guidelines and includes the recommendations as part of preventing cancer-related infections (NCCN, 2018). The CDC performed a cost-benefit analysis of PCV13 and PPSV23 by following groups of patients over one year; it concluded that the cost of the vaccines
and administration led to a cost savings of over $7 million and added over 1,300 quality-adjusted life years in addition to preventing 57 cases of pneumonia in vulnerable populations (CDC, 2012).

The literature on the importance of vaccinating oncology patients, as well as the various QI strategies for implementing immunization guidelines, are abundant. Barriers to increasing rates of pneumococcal vaccinations among all adults, not just oncology patients, include lack of education on the guidelines, fears about the safety of vaccinations, and limited access to immunizations (Tuberville et al., 2018). Disseminating information on the guidelines and encouraging physicians to discuss the efficacy of vaccines with patients has been shown to increase immunization rates. However, the results are not sustainable without consistent reminders (Alkan et al., 2017; Toleman et al., 2016). The importance of utilizing the EMR and reminder alerts to prompt clinicians to assess immunization history and order the vaccines when appropriate is noted in the literature also. Shah and Kamboj (2018) advocate for nurse-driven assessments and EMR logic tools to provide necessary vaccinations to patients. Arzt (2016) posits that decision support technology is vital to improving vaccination rates by aiding providers in the timely prescribing of correct immunizations; built-in EMR tools are helpful in housing the most current vaccination schedules for clinicians to use. Every patient encounter presents an opportunity to vaccinate patients, and EMR prompts to assess immunization needs must be integrated into the workflow to assure all patients will benefit.

Nurses are leaders in the oncology ambulatory care setting. Nurse practitioners and clinic nurses are trusted care providers who assist patients in decision making. Patients look to nurses for education, advocacy, and support in shared decision making (Tariman et al., 2016). Likewise, nurses are integral in implementing evidence-based practice initiatives to drive quality in direct
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patient care settings. The 4Pillars™ Practice Transformation Program depends on nurses and other medical staff to improve immunization rates in various clinical settings. Nowalk et al. (2014) developed a toolkit of strategies for outpatient practices to increase adult vaccination rates. Pillar one improves access to immunizations, pillar two involves educating staff and patients about vaccinations, pillar three focuses on incorporating immunization assessment and vaccine administration into a standard of care practice, and the fourth pillar provides motivation and feedback to the practice staff (Nowalk et al., 2014). The 4Pillars™ program has been tested and proved successful in multiple clinical settings for increasing rates of pneumococcal, influenza, and Tdap vaccinations for adults (Lin et al., 2016; Nowalk et al., 2014; Nowalk et al., 2016; Zimmerman et al., 2017). Each pilot to test the program utilized standing order sets for nurses and APPs to access and vaccinate patients appropriately. Doctor's orders were not needed to provide vaccinations. Each practice setting had a designated vaccine champion; most often, the champion was a nurse practitioner or clinic nurse. The authors noted marked improvements in vaccination rates in each pilot and stressed that practices that used interventions from each pillar were the most successful. The program was favorable from a monetary standpoint. Wateska et al. (2018) performed a cost-benefit analysis on the 4Pillars™ toolkit to evaluate the financial impact when utilized for increasing vaccination rates among high-risk adults. The authors concluded the program was beneficial over a 10-period, noting that the program cost the clinic $31.15 less than no program while significantly decreasing the incidence of pneumonia, influenza, and pertussis. The toolkit was successful when used in outpatient clinics caring for chronically ill patients, for this subset of patients were more likely to access health care services regularly.

Rationale
The Diffusion of Innovation (DOI) theoretical framework was used for this QI project. First described in 1962 by Everett M Rogers, DOI theory involves the process of disseminating new ideas and knowledge to elicit behavior change in many social contexts (Kreps, 2017). The method has been applied in many fields, such as education, sales, public policy, and health care. Diffusion, as described by Kreps (2017), is the communicative process used by various social groups, such as health care professionals, to promote progress in their respective fields. The DOI framework successfully guides the adoption of new behaviors and processes, particularly in health education and health promotion efforts. The 4Pillars™ Transformation Program pairs well with DOI theory, as each pillar offers interventions to change the behaviors of healthcare providers and educate both providers and patients to increase vaccination rates. Nowalk et al. (2016) successfully used DOI theory with the 4Pillars™ to increase Tdap immunizations in multiple primary care offices. Likewise, interventions from all four pillars were implemented to promote a change in practice within the thoracic medical oncology group. The goal was to increase the consistency of immunization assessment and documentation to improve the rate of pneumococcal vaccination for patients with lung cancer. As noted by Nowalk et al. (2016), offices that integrated interventions from all four pillars saw further increases in immunization rates, which indicated that full use of the program and a commitment to change practice were indicators of success.

Initial assumptions were very positive that the nurses and APPs would readily accept the project, and immunization rates would steadily increase. The QI interventions were focused mainly on thoracic oncology providers. Independent variables included the education and resources provided to the MDs and APPs, standing order set within the EMR, and the CDC posters displayed in the clinic rooms and check-in desk. The outcome of the project was
contingent upon the providers changing their behavior to include regular immunization assessments and pneumococcal vaccination orders during office visits. The dependent variables for the project were the frequency of immunization assessments documented in the EMR and prescriptions for pneumococcal vaccinations. A slow and steady increase in rates of vaccination was assumed. However, this author expected that some providers would be willing to incorporate this change into practice faster than others. It was assumed that some patients and family members would read the information on the CDC informational posters and initiate conversation about immunizations with their provider. Lastly, it was acknowledged that some patients might refuse the vaccination despite counsel and encouragement from their provider.

**Specific Aims**

The purpose of the QI project was to provide educational resources, use a standing order set, and implement an EMR alert for vaccination assessments to improve the consistency in which patients with lung cancer were assessed for and vaccinated against pneumonia by the thoracic medical oncology provider. The intended impact of this project was to increase pneumococcal vaccination rates through improved standardization of immunization assessments, thereby decreasing the incidence of pneumonia among the practice’s lung cancer population. By lowering the incidence of pneumonia, patient outcomes, and overall survival will improve while associated health care expenses for patients and the healthcare system will decrease. Initially, this author attempted to institute an EMR alert for immunization assessments during thoracic oncology office visits. Through discussion with Information Technology (IT) staff, the proposal was declined due to the presence of a Health Maintenance (HM) tab and immunization workflow within the EMR. The HM tab is accessible in multiple sections of a patient’s chart and details the patient’s recommended immunizations and other health-promoting care (colonoscopies,
mammograms, etc.) along with respective due dates. Clinical practice guidelines are embedded along with logic tools in the EMR, so patients' HM recommendations are accurate for each patients' age and risk factors. If a vaccination, specific lab test, or procedure is due, it will be written in red and appear separate from the activities which are up to date. However, providers must intentionally seek out this information. The immunization workflow does not have alerts or hard stops that prompt providers to review a patient’s HM information.

The health system maintains a supply of PCV13 and PPSV23 through the pharmacy. The vaccination ordering process through the EMR is straightforward for oncology providers. Electronic orders are sent to the pharmacy and are listed within the patient’s chemotherapy treatment record. Clinic nurses are alerted to the vaccination prescription and will administer the immunization while the patient is receiving an infusion or other treatment. The nurse electronically documents administration once, which updates the medication and immunization tabs simultaneously within the EMR. The HM tab is updated automatically as well, thereby effectively documenting the vaccination in three separate places within a patient’s chart.

Before this QI project, immunization assessment was not a routine part of thoracic medical oncology office visits. As previously mentioned, only one assessment was noted out of 50 random chart audits. Many lung cancer patients were not vaccinated against pneumonia while receiving chemotherapy, targeted therapy, or immunotherapy. Providing the pneumococcal vaccination is a sound and cost-conscious intervention to protect oncology patients from infectious complications during and after treatment. Up to date clinical guidelines, standing order sets, and workflow for ordering the appropriate vaccination are in place within the EMR. The process for administering and documenting the immunization by the clinic nurses is well established. Despite this, providers underutilized the HM tab and immunization workflow. Some
providers were unaware of the HM tab altogether. All of the providers are managing busy clinics where oncology concerns and urgent clinical matters take priority over preventative care. Aside from education, resources, and reminders, it was clear that the process for immunization assessment required modification to make addressing patients’ vaccination needs easier for the providers.

**Methods**

**Context**

The QI project interventions consisted of providing education on pneumococcal vaccination recommendations and HM workflow within the EMR to thoracic medical oncology MDs and APPs to increase the frequency of immunization assessment and documentation as well as pneumococcal vaccination prescriptions. This endeavor was best suited for QI utilizing the 4Pillars™ Practice Transformation Program because this method is a validated evidenced-based process for improving immunization rates in the outpatient setting (Lin, et al., 2016). The goal was to bring about positive practice change by implementing proven strategies. The interventions developed combined best practices with clinical expertise and knowledge of the specific practice location to improve patient outcomes (Portela, Pronovost, Woodcock, Carter, & Dixon-Woods, 2015). Interventions, as outlined in the four pillars, were implemented over a 2-month prospective period in the thoracic medical oncology practice to test its effectiveness for improving pneumococcal vaccination rates.

The QI project was conducted at a large academic medical center located in a metropolitan city. The cancer center is accredited by the Commission on Cancer (CoC) and the National Comprehensive Cancer Network (NCCN). The stakeholders of the thoracic medical
oncology practice include five MDs, six APPs, and two clinic nurses. Most of the patients cared for by the practice are from the tristate area but also include patients from around the United States and other countries. As such, the patient population varies in ethnic and socioeconomic backgrounds. The APPs perform on-treatment and follow up office visits independently in collaboration with a thoracic medical oncologist. The clinic nurses support the practice through triaging symptom management phone calls, reconciling medications before office visits, and assisting with prior authorizations for treatments and durable medical equipment. Each provider documents patient care and patient interactions within the EMR. An oncology pharmacist is assigned to the thoracic medical oncology group to assist with medication concerns specific to the lung cancer patient population.

The Plan-Do-Study-Act (PDSA) model of quality improvement was utilized for this capstone project. As described by Easter and Tamburri (2018), PDSA is a systematic process for performance improvement; it allows healthcare teams to test the efficacy of small practice changes before large scale implementations. To this end, PDSA aligned well with DOI theory and 4Pillars™ program to improve vaccination rates in one medical oncology practice within the cancer center. The “plan” phase included disseminating education and resources on pneumococcal vaccination guidelines and EMR workflow to the providers. The “do” portion of the project occurred over eight weeks, where the providers were encouraged to assess patients’ vaccination needs during office visits while this author tracked the frequency of assessments, prescriptions, and administrations of pneumococcal vaccinations. Patient education flyers were also posted throughout the clinic for patients to read, as well. The “study” phase of the PDSA model involved data analysis evaluating if the 4PillarTM interventions had the intended effect.
The act phase is in progress as the results of the project are discussed with stakeholders to plan the next steps.

**Interventions**

Interventions to increase the rate of pneumococcal vaccinations for lung cancer patients aligned with recommendations from the CDC, utilizing the 4Pillars™ Immunization Toolkit. The 4Pillars™ Practice Transformation Program, developed by the University of Pittsburgh School of Medicine (2018), provides a step by step guide for clinical practices to increase immunization rates in a variety of outpatient healthcare settings. The self-guided immunization toolkit, available online, describes the actions necessary to change clinical practice to improve vaccination rates, including evidenced-based interventions, educational resources, and outcome measurement. This author engaged the stakeholders to implement the interventions as part of a Doctor of Nursing Practice (DNP) capstone project with the guidance of a thoracic medical oncology APP. The pillars for QI and associated interventions are as follows:

**Pillar 1: Convenience and Easy Access Strategies**

Every patient interaction is an opportunity to vaccinate. Providers were encouraged to assess patients' vaccination history at each visit and provide pneumococcal vaccinations as indicated. As noted earlier, the health system’s EMR utilizes logic tools and standing order sets available to the providers, which ease the process of assessing and prescribing necessary HM services such as vaccinations and routine preventative health care. As such, it was imperative to make providers aware of the workflow process and encourage the use of the tools for the betterment of the patient.

**Pillar 2: Patient Communication Strategies**
Informational posters, developed by the CDC to promote pneumococcal vaccination, were displayed at the check-in desk and in the clinic rooms for patients and caregivers to read (see Appendix C). The practice manager approved the content and location of the educational posters. Also, this author discussed vaccination history record retrieval with the thoracic oncology New Patient Coordinator (NPC). The NPC is responsible for gathering medical records before new patient visits within the practice. The supervisor declined to include vaccination record requests to the coordinator’s workload, stating this added work would be too time-consuming. As an alternative, the NPC included written instructions in the new patient packet requesting patients bring a copy of their vaccination history to the first appointment; however, this added written instruction had little to no effect. There were no immunization history documents noted in the chart audits completed during the project timeframe.

Pillar 3: Enhanced Vaccination System Strategies

As advocated by the CDC and CPSTF, pillar 3 supports the creation of standing order protocols for nurses to assess and vaccinate patients without a physician’s order. This author collaborated with the thoracic medical oncology practice to review the health maintenance (HM) workflow and standing order set for pneumococcal vaccinations embedded within the EMR. Documentation of vaccination history and administration is emphasized in this pillar as well. Thus, the processes for updating vaccination history and ordering and documenting pneumococcal vaccinations were reviewed with the providers. Providers received multiple resources such as print outs of the CDC recommendations, information on PneumoRecs VaxAdvisor for mobile devices, and screenshots of the HM and vaccine ordering workflow to refer to when in the clinic with patients. PneumoRecs VaxAdvisor is a mobile application that
assists providers in assessing for and ordering pneumococcal vaccinations for eligible patients (CDC, 2018b).

Pillar 4: Motivation Strategies

Finally, the toolkit recommends motivational interventions to maintain momentum for the practice change. During the first few weeks of the project, this author spent time in the clinic working directly with the APPs to review the CDC recommendations, EMR workflows and documentation, and discussing the importance of vaccinations. Due to busy clinic schedules, the physicians were not engaged during clinic but did receive the education and resources via e-mail. Chart review identified patients in need of pneumococcal vaccinations before their appointments; this author reviewed the list of patients who did not have a pneumonia vaccine documented with the provider before the clinic visit. This author used a spreadsheet to track the frequency of immunization assessments and pneumococcal vaccinations. The weekly tally was available to providers for their review.

Study of the Interventions

Weekly EMR reports tracked the number of patients seen in the clinic, the number of PCV13 and PPSV23 vaccinations ordered, and the number of pneumococcal vaccinations administered to evaluate the impact of the 4Pillars™ interventions. From the clinic visit report, a random chart audit was performed on two patients per provider per week over eight weeks to assess if immunization assessments occurred, and if patients’ HM information was up to date. The patients included were thoracic medical oncology patients who were receiving treatment or under active surveillance during the intervention period; all patients in this practice are 18 years of age or older. Patients being referred to hospice were excluded from the chart audit, since
immunization assessment was not relevant to their office visit. There were also a few patients who did not have lung cancer and those patients were excluded from the chart audit. The data included notations if patients were previously vaccinated to track which patients did not require immunization. The total number of vaccination orders and vaccination assessments were compared to the baseline chart audit to note any increase in frequency during the intervention period. No other QI projects or health system initiatives were in place to increase the rate of vaccination administration in the oncology department. Therefore, any increase in vaccinations would be a result of the 4Pillars™ interventions.

Measures

Data for the QI project was collected by this author in an Excel spreadsheet using the EMR to track the frequency of immunization assessment documentation, orders for PCV13 and PPSV23 vaccines, and pneumococcal vaccination administration. Nominal data in the form of yes/no answers were utilized to track frequencies. Weekly data were collected on two patients per provider over an 8-week timeframe. The goal was to collect data on approximately 105 patients at minimum; a total of 149 chart audits were completed. The frequency of pneumococcal vaccinations was the primary outcome measure; the rate of immunization history documentation and pneumococcal vaccination orders placed were the process measures. This author completed the chart audits independently to ensure consistent data collection. Reports generated from the EMR provided an accurate count of clinic visits and pneumococcal vaccinations ordered. In addition to the nominal data, the patient's age, gender, diagnosis, smoking status, and pneumonia history was included during the chart audit. The descriptive statistics are noted in the chart below (see Appendix A).

Analysis
With the help of a statistician, pre- and post-project data were analyzed. The baseline chart audit included 50 patients with a 2% success rate for assessing and administering pneumococcal vaccinations. Quantitative methods were utilized to compare baseline frequencies and post-intervention frequencies. Descriptive statistics were gathered to further characterize the patient population.

**Ethical Considerations**

Institutional Review Board (IRB) approval of the pneumococcal immunization QI project was granted by Capella University and the practice site. Recommendations by the health system’s IRB for electronic data collection and storage were followed per the policy. The researcher did not need to consent patients for the study. Interventions focused on changing provider behavior during regular clinic visits to include discussion on pneumonia vaccinations. Providers utilized the existing workflow for immunization prescriptions and administration.

**Results**

Interventions and data collection began on the same day and continued simultaneously for eight weeks. As previously stated, thoracic oncology MDs and APPs received a summary of the project, educational resources about pneumococcal vaccination recommendations, and information on the EMR’s Health Maintenance (HM) workflow. For the first four weeks, many of the providers were engaged in-person to discuss specific patients who met the criteria for pneumococcal vaccinations. Providers were encouraged to update patients’ immunization histories and offer vaccines when indicated. Additionally, CDC informational posters were displayed at the check-in area and clinic rooms. Despite these interventions, there was no
statistically significant increase in pneumococcal vaccination orders or administration. The weekly tally for the intervention period is noted in Appendix B.

The APPs expressed many concerns about including vaccination assessment into a typical clinic visit. One physician assistant verbalized a lack of time to address patients’ questions about vaccinations while on anti-cancer treatment; follow up appointments are 20 minutes in length, and the APP must address laboratory results, side effects, treatment plan concerns, and other oncology-related issues. Discussions on the need to vaccinate against pneumonia were challenging to incorporate in a limited clinic visit. Another APP expressed that preventative care was not part of the oncology providers’ responsibility; they believed that the PCP should ensure patients are up to date on their health maintenance and preventative care. Lastly, one provider expressed doubt that the HM information was accurate and feared they would order the wrong immunization at the wrong time.

In 8 weeks, the thoracic oncology providers completed 1187 clinic visits. Of those appointments, 149 charts were audited. A total of 13 patients were assessed for immunization needs and 9 patients received either a PCV13 or PPSV23 vaccination. Three of the providers in the thoracic oncology group were responsible for all assessments and vaccinations ordered. Only one patient declined to be vaccinated. It was noted by one APP that many of the patients assessed for vaccination needs asked about receiving the pneumococcal vaccination after reading the informational posters in the check-in area and clinic room.

Discussion

Summary
In summary, a QI initiative was completed at a cancer center in an academic medical center to increase the frequency of immunization assessment and pneumococcal vaccination for patients with lung cancer. Before the QI project, providers did not routinely offer vaccines to patients undergoing chemotherapy and immunotherapy. Pneumonia is a common and morbid complication for patients with compromised immune systems, which leads to increased clinic visits, hospitalizations, and associated expenditures. Vaccination is the most clinically and financially effective way to prevent infection in this vulnerable population. The 4Pillars™ Practice Transformation Program was utilized in conjunction with DOI Theory and the PDSA model to implement several interventions to embed vaccination assessment and pneumococcal immunization administration as a routine part of clinic visits. The thoracic medical oncology providers received education and resources on the CDCs recommendations for pneumococcal vaccination as well as the health system’s EMR HM and immunization workflow. Informational posters were displayed in the clinic rooms and check-in desk for patients and families to read. Due to the pre-existing workflow within the EMR, the IT staff declined to institute an EMR alert to remind providers to assess immunization status during office visits. The onus was on the provider to remember to review their patient’s HM information during a brief oncology clinic visit. Despite receiving education and reminders about this project, providers were not prompted to review their patients’ immunization needs at the time of service. Additionally, clinic nurses did not have the capability to utilize the standing order set for vaccinations; an order from an MD or APP was required before immunizing a patient in the outpatient setting. The frequency of immunization assessment and pneumococcal vaccination administration did not increase compared to the baseline data. Concerns by the APPs were noted, including lack of time to discuss vaccinations and patients’ concerns during a clinic visit, and feelings of distrust in the...
HM information within the patients’ charts. One provider verbalized that the patients’ PCPs should be responsible for ordering vaccinations. This author will share the data with IT and continue to advocate for an EMR alert to prompt immunization assessment and vaccination orders via a standing order protocol. As described in the DOI framework, behavior change occurs over time with some individuals adopting the change readily while others take more time to incorporate new behaviors as routine (Kreps, 2017). This QI project occurred over an eight-week period so it stands to reason that the interventions will need to be applied consistently over a longer timeframe to realize their full impact.

**Interpretation**

The QI project did not yield the results initially anticipated. At first, this author endeavored to embed an EMR alert for vaccination assessment which was subsequently denied by the IT staff. This intervention would have been the most impactful, for EMR alerts and logic tools are very useful to health care providers to prompt discussion on health topics such as immunization history. As noted by Tan et al. (2019), clinics with EMRs equipped with risk and age-based algorithms in conjunction with immunization alerts experienced greater increases in vaccination rates compared with clinics where providers had to remember to address immunization assessment during office visits. There were also time constraints which prevented the providers from addressing vaccination needs. Most appointments are 20 minutes in length, which offers minimal time to review oncology-related concerns, and adding discussion on immunizations was not feasible. In the literature, lack of time is documented as one of the main barriers to vaccination during office visits especially when urgent and chronic medical conditions are the focus of the appointment (Zimmerman et al., 2017). Most studies validating the use of the 4Pillars™ Practice Transformation Program included a vaccination champion who worked
directly in the clinic to keep the forward momentum (Lin et al, 2016; Nowalk et al, 2016; Zimmerman et al, 2017). For this project, a champion working in the practice full time was not available; this author led the project but was not directly part of this medical practice. Additionally, clinic workflow in other projects included standing order sets which clinic nurses could utilize without an order from a provider (Delacruz et al, 2017; Tan et al, 2019). Standing order sets combined with logic tools within the EMR are intended to empower the clinic nurses and promote efficiency by removing the need for a providers’ order to administer a vaccination (Tan et al, 2019). At this project site, the pneumococcal vaccination standing order set from the CDC is embedded into the EMR, but a prescription from a provider is still necessary for patients to receive an immunization.

Despite these limitations, the QI project had strengths. The 4Pillars™ Practice Transformation Program is a practical toolkit which has proved to increase vaccination rates in various clinic settings. Interventions from all four pillars were implemented, and this author endeavored to mirror many of the toolkit’s ideas as closely as possible within the thoracic oncology practice. There were a few APPs who were very supportive of the project and continued to discuss pneumococcal vaccinations with their patients after the 8-week endeavor was over. Additionally, the CDC posters remain available at check-in and in the clinic rooms. Some patients ask for the pneumococcal vaccination directly while in the clinic. Lastly, the data from this project will strengthen the argument for implementing an EMR alert to prompt providers to assess immunization needs of patients at regular intervals.

Limitations

The project did have some restrictions. The most impactful limitations were the proposed interventions that were subsequently denied by IT and the new patient coordinator’s supervisor.
The EMR alert and patients’ immunization documentation would have helped to increase the frequency in which providers discussed vaccinations with their patients. There was also no designated vaccination champion directly working within the thoracic medical oncology group. Some of the providers expressed concerns with adding routine immunization assessment during clinic visits. Lastly, the QI project was completed in a short eight weeks and did not allow enough time for all stakeholders to adopt the behavior change. The limitations are similar to other QI projects and supports the need for standing order sets usable by clinic nurses as well as the use of interventions from all 4 pillars to maintain consistent vaccination rates in the outpatient clinic setting.

Conclusions

In conclusion, patients with lung cancer are susceptible to pneumonia which contributes to the high morbidity and mortality for this population. Pneumococcal vaccination is the only effective intervention to prevent this complication. The health system’s EMR includes standing order sets for vaccines and logic tools to maintain accurate health maintenance data on patients. There is no EMR alert or hard stop in the outpatient setting to ensure that all patients are assessed for immunization needs. During a brief QI project, immunization assessment and vaccination rates did not increase as anticipated despite the implementation of the 4PillarsTM Practice Transformation Program; however, providers did receive education and resources to this end. Two of the APPs have reported continual use of the HM tab in the EMR and note increased frequency of discussions about the pneumococcal vaccination with patients. While this particular project did not yield the expected results, its importance and relevance to the thoracic medical oncology practice cannot be understated. The project’s outcomes support the need to apply the 4PillarsTM interventions on a continual basis while implementing an EMR alert for immunization
assessment in the oncology clinic. Increasing pneumococcal vaccination rates within the thoracic medical oncology practice is vital to delivering high quality care to the patient population.
REFERENCES


### Thoracic Medical Oncology Patient Descriptive Statistics

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<th>Patient Characteristics (n= 149)</th>
<th>Characteristics No. of Patients (%)</th>
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<tr>
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<tr>
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Appendix B

Weekly Tally of Appointments, Assessments, and Vaccinations

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<th>Week</th>
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<th>Immunization Assessments</th>
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Appendix C

Informational Poster Displayed in Clinic Room

Protect yourself from pneumococcal disease…
Get vaccinated!

What is pneumococcal disease?
Pneumococcal disease is caused by bacteria that can lead to serious infections in the lungs (pneumonia), blood, and brain (meningitis).

How do you catch it?
You can catch pneumococcal bacteria from infected people who cough or sneeze around you.

Is it serious?
Yes. Even with good medical care, pneumococcal disease can be deadly. The disease is hard to treat because some bacteria have become resistant to antibiotics. Pneumococcal bacteria can cause pneumonia, blood infections, and meningitis. Such infections can lead to deafness, brain damage, and even death.

Am I at risk?
Yes. Anyone can get pneumococcal disease. You are at greater risk if you are 65 or older, very young, or have certain health conditions.

How can I protect myself from pneumococcal disease?
You can protect yourself against these serious types of blood and brain infections by getting vaccinated.

There are 2 vaccines that can prevent pneumococcal disease: PCV13 and PPV23. You should get both vaccines if you are age 65 years or older. You might need these shots before age 65 if you are a smoker or if you have certain health conditions.

For more information, visit www.vaccineinformation.org

For other vaccine handouts in this series, visit www.immunization.org/hcfa.html#immunization.
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