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Innovative Strategies Designed to Improve Adult Pneumococcal Immunizations in Safety Net Patient-Centered Medical Homes

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Abstract

Streptococcus pneumoniae is a principal cause of serious illness, including bacteremia, meningitis, and pneumonia, worldwide. Pneumococcal immunization is proven to reduce morbidity and mortality in high-risk adult and elderly populations. Current pneumococcal vaccination practices are suboptimal in part because of recommendation complexity, the high cost of provider-driven immunization interventions, and outreach methods that are not patient-centric. These barriers are amplified within the safety net. This paper identifies efforts by the Los Angeles County Department of Health Services to increase pneumococcal immunization rates for adult indigent patient populations. A 4-part approach will be used to increase vaccination rates: (1) protocol driven care, (2) staff education, (3) electronic identification of eligible patients, and (4) automated patient outreach and scheduling. The proposed analytics plan and potential for scalability are described. (*Population Health Management* 2016;19:240–247)

Background

Streptococcus pneumoniae is a principal cause of serious illness, including bacteremia, meningitis, and pneumonia, worldwide.[1] In both the United States and in Europe, pneumonia is a frequent cause of death, with a mortality rate that ranges from 6.4% to more than 40%.[2] Pneumococcal disease (PD) results in high economic burden; in 2004, direct health care costs of PD in the United States totaled $3.5 billion.[3] With a high incidence rate and a high mortality risk from PD, elderly patients with comorbidities are more vulnerable than other patient subgroups.[4]

Immunization against PD has significant impact on the reduction in morbidity and mortality and is an important component of adult preventive services. One objective of Healthy People 2020 is to increase the percentage of adults who are vaccinated against PD.[5]

The Advisory Committee on Immunization Practices (ACIP) recommendations for pneumococcal immunization were unequivocal until 2011. At that time, the Pneumococcal Vaccine Polyvalent 23 [Pneumovax 23®] (PPSV23) was the only vaccine available for adult use and the target population was well circumscribed. The timing and spacing of doses were uncomplicated. With the introduction of the Pneumococcal 13-valent conjugate vaccine [Prevnar 13®] (PCV13; Diphtheria CRM 193 Protein) for select adult populations in 2011, and the subsequent revisions to the recommendations in both 2012 and 2014 to include a broader patient cohort, a level of complexity was introduced that has resulted in suboptimal PD coverage.[4,5]

Barriers to PD control are numerous and multifaceted. At the provider level, barriers to effective pneumococcal immunization include difficulties in identification of appropriate patient cohorts and understanding the timing and sequencing of PCV13 and PPSV23 administration. Two randomized, multicenter, immunogenicity studies conducted among older adults in the United States and Europe showed that for the 12 serotypes that the 2 vaccines have in common, PCV13 induced an immune response as good as or better than that induced by PPSV23, yet providers frequently order only PPSV23.[5,6] At the system level, requiring provider-level contact with the patient to initiate vaccine orders is common, costly, and unnecessary. At the patient level, there are numerous reasons why patients are reluctant to seek or accept recommended vaccines. Effective immunization processes require cross-dimensional implementation strategies that target the patient, provider, support staff, and health system.[7]

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Current immunization outreach is based primarily on human-driven interventions.[8–10] They are effective, but are costly, consume limited resources, and have limited sustainability. Increasingly, preventive care outreach is utilizing technology to direct population-level health management.[11,12]

Mobile telehealth programs have high rates of success with African Americans and Hispanic/Latinos, particularly among women.[13–15] Patients report that these systems increase communication with providers without interfering with daily routines.[13–16] Automated telehealth programs have resulted in improved health outcomes and compliant health behaviors. [13,14,15,17–22]

Conceptual Framework (Theory and Study-Specific Interventions)

The US median (inclusive of all races/ethnicities) for appropriate pneumococcal immunization is approximately 69%. Racial/ethnic disparities related to adult immunization have been well documented and substantial gaps persist.[23] Among racial/ethnic disparate populations nationally, protection against pneumococcal pneumonia is less than the US median; estimates of pneumococcal vaccination rates for African Americans range from 46%–61% and for Hispanics from 19%–59%.[8,24–26] Pneumococcal vaccination care gaps within the Los Angeles County Department of Health Services (DHS) are consistent with that of other safety net health care organizations.[8]

In an effort to consolidate, simplify, and integrate current pneumococcal immunization recommendations into their safety net health care data system, and to maximize outreach and optimize immunization processes, the research team has developed an approach to pneumococcal vaccination that will be implemented across all DHS Ambulatory Care Network facilities.

Program components include: (1) electronic identification of at-risk outpatient adults; (2) automated interactive multimodal outreach, communication, and scheduling; and (3) a pneumococcal immunization protocol that simply delineates patient eligibility, vaccine choice, and timing and sequencing of the 2 vaccines, while expanding access to immunization through the use of nurses and other health care professionals.

Methods

Setting, population, and subjects

As the second largest safety net provider in the country, DHS employs more than 21,000 individuals and serves 800,000 patients annually with 2.7 million ambulatory care visits, 280,000 emergency department visits, 230,000 urgent care visits, and 75,000 inpatient admissions. The population seen at DHS facilities is multicultural and diverse; 15% of patients are African Americans and 65% are Hispanic/Latinos. Many DHS patients have multiple chronic conditions, are nonnative English speakers, and remain residually underinsured at higher rates than state or national levels.[27,28] Social problems (ie, poor social/community support, chronic homelessness) compound the impact of disease in this population. Within DHS, more than 40% of patients have diabetes, heart failure, or asthma, and one or more other chronic conditions. [27,28] Most of these patients should receive one or both pneumococcal vaccines. Yet, within Los Angeles County, across all socioeconomic and insurance statuses, the estimated pneumococcal vaccination rate is lower than the national median, particularly as it affects indigent and minority populations.[29,30]

This program will be implemented across more than 120 DHS Patient-Centered Medical Homes (PCMHs) that care for more than 450,000 empaneled patients. DHS PCMHs are responsible for ongoing and coordinated care to maximize health outcomes. Care management programs support implementation of standard interventions for patients with chronic conditions, ensure coordination of care between health care settings, and conduct health maintenance/prevention activities. The PCMH team is led by a primary care provider (doctor of medicine, doctor of osteopathy, physician assistant, or nurse practitioner) and includes nurses, care managers, certified medical assistants, and clerks. Each full-time provider has a target panel size of approximately 2000 member equivalents.

Study design

This program is designed to address a number of system, provider, and patient barriers using a 3-pronged approach to increase pneumococcal outpatient immunization rates in DHS. This includes the use of a simple but explicit immunization protocol in conjunction with provider and staff education, implementation of an electronic algorithm to identify at-risk adults, and employment of automated multimodal outreach and scheduling.

Care protocol. The DHS structured pneumococcal vaccine order and documentation form includes an algorithm that organizes a complicated decision process and helps guide the user through the maze of recommendations for adult patients that was put forth in 2014 by the ACIP. Approved by an Interdisciplinary Practices Committee (IDPC), it is written as a standardized procedure to provide a mechanism by which licensed or certified staff (provider, nurse, or certified medical assistant) can safely, efficiently, and effectively facilitate and expedite patient care. It includes: (1) inclusion and exclusion criteria for patients at risk for pneumococcal pneumonia; (2) steps for selecting, sequencing, and ordering both PCV13 and PPSV23 vaccines; and (3) documentation of which vaccine was administered, if indicated, or reasons if it was not given.

Provider and patient education. One barrier to optimal pneumococcal coverage is provider knowledge deficit. It is critical that providers understand vaccine indications, exclusions, and proper sequencing of PCV13/PPSV23, as well as techniques like motivational interviewing to dispel treatment misconceptions and overcome patient resistance to vaccination.[9] A key technique to overcome access issues includes delegating pneumococcal immunization screening responsibility to nonprovider staff through an IDPC-approved protocol. Study investigators will lead education and implementation efforts with both provider and nonprovider staff to address these barriers.

DHS staff education will include a series of pneumococcal immunization education events. Discussion points include the appropriate use of, indications for, and

sequencing of PCV13 and PPSV23 vaccines, as well as training on the use of the protocol tool. The research team will present methods to encourage vaccination acceptance by patients that are culturally sensitive. The team will conduct an expert-led presentation on pneumococcal immunization that will be recorded and available on the DHS intranet for system-wide viewing. Subsequent on-site refreshers with case study application assessments, performed by local medical directors or their designees, will reinforce education efforts.

Patient outreach will include pneumococcal immunization education designed for safety net, minority, and low-literacy English and Spanish-speaking populations (Figs 1A & 1B). This should improve patient activation and promote perceptions of patient-centric care within the PCMH while achieving the goal of delivering appropriate preventive services.

Electronic identification of at-risk adults via automated multimodal outreach and scheduling. DHS has a strong track record of successfully integrating technology for improved clinical care in the safety net. Building on the success of structured telephone support and telemonitoring to reduce hospitalizations and improve health outcomes, with a technology partner the research team created a series of Automated Remote Monitoring Systems (ARMS) in other disease states.[31–34] This technology is a cost-effective, proven technique for improved clinical performance, with positive fiscal and satisfaction outcomes that have demonstrated efficacy for patients regardless of education and technology experience.[34–36] It reduces disparities and improves health outcomes regardless of race, ethnicity, and social class.[20,31,35]

The research team has demonstrated the utility of ARMS for both heart failure and depression; both applications highlight its ability to facilitate low-cost, high-impact care. The Heart Failure Automated Remote Monitoring System (HF-ARMS) is a data collection tool that uses an automated speech recognition system that is able to provide multiple simultaneous outbound calls to patients on a scheduled and triggered basis. Communication results with details of the patient interaction are made available via a secure Web interface in real time to care providers. More than 92% of data collected by the HF-ARMS were clinically equivalent to data collected by human researchers; 80% of satisfaction survey respondents preferred the HF-ARMS calls to less frequent human monitoring. Patients reported protective effects of using the HF-ARMS, suggesting that regular cognitive prompts reinforced healthy behaviors. On average, successful HF-ARMS calls lasted 2.34 minutes at a cost of $0.85 per call.

The automated remote monitoring technology used by the HF-ARMS was adapted for the Department of Health and Human Services R18, *Care Management Technology to Facilitate Depression Care in Safety Net Diabetes Clinics* (1R18AE000054-01). The Depression Automated Remote Monitoring System (D-ARMS) is a bilingual system that gathers patient Patient Health Questionnaire (PHQ-9) scores, behavior responses, and information about antidepressant medication use and cognitive behavior therapy activities. Preliminary data show that patients randomly assigned to use the D-ARMS have significantly improved PHQ-9 depression scores (differences-in-differences analysis of variance test, $P < 0.05$) and are less likely to have persistent major depression (Pearson chi-square test, $P < .01$), baseline measure to 6-month follow-up, when compared to patients in usual care.

DHS is uniquely situated to leverage technology for the creation of a scalable and sustainable automated system that provides remote interactive communication and patient self-scheduling. The system, built on the ARMS infrastructure, is the Immunization Outreach Automated Remote Monitoring System (IO-ARMS).

DHS does not have a consistent, automated method to identify patients who are eligible for pneumococcal immunizations. The research team will translate the standardized protocol into an electronic algorithm to be used in the electronic health registry that will identify which of the 329,000 PCMH empaneled patients are potentially eligible for vaccination. The benefits of an algorithm are that (1) it will be easy to update and refine all criteria as national recommendations evolve; (2) patients can be systematically identified using consistent criteria; (3) it can be integrated into existing infrastructure and capitalized on; and (4) it provides a foundation for a generalized solution that is scalable across health care networks and systems.

Capitalizing on the success with the HF-ARMS and D-ARMS, the IO-ARMS will contact patients whom the algorithm determines are potentially eligible for pneumococcal immunizations via a combination of e-mail, text message, and automated phone call to provide awareness and outreach, and electronically negotiate vaccination appointment scheduling.[32,33,37,38] The bilingual communication (English and Spanish) will inform the patient of his or her eligibility, provide a brief message on the importance of pneumococcal immunization, ask if the patient has received the immunization outside of DHS, allow the patient to indicate if he or she would like to speak with a DHS care team member to ask questions, and prompt the patient to self-schedule an immunization appointment. This will increase convenience, patient travel and waiting times, and avoid delays in care. Based on previous ARMS experience, the research team believes this patient-centric approach will educate patients about pneumococcal disease and immunizations directly (through messaging in the ARMS communication), and indirectly through a ''halo'' effect whereby patients become more cognizant of pneumonia risks and vaccination benefits.[31,37,38] The cost of these communications is expected to average less than $0.50 per communication.

Outcome measures and proposed evaluation design

A quasi-experimental design will be used to test 2 main hypotheses: (H1) there will be an increased percentage of eligible patients who receive PCV13 or PPSV23 vaccine, and (H2) automated outreach and communication will significantly drive the increased rate of pneumococcal immunization for the target population. The main patient interventions, electronic identification of patients eligible for pneumococcal vaccinations, and IO-ARMS messaging to these patients will be implemented broadly across all PCMHs, targeting a population of 65,000 patients. In order to reduce bias, the evaluation of this project will be conducted by the Center for Community Health and Evaluation, Group Health Research Institute.

The research team will examine 2 additional research questions, implemented through modifications within the

County of Los Angeles — Department of Health Services

Adult Pneumococcal Immunization

Step 1: Eligibility *(see back of form for Risk Groups)*

A. Prevnar 13 (PCV13) Vaccine Criteria - Select if appropriate

- *If patient meets one of the criteria, vaccine indicated*
- *Only one lifetime dose of Prevnar 13 is indicated*

☐ Age 65 years or older who have never received this vaccine (or status unknown)
☐ Age 19-64 years in Risk Group 1-B (CSF leak or cochlear implant), 2 (asplenia) or 3 (immunocompromised) who have never received this vaccine (or status unknown)

B. Pneumovax 23 (PPSV23) Vaccine Criteria – Select if appropriate

- *If patient meets one of the criteria, vaccine indicated*

☐ Age 65 years or older who have never received this vaccine (or status unknown) or last dose was before age 65 and more than 5 years ago
☐ Age 19-64 years in any Risk Group who have never received this vaccine (or status unknown)
☐ Age 19-64 years in Risk Group 2 (asplenia) or 3 (immunocompromised) who received first and only dose more than 5 years ago

If both Prevnar 13 (PCV13) and Pneumovax 23 (PPSV23) are indicated, give Prevnar 13 (PCV13) first

- *If Prevnar 13 (PCV13) administered, give Pneumovax 23 (PPSV23) at first scheduled visit that is at least 8 weeks after Prevnar 13 (PCV13) vaccination*
- *Wait at least 12 months to administer Prevnar 13 (PCV13) after administration of Pneumovax 23 (PPVS23)*

Step 2: Vaccine Order/Standardized Procedure

☐ **No criteria selected, vaccine not indicated**

☐ **History of severe allergic reaction (e.g., anaphylaxis) to any component of Pneumovax 23 (PPSV23), Prevnar 13 (PCV13), or any diphtheria toxoid-containing vaccine - Do not order vaccine by protocol, notify provider**

☐ **Administer pneumococcal vaccine**

☐ **Prevnar 13 (PCV13) vaccine 0.5 mL IM** **OR** ☐ **Pneumovax 23 (PPSV23) vaccine 0.5 mL IM**

May be given concurrently with influenza vaccine. If both PCV13 and PPSV23 are indicated, DO NOT administer at the same time. Administer PCV13 first, followed by PPSV23 as indicated above. Do not administer either if patient actively receiving chemotherapy or radiation.

☐ **Follow-up for Prevnar 13 (PCV13) administration:** Administer Prevnar 13 (PCV13) vaccine at first scheduled visit at least 12 months after Pneumovax 23 (PPSV23) administration

☐ **Follow-up for Pneumovax 23 (PPSV23) administration:** Administer Pneumovax 23 (PPSV23) vaccine at first scheduled visit after Prevnar 13 (PCV13) administration per risk group interval on back of form

MD/NP/PA/RN/PharmD Print Name:_____ Signature:_____ Date:_____ Time:_____

Step 3: Administration Record: check one ☐ Entered into ORCHID ☐ Entered into the medical record and CAIR

If administering with influenza vaccine do not administer both vaccines in the same site. Give only when patient temperature has been less than 38.6°C (101.4°F) for at least the prior 12 hours. Do not give pre-operatively or within 24 hours of operative procedure. If patient experiences an adverse reaction to administered vaccine(s), notify provider immediately and document reaction in ORCHID and CAIR.

Prevnar 13 (PCV13) vaccine	**Pneumovax 23 (PPSV23) vaccine**
☐ R ☐ L deltoid	☐ R ☐ L deltoid
Manufacturer: Pfizer Lot #_____ Exp. Date:_____	Manufacturer: Merck Lot #_____ Exp. Date:_____

☐ Vaccine information statement (version date:_____) has been given, explained and questions answered

RN/PharmD/LVN/CMA Print Name: _____ Signature:_____ Date:_____ Time:_____

VACCINE NOT ADMINISTERED:

☐ Patient/guardian refused _____vaccine(s), provider notified
☐ Pneumovax 23 (PPSV23) vaccine not available
☐ Prevnar 13 (PCV13) vaccine not available
☐ Vaccine information statement (VIS) given
☐ County Info Line 2-1-1 given

RN/PharmD/LVN/CMA Signature:_____ Date:_____ Time:_____

Adult Pneumococcal Immunization

FORM NO. HS3004 (09/15/2015)

T-HS3004

FIG. 1A. Adult pneumococcal immunization standardized protocol for LVNs and CMAs (Front).

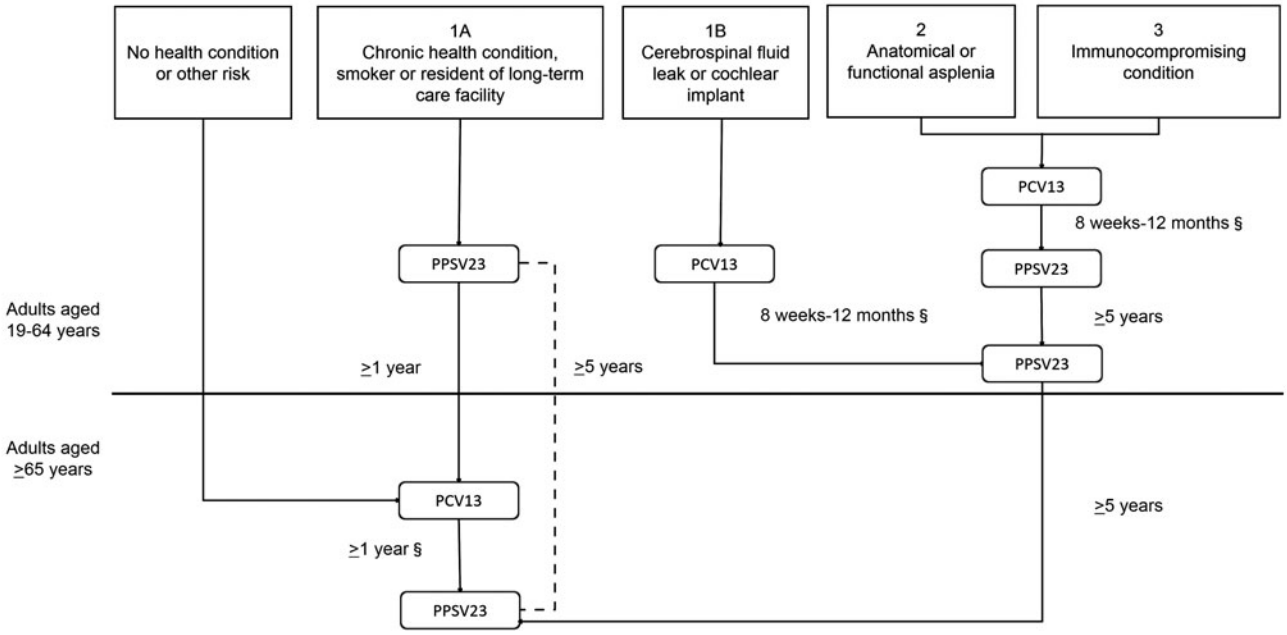
Risk Group Classification and Underlying Medical Condition for Administration of PCV13 and PPSV23 for Adults 19 years of Age and Older			
1A Chronic health condition *or* smoker *or* resident of long-term care facility	**1B Cerebrospinal fluid leak *or* cochlear implant**	**2 Anatomical or functional asplenia**	**3 Immunocompromising condition**
Chronic heart disease†	CSF leaks	Sickle cell disease/ other hemoglobinopathies	Congenital or acquired immunodeficiencies¶
Chronic lung disease*	Cochlear implants	Congenital or acquired asplenia	HIV infection
Diabetes mellitus			Chronic renal failure
Alcoholism			Nephrotic syndrome
Chronic liver disease			Leukemia
Cigarette smoking			Lymphoma
Residents of nursing homes or long-term care facilities			Hodgkin disease
			Generalized malignancy
			Iatrogenic immunosuppression‡
			Solid organ transplant
			Multiple myeloma

†Including congestive heart failure and cardiomyopathies

*Including chronic obstructive pulmonary disease, emphysema, and asthma

¶Includes B-(humoral) or T-lymphocyte deficiency, complement deficiencies (particularly C1, C2, C3, and C4 deficiencies), and phagocytic disorders (excluding chronic granulomatous disease)

‡Diseases requiring treatment with immunosuppressive drugs, including long-term systemic corticosteroids and radiation therapy



PCV13 = 13-valent pneumococcal conjugate vaccine; PPSV23 = 23-valent pneumococcal polysaccharide vaccine.
The dashed line represents the interval between the two PPSV23 doses.
§ Administer PPSV23 as soon as possible if the 12 month limit has passed.
Adapted from Kim DK, Bridges CB, Harriman HK; Advisory Committee on Immunization Practices. Advisory Committee on Immunization Practices recommended immunization schedule for adults aged 19 years or older: United States, 2015. Ann Intern Med. 2015:162:214-23. doi:10.7326/M14-2755.
‡Recommendations taken from ACIP Adult Immunization Work Group published in MMWR / September 4, 2015 / 64(34);944-947

FIG. 1B. Adult pneumococcal immunization standardized protocol for LVNs and CMAs (Back). CAIR, California Immunization Registry; CMA, certified medical assistant; DHS, Department of Health Services; LVN, licensed vocational nurse; ORCHID, Online Real-Time Centralized Health Information Database; RN, registered nurse.

IO-ARMS: (Q1) Does an education and barrier reduction statement, delivered as part of the automated messaging, influence rates of pneumococcal vaccinations? (Q2) Does choice of venue (walk-in versus scheduled appointment) compared with non-choice (patients are allowed to select a scheduled appointment time; if they are unable to select an appointment time they are given walk-in venue information) influence pneumococcal vaccination immunization rates?

Patients targeted for communication from the IO-ARMS will be randomly assigned to 4 subpopulations: (1) Receive Education Statement + Choice of Venue, (2) Receive Education Statement + No Choice in Venue, (3) Do Not Receive Education Statement + Choice of Venue, and (4) Do Not Receive Education Statement + No Choice in Venue.

The research team will utilize a combination of existing data sources, supplemented by patient survey data. Existing DHS data sources include the Enterprise Data Repository, which contains appointment/scheduling data, visit data, and encounter (*International Classification of Diseases, Ninth Revision* and Current Procedural Terminology 4) data.

The intent is to roll out interventions, staggering implementation across clusters of PCMHs, in 30-day intervals. This will allow for site-specific modifications and improvements based on staff feedback to ensure optimal utility. The staggered approach also will mitigate the confounding effect of global temporal changes in vaccination rates.

Patients will be included in the received IO-ARMS messaging + received pneumococcal immunization group if they receive an immunization within 16 weeks post messaging. Surveys will be administered either in person or over the phone within 4 weeks post immunization. Members of the PCMH teams will be invited to complete surveys to measure their satisfaction, how the interventions integrate into the workflow, and their perceived knowledge of pneumococcal immunization.

Significance, sustainability, and dissemination

This project was approved by the Los Angeles County Department of Public Health Institutional Review Board.

This study is designed to be implemented even in resource-constrained settings to improve pneumonia prevention in vulnerable communities and to reduce disparities in immunization practices. It is designed to improve adherence to immunization guidelines in the outpatient setting by using a coordinated approach of IO-ARMS technology, ''protocolization'' of the ACIP recommendations, and patient/provider education. Because patients will receive vaccinations as part of usual care, and by building telephonic outreach on existing infrastructure, the research team anticipates enhanced sustainability beyond the funding period.

Limitations

The research team will only be able to contact those patients who have a working phone number on record, or a valid e-mail or home address. As recommendations change, the team will need to provide periodic updates to the protocol, algorithm, and call representations of the algorithm.

Funding for this study was provided by Pfizer Independent Grants for Learning & Change (Pfizer), a maker of one of the pneumococcal vaccinations. Pfizer has had no input into clinical recommendations, study design, IO-ARMS design, and the proposed analytics plan.

Summary

Pneumococcal immunization is a known method for reducing morbidity and mortality in high-risk adult and elderly populations. Current pneumococcal vaccination practices are inadequate in large part because of complicated and rapidly changing recommendations. The 3-part approach to increasing vaccination rates proposed by Los Angeles County DHS includes enhanced and simplified protocol-driven clinical staff education, electronic identification of eligible patients, and automated patient immunization outreach and scheduling. Broad education and spread efforts combined with a communication infrastructure designed for low socioeconomic and minority patients will result in sustainable system-level change.

This multifaceted effort will increase knowledge and expand traditional roles common in immunization practice. It will provide a patient-centric automated approach that will reduce human effort and increase awareness and risk reduction. Successful implementation in a safety net health care system will indicate scalability to other care settings that experience high levels of pneumonia disparity or low levels of adult immunization.

Author Disclosure Statement

Drs. Park, Gross-Schulman, Tran, Campa, and Guterman, and Ms. Sklaroff, Ms. Hoang, and Mr. Scheib declared no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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