

Barriers to Seasonal Influenza Vaccine Uptake in a Pediatric Inpatient Healthcare Setting After Implementation of Clinical Decision Support

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Abstract

Every healthcare encounter is an opportunity to provide both acute care and health maintenance to children. A Clinical Decision Support (CDS) intervention was instituted in a tertiary pediatric health system to improve influenza vaccination rates during the 2019-2020 season among eligible children receiving care in an acute care inpatient healthcare setting. This study explores reasons for low vaccine uptake following implementation of a CDS aimed at improving vaccine administration as well as identifying possible solutions to improve flu vaccine coverage.

Keywords:

Clinical Decision Support, Preventive Health Services Implementation Science

Introduction

Globally, it is estimated that influenza results in approximately 374,000 hospitalizations in children <1 year old and 870,000 hospitalizations in children <5 years old annually.[1] The Centers for Disease Control and Prevention (CDC) estimated that, in the United States there were 11.1 million symptomatic illnesses, 6.4 million medical visits, 46,340 hospitalizations and 477 deaths associated with influenza in children during 2018–2019.[2] Influenza vaccination prevents millions of healthcare visits each year and reduces deaths, intensive care unit (ICU) admissions, ICU length of stay, and duration of hospitalization.[3; 4] Despite its effectiveness, vaccine coverage rates were only 63.8% in US children in the 2019-2020 influenza season.[5] In a cohort of healthy children hospitalized for influenza, 42% were found to have had a missed opportunity for prior vaccination.[6] The CDC Advisory Committee on Immunization Practices recommends vaccination at all opportunities, including hospitalizations, and not only routine healthcare visits.[7] In the setting of the COVID-19 pandemic, strategies to promote vaccination among vulnerable, hard to reach populations are especially important.[8]

Several strategies have been described in the literature to improve influenza vaccination in hospitalized children such as adding an influenza vaccine order into oncology admission order sets, nurse-driven protocols for vaccination, alerts for physicians, changes to the History & Physical note template, and education[9-11] Though such clinical decision support interventions can help improve outcomes, their impact on outcomes has been inconsistent,[12] particularly in promoting health maintenance interventions in acute care settings [13; 14]. At a tertiary pediatric health system in southeastern region of the

United States we implemented clinical decision support in the form of a nurse screening questionnaire with an opt out presumptive communication strategy [15, 16] and default orders in order sets. After implementation of a new CDS in the 2019-2020 influenza season [17], influenza vaccination rates increased to 31% of eligible admissions, which was significantly higher than baseline (14%), yet still demonstrated relatively low vaccine uptake and an ongoing opportunity for improvement. Though this intervention significantly improved influenza vaccine administration, there was a difference between the proportions of eligible encounters in which the influenza vaccine was ordered (77%) versus administered (31%). We evaluated reasons for this difference between rates of vaccine ordering and delivery using triangulation of clinician interviews and retrospective analysis of nurse cancellation of influenza vaccine orders in order to identify new solutions.

Methods

Setting

This study was performed at an urban pediatric health system including 3 freestanding children's hospitals in the southeastern region of the United States. All three sites utilize a common electronic health record (EHR) instance of Epic Systems®.

Assessment of Reasons for Low Vaccine Uptake

Reasons for low vaccine uptake were identified in two phases.

Phase 1: Retrospective Analysis of Nurse Cancellation of Influenza Vaccine Orders:

We conducted a retrospective analysis of nurse documentation associated with influenza vaccine orders placed at the 3 hospitals within our health system. When nurses did not administer influenza vaccine that had been ordered, they had the opportunity to document the cancellation reason in free text. Orders that were not completed by the time of discharge were also subsequently cancelled by the EHR with an indicator stating "automatic cancellation".

A human factors expert (SK) coded each order based on information contained in the nurse documentation. Categories were inductively developed by SK and subsequently reviewed and discussed with a pediatric hospital medicine physician and clinical informaticist (EO). Final categorizations were derived by consensus.

Phase 2 Interviews with Front-line Clinicians:

We conducted interviews with residents and nurses involved in the vaccine administration process. They were asked to describe their typical process from admission until influenza vaccine administration and challenges in achieving high vaccine uptake. Finally, they were also asked to suggest steps that they thought would improve influenza vaccine uptake. The participant responses were analyzed by SK and EO and barriers were summarized and reviewed with all study authors. Study authors used these barriers to come up with a set of potential solutions. The study was deemed to be non-human subjects research by the Institutional Review Board based on its focus on quality improvement.

Results

Phase 1:

We extracted a total of 1056 flu vaccine orders placed at the three hospitals that were not administered. These represented 1010 unique patient encounters and 978 unique patients. A total of 17 categories were identified. Figure 1 shows the frequency of the reasons for influenza vaccine order cancellation. The most common reason was order cancellation by the system after patient discharge (31%, 326/1056). In 22% (231/1056) of the cases, the comments indicated, that the parents/guardians stated that the patient had already received influenza vaccine in the current season. In 19% (231/1056) of the cases, documentation indicated that the parents/guardians refused influenza vaccine for their child when the nurse offered a vaccine. Parental preference for vaccine administration to occur closer to discharge (6%, 65/1056) or to have it done by the child's primary care physician (6%, 63/1056) were also in the top 5 most common reasons.

Phase 2:

A total of six clinicians (2 residents, 4 nurses) participated in the interviews. Residents communicated that the default order in admission order sets was very helpful in getting the vaccine ordered as were the links in the order to articles on influenza vaccine for patients with asthma, egg allergy, etc. However, both felt that key barriers included: (1) Admitting residents often did not know if a patient was eligible for influenza vaccine when they first met/interviewed the patient/family to complete the History and Physical exam and therefore did not discuss influenza vaccine with the patient/family. (2) Residents were unaware if vaccine was administered or refused by the patient/family unless notified by nursing staff. Thus, without a physician discussing a patient/family's concerns about the vaccine, an opportunity to vaccinate a child is lost.

Nurses described multiple reasons that might contribute to poor uptake. Key barriers included: (1) Some nurses tended to delay influenza vaccine conversations until the day of discharge. However, patient/family didn't want to delay discharge to get influenza vaccine and their readiness to leave as well as other discharge activities allowed for vaccine administration to be missed. (2) Nurses expressed that they did not feel empowered due to (i) lack of knowledge to have vaccine conversations in case families have questions (ii) uncertainty if it is their place (vs physicians') to talk to patient/family, (iii) uncertainty if vaccine should be given during hospitalization vs a medical home, (iv) unwillingness to administer a shot that might cause a sick

child additional pain. (3) Vaccine supplies, particularly needles for intramuscular injections, were low on the patient floors, leading to delays and discharge without vaccine administration. (4) Influenza vaccine orders that were not immediately administered might languish on their nursing task lists in an area that was not prominent, leading nurses to forget a vaccine was still necessary since they did not have an easy mechanism to follow up on orders regularly and identify patients with an unadministered vaccine.

Participants suggested multiple interventions within the EHR to improve vaccine administration: (1) Reminders or messages to residents in the morning about influenza vaccine eligible patients on their team so they could talk about the vaccine with the family during morning rounds, (2) Reminders to residents prior to their first interaction with the patient to start a conversation with family and answers questions that patient and family may have as early as possible, (3) Alerts when placing discharge orders for patients with an active influenza vaccine order that had yet to be administered, and (4) Explicit scripts and materials to aid nurses with vaccine conversations.

Based on these barriers and participant suggestions, we developed a set of candidate interventions to promote vaccine uptake in inpatient settings (Table 1).

Discussion

While a CDS system significantly improved influenza vaccine uptake, ongoing barriers to increasing coverage include inadequate insight for nurses and physicians into the status of influenza vaccine orders, busy discharge processes, and insufficient knowledge or empowerment for vaccine discussions. Most influenza vaccine orders that were not administered were active at the time of discharge and cancelled automatically by the EHR. Only one in four cancelled influenza vaccine orders indicated the parents had specifically refused the vaccine. Even if we assume all automatically cancelled orders were due to refusal, nearly half of cancellations would be for other reasons such as preference for vaccination at discharge or with primary care physician. Our findings suggest that seasonal influenza vaccine uptake in the inpatient pediatric setting could be improved with optimization of workflow to integrate vaccine delivery into the encounter workflow. Despite the presence of a clinical decision support system that was integrated with the state immunization registry, nearly one in four cancellations were due to parents stating the child had already received a seasonal influenza vaccine. This discrepancy may be due to vaccine administrations in the community that were not communicated to the state system or occurred outside of the state. It may also be due to parents wishing to avoid controversial conversations. Efforts to improve coordination between the EHR, the state registry, and vaccine administration systems in the community may improve the ability of systems to accurately detect eligible children.

This study is limited by the analysis of barriers to influenza vaccine uptake at one health system. The small sample size may have limited the reasons identified by participants. Future studies should look at barriers that are common to health systems and those unique to organizations based on their local practice. These will help develop approaches to improve vaccine uptake. Finally, the solutions identified are yet to be tested for effectiveness.

Figure 1 – Frequency of reasons for flu vaccine order cancellation

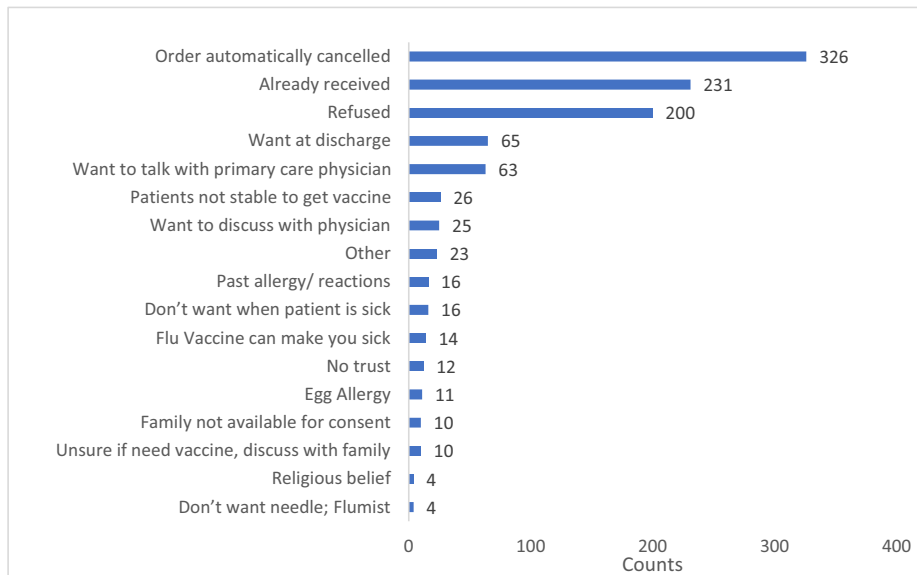


Table 1- Barriers to flu vaccine uptake and potential solutions

| Barriers | Potential Solution(s) |
|---|---|
| 1. Nurse culture to defer orders to discharge | <ul style="list-style-type: none"> Message from management that vaccines can be given earlier in the admission |
| 2. Nurses do not feel empowered to talk to families about influenza vaccine | <ul style="list-style-type: none"> Nurse education through various avenues within the organization Scripts for nurses to start early conversations and answer family questions and initial hesitancy |
| 3. Influenza vaccine conversation with patients did not happen early during the admission | <ul style="list-style-type: none"> Daily huddles to give nurses resources to talk with patients Information to answer patient questions and scripts tied to order for "just-in-time" support so nurses have information when working on influenza order |
| 4. Nurses cannot follow up on orders regularly ; pending orders may fall off nurses attention | <ul style="list-style-type: none"> Handout given to patients for answering questions Provide reminder or questionnaire in their H&P section Resident education via email and grand rounds |
| 5. Residents cannot follow up on orders regularly | <ul style="list-style-type: none"> Charge nurse and Resource nurse to look at list of patients who are eligible for flu and help follow-up on flu vaccine administrations Daily huddles to remind nurses about flu vaccine Banner on the patient chart to indicate status (1) Eligible, but not ordered and (2) Ordered but not given Daily reminder on list of patients on their team who are eligible for influenza vaccines prior to morning rounds so physicians can bring it up with the family during rounds. |
| 6. Low supply of needles for Intramuscular injections on the floor | <ul style="list-style-type: none"> Work with pharmacy to ensure supply |
| 7. Missing pending influenza vaccine orders during hectic discharge | <ul style="list-style-type: none"> Non- interruptive alerts to show warning when printing "After Visit Summary" Interruptive alert for patients with active discharge order and active flu vaccine order not yet administered Conditional discharge order for patients with active flu vaccine order and no administration |

Conclusions

The presence of a CDS opt out order for influenza vaccine increases vaccine uptake but its full potential may not be realized. Interventions to assist conversations with patient families for clinical providers of care and easier process flow to follow up on orders may further improve vaccine uptake in inpatient care settings.

Acknowledgements

The authors would like to acknowledge the pediatric residents and nurses for their participation and valuable insights. EO has equity in Phrase Health© a clinical decision support analytics company. He does not receive any direct revenue. SK had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

EO and SK's work was supported by the Agency for Healthcare Research and Quality award number R03HS027689-01. The funder had no role in design and conduct of the study, collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit.

References

- [1] K.E. Lafond, H. Nair, M.H. Rasooly, F. Valente, R. Booy, M. Rahman, P. Kitsutani, H. Yu, G. Guzman, D. Coulibaly, J. Armero, D. Jima, S.R. Howie, W. Ampofo, R. Mena, M. Chadha, O.D. Sampurno, G.O. Emukule, Z. Nurmatov, A. Corwin, J.M. Heraud, D.E. Noyola, R. Cocjaru, P. Nymadawa, A. Barakat, A. Adedeji, M. von Horoch, R. Olveda, T. Nyatanyi, M. Venter, V. Mmbaga, M. Chittaganpitch, T.H. Nguyen, A. Theo, M. Whaley, E. Azziz-Baumgartner, J. Bresee, H. Campbell, M.A. Widdowson, and G. Global Respiratory Hospitalizations-Influenza Proportion Positive Working, Global Role and Burden of Influenza in Pediatric Respiratory Hospitalizations, 1982-2012: A Systematic Analysis, *PLoS Med* **13** (2016), e1001977.
- [2] Estimated Influenza Illnesses, Medical visits, Hospitalizations, and Deaths in the United States — 2018–2019 influenza season, in, Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases (NCIRD), January 8 2020.
- [3] M.A. Rolfes, B. Flannery, J.R. Chung, A. O'Halloran, S. Garg, E.A. Belongia, M. Gaglani, R.K. Zimmerman, M.L. Jackson, A.S. Monto, N.B. Alden, E. Anderson, N.M. Bennett, L. Billing, S. Eckel, P.D. Kirley, R. Lynfield, M.L. Monroe, M. Spencer, N. Spina, H.K. Talbot, A. Thomas, S.M. Torres, K. Yousey-Hindes, J.A. Singleton, M. Patel, C. Reed, A.M. Fry, t.I.H.S.N. Us Influenza Vaccine Effectiveness Network, I.S.D.C.f.D.C. the Assessment Branch, and Prevention, Effects of Influenza Vaccination in the United States During the 2017-2018 Influenza Season, *Clin Infect Dis* **69** (2019), 1845-1853.
- [4] M.G. Thompson, N. Pierce, Q. Sue Huang, N. Prasad, J. Duque, E. Claire Newbern, M.G. Baker, N. Turner, and C. McArthur, Influenza vaccine effectiveness in preventing influenza-associated intensive care admissions and attenuating severe disease among adults in New Zealand 2012–2015, *Vaccine* **36** (2018), 5916-5925.
- [5] Flu Vaccination Coverage, United States, 2018–19 Influenza Season, in: *FluVaxView*, Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases (NCIRD), September 26 2019.
- [6] S. Rao, J.T. Williams, M. Torok, M. Cunningham, M. Glodé, and K. Wilson, Missed Opportunities for Influenza Vaccination Among Hospitalized Children With Influenza at a Tertiary Care Facility, *Hospital pediatrics* **6** **9** (2016), 513-519.
- [7] L.A. Grohskopf, E. Alyanak, K.R. Broder, L.H. Blanton, A.M. Fry, D.B. Jernigan, and R.L. Atmar, Prevention and Control of Seasonal Influenza with Vaccines: Recommendations of the Advisory Committee on Immunization Practices - United States, 2020-21 Influenza Season, *MMWR. Recommendations and reports : Morbidity and mortality weekly report. Recommendations and reports* **69** (2020), 1-24.
- [8] T.A. Santibanez, K.H. Nguyen, S.M. Greby, A. Fisher, P. Scanlon, A. Bhatt, A. Srivastav, and J.A. Singleton, Parental Vaccine Hesitancy and Childhood Influenza Vaccination, *Pediatrics* **146** (2020), e2020007609.
- [9] D.M. Foradori, E.M. Sampayo, S.A. Fanny, M.K. Namireddy, A.M. Kumar, and H.-y. Lo, Improving Influenza Vaccination in Hospitalized Children With Asthma, *Pediatrics* **145** (2020), e20191735.
- [10] A.J. Mihalek, L. Kysh, and P.S. Pannaraj, Pediatric Inpatient Immunizations: A Literature Review, *Hospital pediatrics* **9** (2019), 550.
- [11] J.L. Freedman, A.F. Reilly, S.C. Powell, and L.C. Bailey, Quality Improvement Initiative to Increase Influenza Vaccination in Pediatric Cancer Patients, *Pediatrics* **135** (2015), e540.
- [12] P.S. Roshanov, N. Fernandes, J.M. Wilczynski, B.J. Hemens, J.J. You, S.M. Handler, R. Nieuwlaat, N.M. Souza, J. Beyene, H.G.C.V. Spall, A.X. Garg, and R.B. Haynes, Features of effective computerised clinical decision support systems: meta-regression of 162 randomised trials, *BMJ : British Medical Journal* **346** (2013), f657.
- [13] P.S. Roshanov, S. Misra, H.C. Gerstein, A.X. Garg, R.J. Sebaltd, J.A. Mackay, L. Weise-Kelly, T. Navarro, N.L. Wilczynski, R.B. Haynes, and C.S.R. Team, Computerized clinical decision support systems for chronic disease management: a decision-maker-researcher partnership systematic review, *Implementation science : IS* **6** (2011), 92-92.
- [14] N.M. Souza, R.J. Sebaltd, J.A. Mackay, J.C. Prorok, L. Weise-Kelly, T. Navarro, N.L. Wilczynski, R.B. Haynes, and C.S.R. Team, Computerized clinical decision support systems for primary preventive care: a decision-maker-researcher partnership systematic review of effects on process of care and patient outcomes, *Implementation science : IS* **6** (2011), 87-87.

- [15] D.J. Opel, R. Mangione-Smith, J.D. Robinson, J. Heritage, V. DeVere, H.S. Salas, C. Zhou, and J.A. Taylor, The Influence of Provider Communication Behaviors on Parental Vaccine Acceptance and Visit Experience, *American journal of public health* **105** (2015), 1998-2004.
- [16] D.J. Opel, C. Zhou, J.D. Robinson, N. Henrikson, K. Lepere, R. Mangione-Smith, and J.A. Taylor, Impact of Childhood Vaccine Discussion Format Over Time on Immunization Status, *Academic pediatrics* **18** (2018), 430-436.
- [17] E.W. Orenstein, O. ElSayed-Ali, S. Kandaswamy, E. Masterson, R. Blanco, P. Shah, P. Lantis, A. Kolwaite, T.E. Dawson, E. Ray, C. Bryant, S. Iyer, A.L. Shane, and S. Jernigan, Evaluation of a Clinical Decision Support Strategy to Increase Seasonal Influenza Vaccination Among Hospitalized Children Before Inpatient Discharge, *JAMA Network Open* **4** (2021), e2117809-e2117809.

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