# Developing a System for Clinician-Focused and Family-Focused Decision Support for Adolescent Vaccines

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The HPV Clinical Decision Support and Delivery System was developed to improve HPV vaccine rates for girls. The system was implemented by The Children's Hospital of Philadelphia Care Network and is based on a set of integrated components including technology, educational content, data analysis and communication.

Different organizations have a wide range of technologies, capabilities and/or even different preferences in delivering clinical decision support. While this guide provides specifications on the development of our system, it is designed to be flexible. We do this by focusing broadly on the concepts and strategies that guide the design of the system and wherever possible include suggestions on alternative approaches, either technological or process-oriented, that support achievement of the system's objectives.

# Overview

**Summary of Background and Significance:** More than ever, healthcare organizations need generalizable approaches for clinical decision support (CDS) design and implementation, a goal that is among the top priorities for the American Medical Informatics Association and the Office of the National Coordinator for Health Information Technology.[1] HPV vaccine delivery in primary care is an ideal setting to study how best to use health IT to support evidence-based decision making for several reasons: families' knowledge regarding the vaccine is often incomplete or inaccurate, parents, adolescents, and clinicians take part in the decision, delay in vaccination jeopardizes health, time for discussion and education at the time of pediatric office visits is limited, and many children are not currently initiating and completing this potentially life-saving vaccine series.

**The Role of Health IT and Clinical Decision Support in Improving Immunization Delivery*:*** Given the health benefit of the HPV vaccine, known barriers to immunization, and low rates of receipt, novel strategies are needed to boost the initiation and completion of the vaccine series. Fortunately, established approaches exist to maximize the effectiveness of these systems.[2-4] Building upon the work of others in the adult setting,[5, 6] our research team developed and tested a clinical decision support system (CDSS) for both routine pediatric immunization and influenza vaccination [7, 8] The intervention described in this guide was built upon this work as it defines an optimal approach for improving decision making around HPV vaccine delivery for clinicians, adolescents, and their parents using health IT.

**Packaging Clinical Decision Support with Feedback:** The approach of summarizing clinical performance over a specified interval, known as audit and feedback, has been extensively used to deliver performance information to clinicians. The use of feedback in an immunization intervention is particularly relevant since prior work has demonstrated that multimodal interventions are more likely to be effective than those using a single approach. In order to maximize the likelihood of success, our system included monthly feedback to all clinicians at sites receiving the clinician-focused decision support described in this guide.

**Using Health IT Directed at Families to Improve Immunization Delivery:** In addition to clinician focused reminders, systems based on health IT have been implemented in both pediatric and adult settings to directly support families in receiving timely vaccination. For adults, computer systems have been used to improve influenza vaccination rates by generating mailed reminders.[9] For children, electronic systems that generate reminders for families through automatically dialed calls or automated letters based on computerized registries have proven effective and cost-effective.[10-14] These reminders have been used for routine childhood immunization among infants and preschool age children and for influenza vaccine. They have often been directed at low-income families. However, these interventions have not provided educational content, none of these studies have focused specifically on adolescent vaccination, and this approach has not been widely evaluated using electronic medical records (EMRs).

# Use Case: Decision Support System in a Clinical Context

*On Tuesday evening Peggy came home to find an automated voice message from the pediatrician's office. The message reminded Peggy that her 11 year old daughter, Chloe, has a routine check up on Thursday with Dr. Fiks. The message also stated that Chloe was now old enough to receive the human papillomavirus (or HPV) vaccine and that more information on the vaccine could be found on an educational website. Peggy visited the website later that evening and it helped her better understand the HPV vaccine. She made a mental note to discuss what she had learned with Dr. Fiks during Chloe's appointment.*

*On Thursday Peggy and Chloe arrived at the clinic. Dr. Fiks came to the exam room and, while asking if they had anything they would like to discuss, brought up Chloe's chart on the computer. The electronic medical record presented a complete immunization history to Dr. Fiks and informed him that Chloe was eligible for the HPV vaccine. After performing the exam Dr. Fiks raised the issue of the HPV vaccine. Peggy told him about what she had learned from the phone message and website. They discussed the vaccine. They decided that Chloe would receive the vaccine. With a single click Dr. Fiks ordered and documented the immunization in the electronic medical record, and Chloe was administered her first of three injections.*

*Two months later Peggy received another automated phone call reminding her that Chloe was now due for her second HPV injection. She called the clinic and was able to make an appointment with the nurse to receive the second injection. Four months after that (six months after the first injection) she received another message reminding her of Chloe's third and final injection.*

*Meanwhile every 3 months Dr. Fiks receives a report detailing how many of his eligible patients are receiving the HPV vaccine. From the report he sees that more of his patients and those of the entire clinic than of other clinicians or clinics are receiving the vaccine and that the reminder system is helping in assuring that more patients receive the entire series of HPV injections.*

The narrative above captures the perspective of the parent, child and physician in interacting with the HPV Clinical Decision Support and Delivery System. This implementation guide provides detailed information for any organization wishing to replicate the same experience for their parents, patients and clinicians. In developing our system we utilized many technology components including a custom-programming framework that allows us to enhance the capabilities of our commercial EMR. This guide includes information to replicate this system. However, we realize different organizations may not wish to follow such an approach due to constraints on resources, time, technology or personnel. Other organizations may have their own technical approaches to decision support. With all this in mind this guide was developed to focus primarily on the concepts and strategies that guide the design of the system.

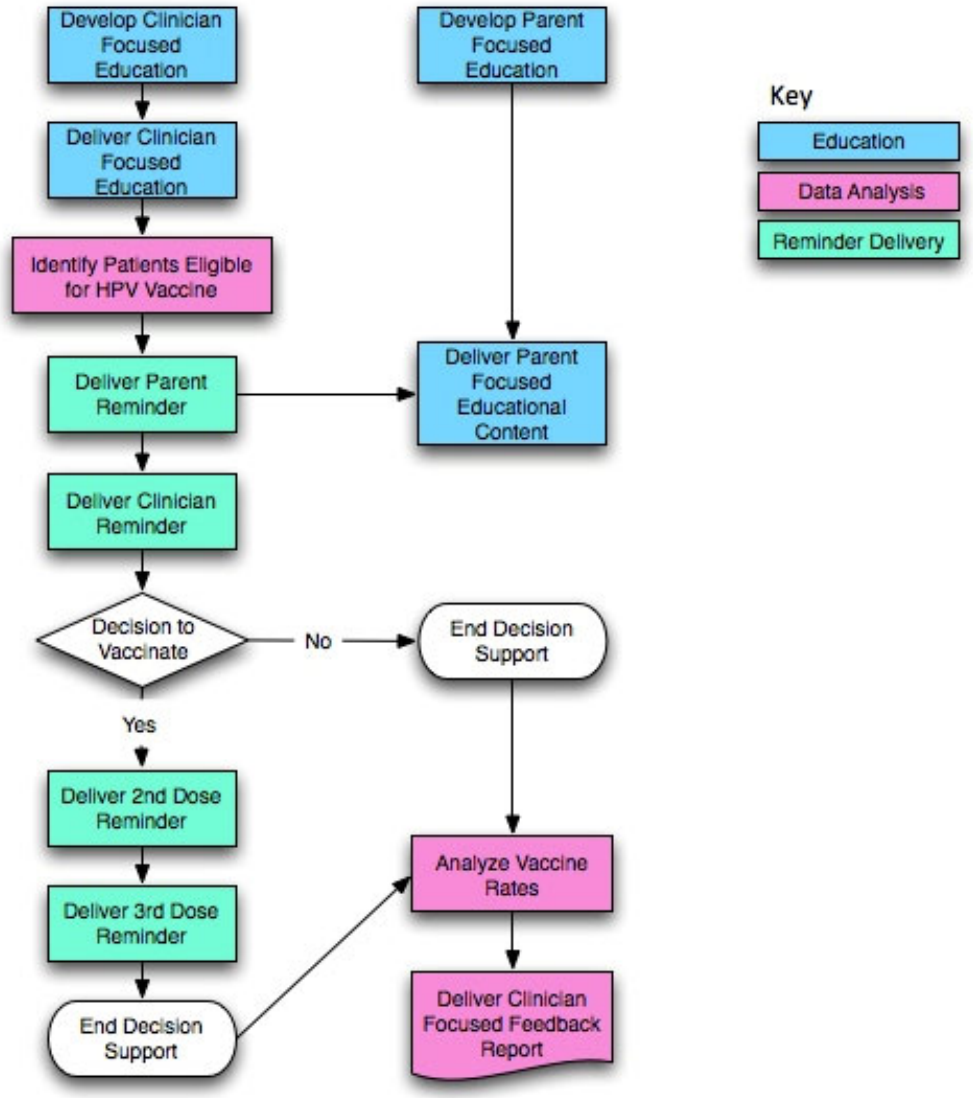
# System Overview

The HPV Clinical Decision Support and Delivery System employs multiple evidence-based strategies to influence HPV vaccine delivery and receipt in primary care. At its most basic level the system can be broken down into three high level functional categories:

1. Education
2. Data Analysis
3. Reminder Delivery

Figure 1 presents these functional categories in a flowchart diagram that can be applied to understanding how the system functions, but also in how it can be developed.

**Figure 1: Vaccine Delivery System Development Workflow**



The system was designed in the following sequence:

- Educational content is developed for both clinicians and parents.
- Clinician education is delivered via a lecture or as an online course with the purpose of better preparing clinicians to discuss HPV with their patients.
- A system is implemented to identify patients who are both eligible for HPV and have an upcoming encounter.
- Prior to the encounter a reminder is triggered and delivered to the parent informing them of their child's eligibility and pointing them to the parent education material.
- During the encounter, a reminder is triggered and delivered to the clinician who initiates a discussion with the parent.
- If the parent agrees to the vaccine, it is administered and the system generates similar reminders for both parent and clinician for the second and third dose.
- At periodic intervals, the system generates reports on vaccination rates. These reports are delivered to clinicians so they can measure their own rates and compare them (anonymously) to the rates of their entire clinic, region, care network or organization.

# Project Team

A key factor in successfully implementing a clinical decision support system is assembling the project team. Table 1 presents the roles, responsibilities and skills of those who developed and managed the HPV Clinical Decision Support and Delivery System. It is important to note that different organizations may combine or divide these roles to better match the skills and/or availability of personnel. This is often true on the technical roles where staff skills can be variable. For example, the EMR Analyst might also fill the role of Testing and Quality Assurance. However, the same could apply to the project management roles. For example, the Physician Lead or Study Coordinator may also be adept at project management and could assume these responsibilities.

**Table 1: Roles, Responsibilities and Skills**

| Role | Responsibilities | Skills |
|---|---|---|
| Physician Lead | The physician champion of the project. | Informatics expertise (research or operational), strong relationship with ambulatory network. |
| Project Manager | Manages the entire project and supports all team members in achieving their own and the team's overall objectives. | Demonstrated success in managing of highly technical projects. |
| Study Coordinator | Responsible for all communication and reporting. Liaison to the clinical end users of the intervention. | Organization and communication. Clinical and informatics training and expertise. Above average skills with productivity software (Word, Excel...). |
| Data Analyst | Compiles and presents data into information accessible for every facet of the project. | Database Manager skills and expertise. Oracle/SQL plus familiarity with the structure and content of the EMR database. |
| Education Expert | Responsible for the creation/adaptation and content of educational materials. | Experience and/or training in clinical education. |
| EMR Analyst * | Configures and manages EMR based alert/reminder functionality. | EMR Training and Certification as required |
| Testing and Quality Assurance* | Tests all technology development work for intended functionality and "bugs." | Experience in developing and implementing test plans. |

Table 2 maps the project team roles to the programming framework and implementation components. Please note, this represents the roles used in our project. Other organizations may choose to manage projects and tasks differently.

**Table 1: Suggested Project Roles Mapped to System Components**

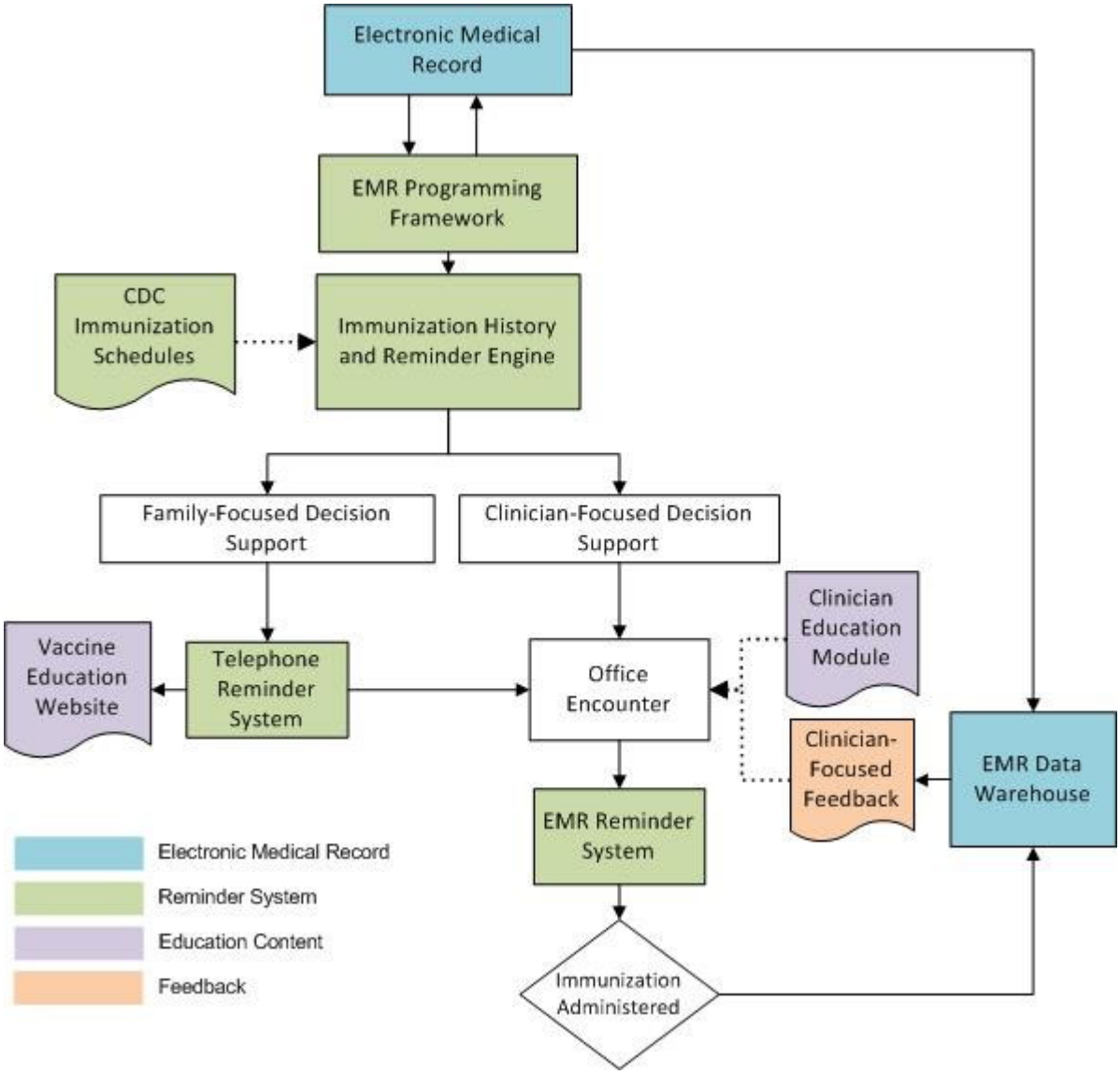
| Roles and System Components | Clinician Focused Education | Parent Focused Education | Identification of Patients Eligible for Vaccine | Parent Reminder Delivery | Physician Reminder Delivery | Clinician Focused Feedback |
|---|---|---|---|---|---|---|
| Physician Lead | Yes | Yes | Yes | Yes | Yes | Yes |
| Project Manager | Yes | Yes | Yes | Yes | Yes | Yes |
| Study Coordinator | Yes | Yes | | Yes | | Yes |
| Data Analyst | | | Yes | Yes | Yes | Yes |
| Education Expert | Yes | Yes | | | | |
| EMR Analyst | | | Yes | Yes | Yes | |
| Testing and Quality Assurance | | | Yes | Yes | Yes | |

# Custom Programming Framework

Our system integrates the data analysis and reminder delivery components via the implementation of a custom-programming framework that allows us to automate and customize EMR functionality. Figure 2 details the component flow of this system.

We realize that not all organizations will have the desire and/or resources to pursue this approach and as a result this guide presents alternative approaches. For example, our custom-programming framework manages the clinician reminder delivery, but others may wish to utilize the built in reminder or alert features of their electronic medical record. Or, our system automates the identification of patients eligible for HPV and interfaces with a telephone reminder system that places an automated phone call to the parent. An alternative to this approach might have an analyst run periodic reports identifying eligible patients that would be used to deliver the reminder to the parent via mailing a form letter or perhaps by having a nurse make the call.

**Figure 2: Vaccine Delivery System Component Flow**



The system component flow from Figure 2 can be described as:

- The Custom Programming Framework is integrated with the EMR and supports the Immunization History and Reminder Engine that is developed with logic derived from the CDC Immunization Schedules.
- The Immunization and Reminder Engine identifies patients who meet the criteria for immunization and feeds this information to both Family-Focused Decision Support and Clinician-Focused Decision Support.
- Family-Focused Decision Support consists of delivering reminders via a Telephone Reminder System. The recorded message of the call includes information pointing the parent to the Vaccine Education Website.
- Clinician-Focused Decision Support occurs in the Exam Room via the EMR Reminder System. Two additional components support Clinician-Focused Decision Support:
    - 1. Clinician-Focused Education delivered via an education module.
    - 2. Clinician-Focused Feedback via periodic reports on the clinician's vaccination rates.

# Clinician-Focused Education

## *Purpose*

Studies demonstrate that clinician recommendation is one of the strongest predictors of HPV vaccine rates. Therefore education can serve as a critical component in the adoption and success of decision support designed to trigger the clinician to make an effective recommendation. The purpose of implementing Clinician-Focused Education is to educate clinicians regarding the importance of their role and to provide them with information that will help them feel confident in recommending the vaccine. As an added incentive, our Clinician-Focused Education module was developed to meet requirements for a one-hour Continuing Medical Education (CME) credit.

## *Overview*

Clinician-Focused Education consisted of creating and distributing an educational module for physicians. The module consisted of the presentation of content followed by a short survey or assessment as required in the CME credit process.

Our module was developed using PowerPoint to contain the basic slides, diagrams and images. Overall, the goal of the presentation was to help clinicians feel comfortable discussing adolescent vaccines, especially HPV, with families and to have data at hand to address concerns and motivate timely vaccination. The presentation began with a review of published guidelines for adolescent vaccines. We next highlighted local data summarizing the low vaccination rates for HPV that this study was designed to address. This data was retrieved from the EMR. For the live presentations, providers were provided with data on vaccination rates specific to their practice. The online module featured aggregate data for the urban and suburban practices, respectively. The presentation also highlighted the variability across practices, likely related to clinician practice and not just families' preferences. The epidemiology of the different vaccine preventable conditions, vaccine efficacy, and safety were also reviewed. For HPV, the discussion featured data on the early age and high prevalence of HPV-related disease and the fact that the vaccine is only effective if given prior to the acquisition of HPV. Background literature on factors influencing vaccine adoption was then reviewed. In particular, the importance of clinician recommendation of vaccines to families' acceptance was emphasized. Evidence-based messages to help families better understand and accept vaccines were discussed in detail. We also highlighted data from our network that showed that rates of attendance at preventive visits steadily decline for adolescents as their age increases from 11 to 18 years. Finally, practices were introduced to the components of the intervention and, for live sessions, had an opportunity to ask questions regarding the upcoming study.

To create the online content, we used the education development application Articulate to add audio narration tracks for each slide and to create the online assessment. With Articulate we compiled the module and assessment into a SCORM complaint file in order for it to be uploaded into our Learning Management system (LMS). From the LMS we automatically assigned the training to physicians in the targeted clinics. Clinicians received an automated email notification from the LMS that training was assigned. Clinicians logged into the LMS to view the education then completed the survey/assessment required for CME credit. The LMS helped us monitor who had completed the training, compile the assessments and to assign the training to any new physicians as required.

## *Optional Approaches*

It is almost certain that different organizations will have a range of technologies, capabilities and preferences in the creation and/or delivery of clinician education content. In addition, though CME credit is not required, if it is possible to coordinate this we highly recommend that it be pursued. In our experience, clinicians welcome the opportunity to be rewarded for the effort it takes to participate in interventions like this one.

For organizations without a LMS, there are a number of different approaches that could be applied. A "technology-free" approach is perfectly acceptable and has been utilized in clinician education for decades. For example, instead of delivering the training online it could be delivered in person as a lecture, perhaps in an auditorium or meeting space, or at lunchtime presentations scheduled at each clinic. The survey/assessment, require for CME credit, could be a simple paper based questionnaire collected at the end of the session.

In the development of our online module, the application Articulate was used mainly to package the content for the LMS including audio tracks and the online assessment. Without a LMS, there is no need for Articulate. Instead, the file could be created in PowerPoint that also provides the ability to record audio. The PowerPoint file could be distributed to clinicians via email or from a webpage link. The assessment could be delivered as an attachment (a Word file or pdf for example) or as an online survey using any of the low cost or even free web based survey applications.

## *Resources*

CHOP HPV Education Module.ppt

The presentation file used in our CME course (audio not included).

# Parent-Focused Education

## *Purpose*

Conceptually, the parent-focused education was based on concepts of the medical home which stress the importance of the prepared, pro-active patient or family. In this case, the parent was informed that the child was due for the vaccine with a reminder call, then referred to the educational web site. The idea was to stimulate thinking by the family prior to the visit so that the family could be prepared with questions or concerns that could then be addressed by the clinician. Because the call was brief, we decided to refer families to an educational web site to learn more. Instead of creating educational content for families from scratch, we referred them to an evidence-based, family-centered vaccine education website already supported by our health system and available to the public.

## *Overview*

Parent-Focused Education consists of web based educational materials that are referenced while delivering the vaccine reminder to parents. As the parent is notified that their child is eligible for the vaccine, they are referred to the website for additional information.

## *Optional Approaches*

Our hospital has developed a comprehensive Vaccine Education Center web site (see Figure 4). This site is available to the public. Anyone interested in vaccines can access it and clinicians anywhere can refer families to its content. For organizations that prefer to use a different site or to create their own, content is available from the Centers for Disease Control and Prevention. For example, see: http://www.cdc.gov/vaccines/vpd-vac/hpv/default.htm

New patient portal systems have the potential to not only deliver reminders to patients by email, but can include links or direct access to patient education resources. By contrast, Patient-Focused Education need not be web based. For example, printed materials could be delivered in clinic or even by mail as part of mail based patient reminders.

**Figure 3: Vaccine Education Center website**

## *Resources*

**Link to CHOP Vaccine Education Center:**
**http://www.chop.edu/service/vaccine-education-center/a-look-at-each-vaccine/hpv-vaccine.html**

# Identification of Patients Eligible for Vaccine

## *Purpose*

The purpose of Identification of Patients Eligible for Vaccine is to utilize patient data to identify patients eligible for the vaccine and to then supply that information to the parent and clinician reminder delivery systems.

## *Overview*

The system is coded to identify patients who meet three different criteria for HPV vaccine eligibility:

- Upcoming visit and due for vaccine
- No visit and due for vaccines and visit
- Only due for vaccine

The source for this logic is the CDC document, "Recommended Immunization Schedule for Persons Aged 7 Through 18 Years." These schedules change frequently so please refer to the CDC website, http://www.cdc.gov/vaccines/recs/schedules/default.htm

The system runs this analysis at periodic intervals. Results from the analysis (e.g. patients eligible for HPV) are utilized by integration with the parent and clinician reminder delivery systems.

## *Optional Approaches*

There are alternate approaches to achieve the objective of identifying patients eligible for the HPV vaccine. Any organization with access to basic patient data should be able to construct a report that would list eligible patients. This report could be run manually at specified intervals and the results delivered to those managing the parent and/or clinician reminder delivery.

In addition, many EMR systems provide built in reminder functionality such as Best Practice Alerts, Health Maintenance or other similar features. These features might be utilized to trigger on the HPV vaccine eligibility criteria and remind clinicians that vaccines are due.

## *Resources*

CDC Immunization schedules at: http://www.cdc.gov/vaccines/recs/schedules/default.htm

# Parent Reminder Delivery

## *Purpose*

The purpose of Parent Reminder Delivery is to notify parents that their child is eligible for the vaccine just prior to a scheduled clinic visit or, if children are due and no visit is scheduled, to remind them to call the office to schedule a visit. The reminder also included a reference to vaccine education materials the parent can access.

Reminders are developed for the following:

1. Before scheduled well visits with shots due
2. When well child care is due and shots are due but well child care has not yet been scheduled.
3. When doses #2 and 3 of HPV are due.
4. No calls if any prior HPV doses were received in the family planning setting (to prevent a breach of confidentiality).

## *Overview*

In our system, data from patients identified as eligible for HPV is integrated with an automated phone reminder system. The phone system initiates an automated call to the patient's household using a script matched to the patient criteria described above. The phone reminder also includes information on the family-focused education website.

## *Optional Approaches*

Delivering the patent reminder could be achieved in many alternative ways. For example, a technology-free option would have a nurse make telephone calls or the reminder could be delivered by mail as a form letter.

By contrast, a more advanced form of implementation could be applied by any organizations with a fully implemented PHR or "patient portal." Instead of the phone-based reminder, an automated email could be delivered with the added benefit of being able to include the supporting parent-focused educational content or links to such content.

## *Resources*

1. Scripts for family-focused phone calls (available in Supplemental Appendix of Fiks 2013 *Pediatrics* publication[15])

# Clinician Reminder Delivery

## *Purpose*

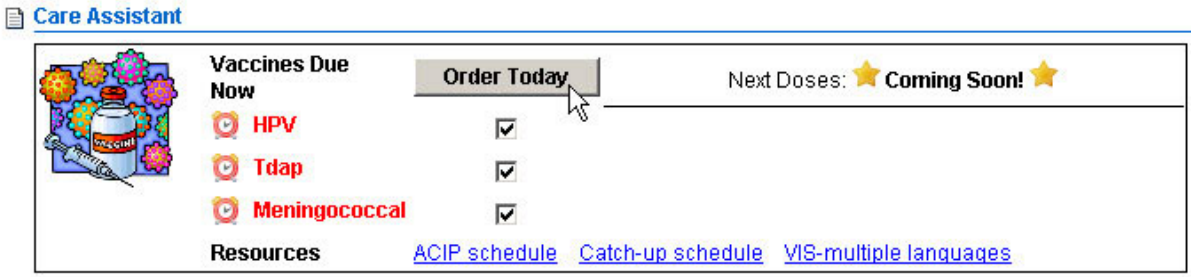
The purpose of Clinician Reminder Delivery is to notify the physician during the visit that their patient is eligible for the vaccine and to prompt a discussion of the vaccine between parent and physician and a recommendation for the adolescent to be vaccinated.

## *Overview*

Data from patients identified as eligible for HPV triggers a built in alert system within the EMR. The physician notes the alert and engages the parent in a discussion about the vaccine and recommends it. If the parent (and child) agrees, the vaccine is administered and a follow up visit for the second dose is arranged.

Our custom-programming framework manages clinician reminder delivery for any and all immunizations via and application called the Immunization Care Assistant. This application is embedded in the EMR and provides the clinician with an alert on all immunizations due and then assists the clinician in automating the order entry process.

**Figure 4: Screen Shot of Immunization Assistant**




## *Optional Approaches*

Delivering the physician reminder could be achieved in many alternative ways.

A technology based approach without the programming framework would be to utilize the EMR's built in reminder functionality such as Best Practice Alerts, Health Maintenance or other similar features. While we have found these features too limited to manage all immunizations, they might be successfully applied to just a single one or group of vaccines that are deemed especially high priority.

If no alert system is in place, but an EMR is being used, a member of the office staff/clinical team could place a note in the chart in a location that clinicians review for each patient, for example in a patient summary screen. For organizations without an EMR, a more traditional and simple approach of placing stickers on patient's paper charts could also be implemented.

## *Resources*

Refer to the CDC Adolescent Immunization Schedule: http://www.cdc.gov/vaccines/recs/schedules/default.htm

# Clinician Focused Feedback

## *Purpose*

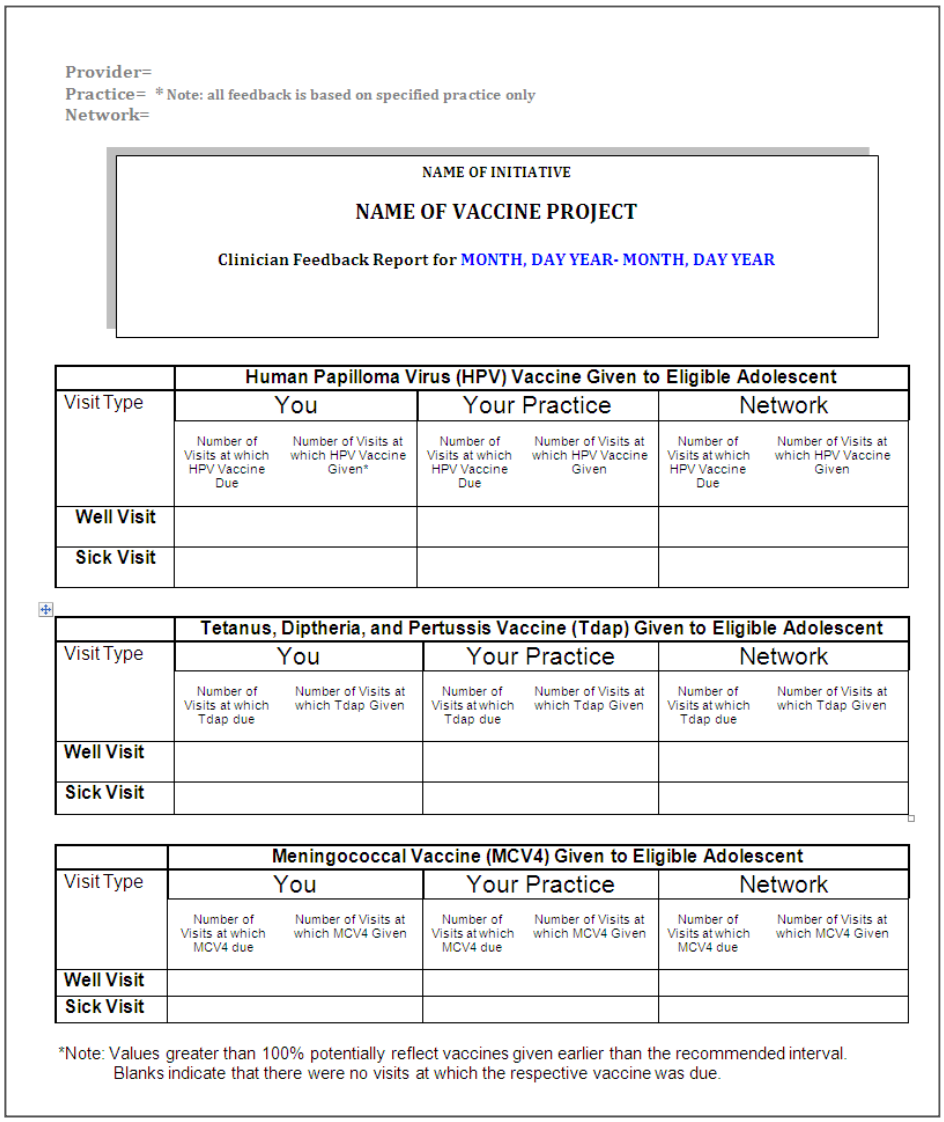
The purpose of Clinician Focused Feedback is to deliver information on vaccination rates to clinicians. The reports allow each clinician to see their own personal results and to compare their rates with that of their own clinic and/or other clinics or the entire ambulatory network. This approach is motivated by the notion of achievable benchmarks. In other words, if others at a clinicians practice or in the network are doing better, then a given clinician could and should aim to achieve the same benchmark. This approach has been shown to be generally more effective than providing feedback without benchmarks. Of course, each clinician can only view their own data and the comparison reports are designed to preserve anonymity. Each organization should consider how best to deliver this information. The overall goal of feedback is also worth emphasizing; the data is not intended to be punitive, but to monitor progress and encourage improvement.

## *Overview*

Clinician-Focused Feedback consists of creating and delivering to each clinicians a report on the rate of immunizations for eligible patients for HPV, Tdap and MCV4 at well visits and sick visits (See Figure 4). The report is designed so that each clinician can review their own results and in comparison to the results of their clinic and across the entire ambulatory network.

The Data Analyst identifies the required data elements and constructs the proper query to extract the data. The query is run and raw results are saved. The Study Coordinator and Data Analyst develop a report template in Word. Using the data file, the Study Coordinator runs a “mail merge” resulting in a report for each physician. The Study Coordinator delivers the reports to the clinicians and responds to any questions or concerns.

**Figure 5: Clinician Feedback Report Template**



Provider=
Practice= * Note: all feedback is based on specified practice only
Network=

NAME OF INITIATIVE

NAME OF VACCINE PROJECT

Clinician Feedback Report for MONTH, DAY YEAR- MONTH, DAY YEAR

| | Human Papilloma Virus (HPV) Vaccine Given to Eligible Adolescent | | | | | |
|---|---|---|---|---|---|---|
| Visit Type | You | | Your Practice | | Network | |
| | Number of Visits at which HPV Vaccine Due | Number of Visits at which HPV Vaccine Given* | Number of Visits at which HPV Vaccine Due | Number of Visits at which HPV Vaccine Given | Number of Visits at which HPV Vaccine Due | Number of Visits at which HPV Vaccine Given |
| **Well Visit** | | | | | | |
| **Sick Visit** | | | | | | |

| | Tetanus, Diptheria, and Pertussis Vaccine (Tdap) Given to Eligible Adolescent | | | | | |
|---|---|---|---|---|---|---|
| Visit Type | You | | Your Practice | | Network | |
| | Number of Visits at which Tdap due | Number of Visits at which Tdap Given | Number of Visits at which Tdap due | Number of Visits at which Tdap Given | Number of Visits at which Tdap due | Number of Visits at which Tdap Given |
| **Well Visit** | | | | | | |
| **Sick Visit** | | | | | | |

| | Meningococcal Vaccine (MCV4) Given to Eligible Adolescent | | | | | |
|---|---|---|---|---|---|---|
| Visit Type | You | | Your Practice | | Network | |
| | Number of Visits at which MCV4 due | Number of Visits at which MCV4 Given | Number of Visits at which MCV4 due | Number of Visits at which MCV4 Given | Number of Visits at which MCV4 due | Number of Visits at which MCV4 Given |
| **Well Visit** | | | | | | |
| **Sick Visit** | | | | | | |

*Note: Values greater than 100% potentially reflect vaccines given earlier than the recommended interval.
Blanks indicate that there were no visits at which the respective vaccine was due.

## *Optional Approaches*

Delivering feedback depends upon querying the EMR to extract relevant information specific to an individual and to practices in aggregate. No single extraction tool is ideal. In each setting, clinicians should work with their EMR vendor to discuss how to extract such information. In addition, when these tools are unavailable, third party vendors have entered the market that are able to extract and present data to practices to promote the improved quality of care.

## *Resources*

Template feedback report (available in Supplemental Appendix of Fiks 2013 *Pediatrics* publication[15])

# Summary

Decision support is often viewed narrowly as a process of reminding clinicians to perform specific tasks as they care for patients. For this project, we conceptualized decision support much more broadly as the full range of automated tools, informed by data in adolescent girls' electronic medical records (EMRs), to improve medical decision making by both families and clinicians. This implementation guide highlights a broad range of EMR-based strategies directed at both clinicians and families, providing alternative approaches for using these systems. In our study, we combined clinician-focused reminders and education, family-focused reminders and education, and performance feedback based on EMR-data to inform evidence-based decision making in an area that has generated substantial controversy: adolescent vaccination. The results of the attached trial demonstrate the potential impact on public health of integrating these approaches. We hope this guide inspires and informs individuals and groups interested in using health IT to improve health to consider and combine a full range of information technology-based options that may lead to improved outcomes.

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