

Pediatric and Primary Care EMR Business Process Management: A Look Back, a Look Under the Hood, and a Look Forward

A White Paper

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Abstract. We describe an ambulatory electronic health record (EHR) workflow management system (WfMS)—employed to create a high-usability pediatric electronic medical record (EMR) workflow system—that is currently in use by 4000 users at 300 medical offices and has been deployed since 1995. WfMS features and functionality include a workflow engine, workflow process definition editor, and a universally viewable annotated worklist that represents patient location and task status in real time. Clinical data flow into and out of the EncounterPRO Pediatric EMR Workflow System via the EncounterPRO Health Information Exchange (EPHIE, HIE) automatically and inexpensively due to coordinated workflow management across EMR and HIE subsystems. Business process management (BPM) add-on modules address the three most important dimensions of ambulatory EMR value: clinical performance, patient satisfaction, and practice profitability. Written physician comments about the resulting electronic medical record (EMR) workflow systems (two pediatric and one obstetrics, gynecology and family medicine) from three award winning case studies support the importance of workflow or process-aware EMRs to successful EMR deployment.

Key Words: Electronic health records, electronic medical records, workflow management systems, business process management, health information exchange, pediatrics

1 Introduction

The EncounterPRO EHR Workflow Management System [1, 2, 3] is a certified electronic health record that implements more than 200 EMR functional requirements on a workflow management system foundation [4]. It is the only commercial EHR WfMS for ambulatory medical office practice of which we know. In 1995 the EncounterPRO EHR WfMS was used to create and deploy the EncounterPRO Pediatric Workflow System to its first pediatric practice.

This report describes the means by which workflow process definitions (called “workplans” by EncounterPRO developers and users) are created, edited, and thereby generate a specialty-specific EMR workflow system such as a pediatric EMR workflow system; coordination of workflow between the EncounterPRO Pediatric EMR Workflow System and the EncounterPRO Health Information Exchange; plans to add pediatric-specific business process management functionality directed towards optimizing clinical performance, patient satisfaction, and practice productivity; and evidence that pediatricians and primary care providers are receptive to the use of workflow or process-aware EMRs at the point of care.

EMR workflow systems are more usable than EMRs without workflow management capability. Consider these usability principles: *naturalness*, *consistency*, *relevance*, *supportiveness*, and *flexibility*. Pediatric (for example) EMR workflow systems more *naturally* match the task structure of a pediatrician’s office through execution of pediatric-specific workflow process definitions. These definitions *consistently* reinforce user expectations. Over time this leads to fast and effective interleaved team behavior. On a screen-by-screen basis, users encounter more *relevant* data and order entry options. A pediatric EMR workflow system tracks pending tasks in real time—which patients are waiting where, how long, for what, and who is responsible—and this data can be used to *support* a continually updated shared mental model among users. Finally, to the degree to which a pediatric EMR workflow system is not natural, consistent, relevant, and supportive, the *flexibility* of the underlying EHR workflow management system can be used to mold workflow system behavior until it becomes natural, consistent, relevant, and supportive. In other words, pediatric (and other specialty-specific) EMR workflow systems based on EHR workflow management system foundations are more usable than traditional pediatric EMRs that are not based on workflow management system foundations.

A brief comment about terminology is required. General usage and meaning of EMR and EHR varies. One proposed dichotomy is between the EMR in the local medical practice versus the EHR that unites patient data across health organizations. On the other hand the federal government and certification bodies often refer EMRs as ambulatory EHRs. Popular use currently favors EMR.

We distinguish between EHR workflow management systems (WfMSs) and EMR workflow systems. Just as a database management system is used to create and manage a database system, the EncounterPRO EHR Workflow Management System is used to create and manage the EncounterPRO Pediatric EMR Workflow System (and the Family Medicine EMR Workflow System and Obstetrics and Gynecology EMR Workflow System, and so on). Since the means to connect, communicate, and coordinate clinical data derives from EHR workflow management system components, tools, and infrastructure (in combination with HIE functionality), the EHR WfMS versus EMR workflow system roughly parallels the EHR versus EMR distinction.

Business process management (BPM) functionality is used to systematically optimize EMR workflow processes with respect to clinical performance, patient satisfaction, and practice productivity. We will speak generally about EHR business process management. However, during day-to-day EMR operation, users do not interact directly with either EHR WfMS or EHR BPM functionality (which is chiefly intended for use by EMR workflow system designers). When pediatric or other primary care EMR workflow system users access, rely

upon, or benefit from BPM system functionality, we refer to that as EMR business process management (hence the title of this white paper).

2 EHR Workflow Management System Functionality

The EncounterPRO EHR WfMS represents and executes user-editable process definitions (“workplans”) that are constructed from a large number of potential screen-based activities (reviewing and entering patient data, entering orders) and screenless activities that can be made to occur automatically without need for user interaction, such as printing patient education materials; creating progress notes; and communication with medical devices, intra-office billing and scheduling applications, and external clinical laboratories, vaccine registries, and pharmacies. Execution of a specialty-specific set of process definitions, such as representing pediatric workflows, results in a specialty-specific (for example, pediatric-specific) EMR workflow system.



Fig. 1. Screenshot: Typical EncounterPRO Pediatric EMR Workflow System data entry screen with large easy-to-hit buttons.

As illustrated in Figure 1, EncounterPRO buttons are much larger than those of a traditional EMR, allowing for quick, accurate data and order entry in response to the right screens being presented to the right user in the right order in the right clinical context in quick succession. These screen sequences mirror the natural structure of specific task to be performed (such as acute sick child visit versus annual well child visit versus a vaccination visit). Figures 2 and 3 depict an early versus a current version of another representative EncounterPRO data entry screen.

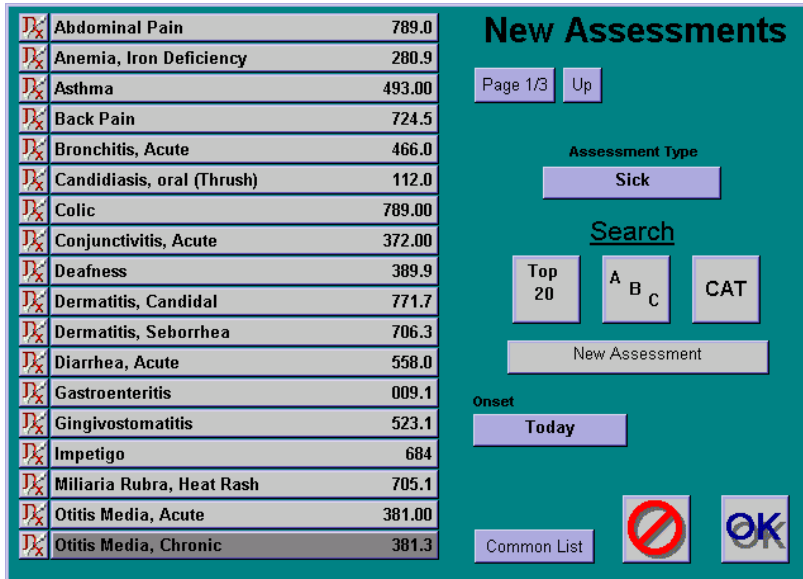


Fig. 2. Screenshot: EncounterPRO EMR Workflow System Version 2.0 (2003): Select one or more assessments and proceed to the next screen.

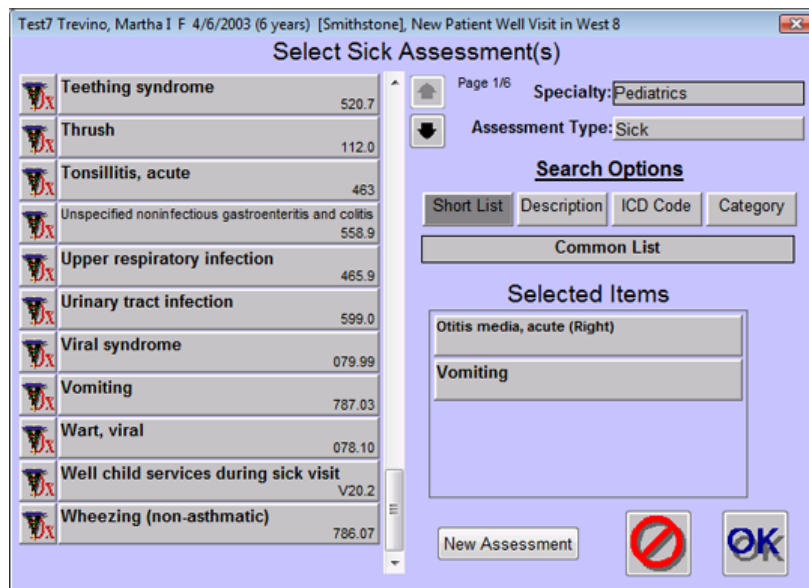


Fig. 3. Screenshot: Collect EncounterPRO EMR Workflow System Version 5.0 (present): Select one or more assessments and proceed to the next screen.

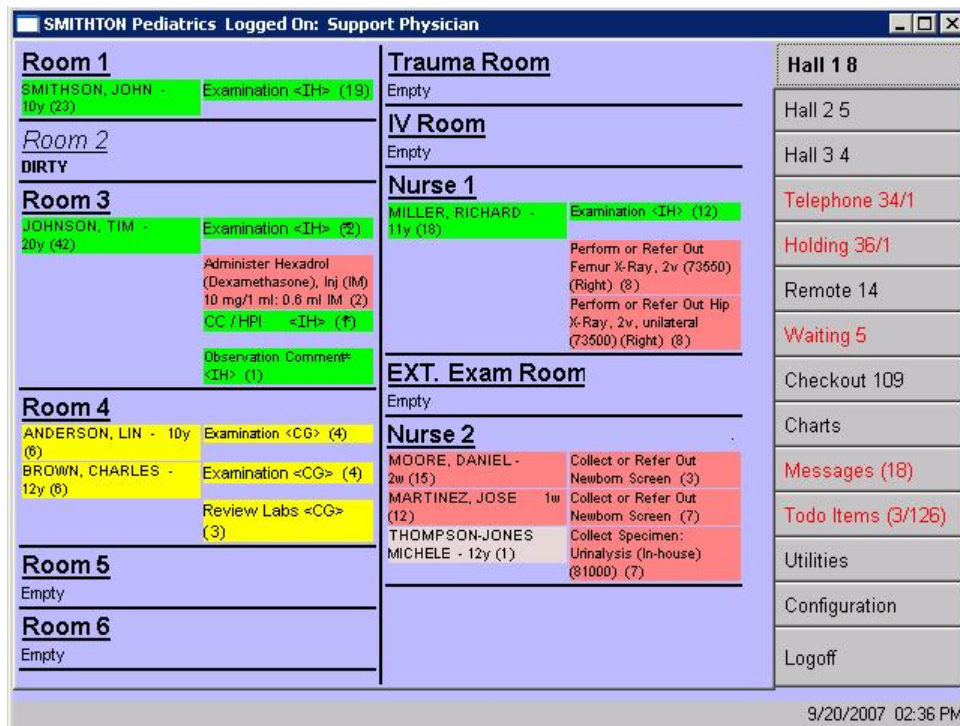


Fig. 4. Screenshot: A real-time global view of current patient locations and task states (including number of minutes since task dispatch) is viewable by all users.

Figure 4 depicts a universally visible worklist (called the “Office View”) containing a typical mid-afternoon set of pending tasks and ongoing activities at the fictional Smithton Pediatrics clinic. Patients and tasks are color coded and annotated so each physician and staff member can see what is waiting to be done and how long it has been waiting. Touching a task brings up the screen necessary to complete the task. The numbers in parentheses represent the continually updated minutes since task dispatch. When a user has started a task but has not yet completed it, an asterisk appears.

The tasks that appear in the Office View are there by virtue of process definition execution by the EncounterPRO workflow engine (executed within Microsoft SQL Server; EncounterPRO extensions, such as device adaptors and wrappers for third party services, are written in MS C#.NET). Different medical specialties—pediatrics (roughly 70% of the 300 practices using the EncounterPRO EMR Workflow System), family practice, obstetrics/gynecology, etc.—rely on different process definitions.

Within pediatric subspecialties (such as allergy, endocrinology, neurology, gastroenterology, rheumatology, and pulmonary) creating and executing workflow process definitions for each different specialty, provide specialty-specific workflows against a common patient database. With respect to related primary care specialties (such as family medicine, general internal medicine, and obstetrics and gynecology) the same holds true. In both cases workflow process definitions span specialty or subspecialty boundaries to coordinate multi-disciplinary care.

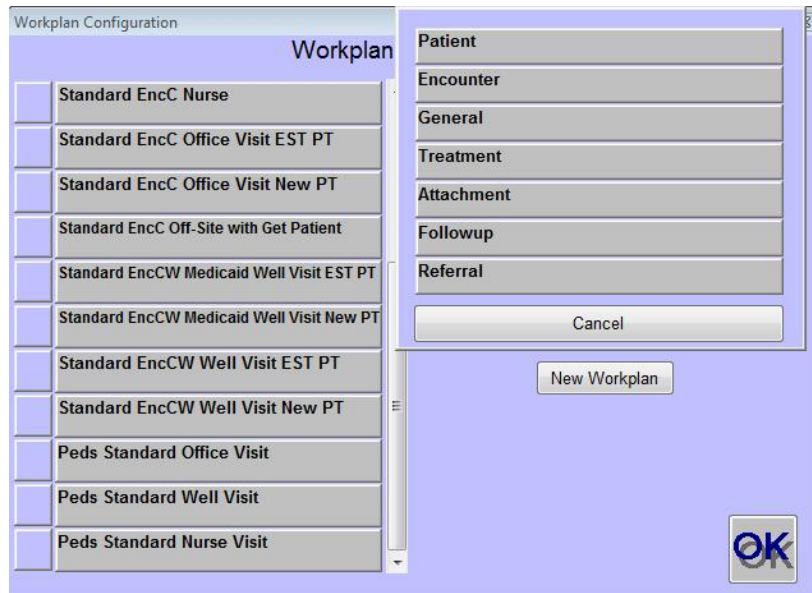


Fig. 5. Screenshot: Choose process definition (“workplan”) type and definition for inspection or editing; or create a new process definition.

Figure 5 illustrates the screen used to select a process definition for inspection or editing. On the right are process definition types (the scope within which the process will execute); on the left are specific process definitions (for example, an episodic child sick visit triggers different tasks than a yearly child well visit).

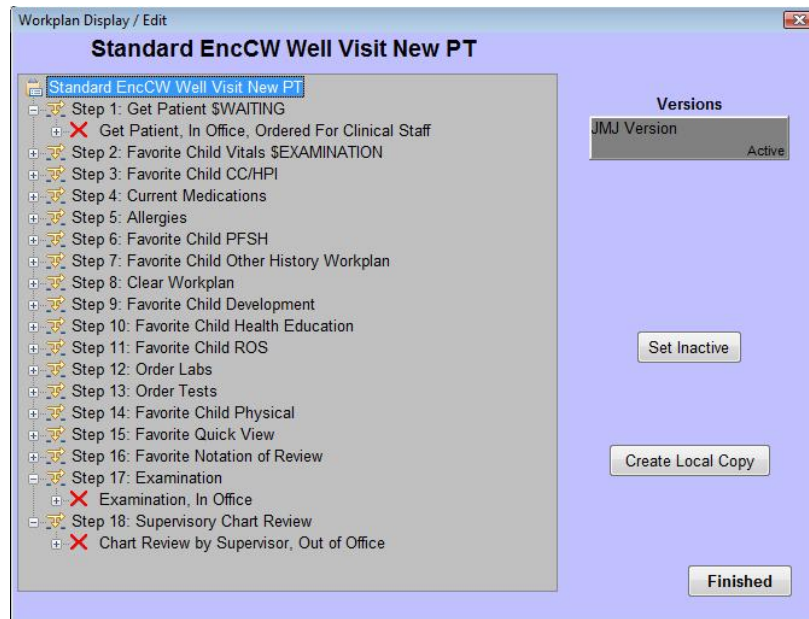


Fig. 6. Screenshot: Display process definition for inspection. Select “Create Local Copy” to customize or “Set Inactive” to inactivate process definition.

Selecting the Standard Encounter Child Well Visit New Patient (“Standard EncCW Well Visit New PT”) process definition brings up its steps (Figure 6), from getting the patient from the waiting room and taking them to the exam room (“Get Patient”), to the various nursing tasks intended to be accomplished for a patient encounter of this type, to the physician tasks of reviewing results and examining the patient (at which point the physician typically triggers execution of other process definitions directed at treatment, follow-up, and referral). Process definition steps are classified as either “In Office” or “Out of Office” (such as is the case for the last step, “Supervisory Chart Review,” which is accomplished after the patient has left the office). New customers are provided with a starter set of process definitions appropriate to their specialty, which they may modify by first selecting “Create a Local Copy.”

Workplan Definition

Type: Patient Location: Specialty:

Description:

Step #	Description	Delay	In Office	Default Room Type
1	Get Patient	<No Delay>	Y	\$WAITING
2	Favorite Child Vitals	<No Delay>	Y	\$EXAMINATION
3	Favorite Child CC/HPI	<No Delay>	Y	
4	Current Medications	<No Delay>	Y	
5	Allergies	<No Delay>	Y	
6	Favorite Child PFSH	<No Delay>	Y	

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Fig. 7. Screenshot: Edit process definition step definition.

Drilling down further to edit workplan steps opens the workplan definition edit screen (Figure 7). Many workflow management systems use editors that represent workflows as graphs somewhat resembling decision trees. EncounterPRO does not, as we prefer to remain consistent with picklists that resemble EncounterPRO’s other data entry and order entry screens.

Each step in a workplan is separately configurable (Figure 8): “Ordered For” (user or role); “Edit Criteria” (conditions to be met for task to be dispatched); “Configure Service” (setup resources necessary for task execution); “Edit Flags” (control task behavior); “Time-out” (specify escalation and expiration durations); “Add Service” (add task to process definition); “Add Treatment” (add process definition of type Treatment); “Add Workplan” (embed another process definition in this process definition).

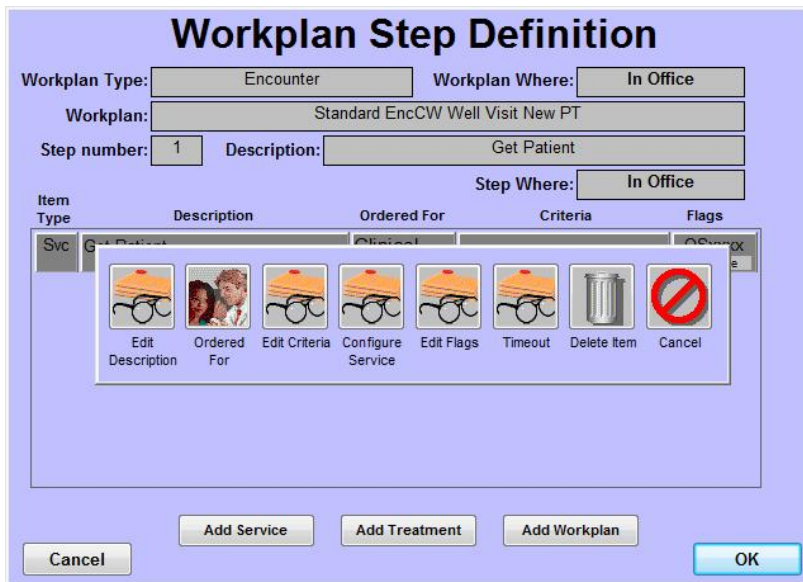


Fig. 8. Screenshot: Edit process definition step definition.

EncounterPRO EHR WfMS activities, screens, picklist content (and content from which to customize picklists), process definitions, etc. are specific to the clinical domain and processes typical for medical office ambulatory settings. Specialty-specific EMR workflow systems are created by formulating specialty-specific workflow process definitions (along with other specialty-specific picklist content and device interfaces). EncounterPRO EMR workflow systems exist for fourteen specialties, though the majority includes pediatric and related primary care EMR workflow systems such as family medicine, general internal medicine and obstetrics and gynecology.

3 EncounterPRO Health Information Exchange and Workflow Management

The EncounterPRO Health Information Exchange (EPHIE, its Greek root means “well spoken”) is a proprietary clinical messaging engine located in Atlanta that manages thousands of messages passing between EncounterPRO customers and external data partners. These data partners include:

- national and regional clinical reference laboratories,
- state vaccine registries,
- retail and mail order pharmacies via the SureScripts Pharmacy Health Information Exchange,
- in-office and remote medical devices, and
- practice management systems (scheduling and billing).

According to its Wiki definition, an HIE effects “mobilization of healthcare information electronically across organizations within a region or community” and “provides the capability to electronically move clinical information among disparate health care information systems while maintaining the meaning of the information being exchanged. The goal of HIE is to facilitate access to and retrieval of clinical data to provide safer, more timely, efficient,

effective, equitable, patient-centered care.” From a purely technical perspective EPHIE is in fact an HIE. It satisfies the requirement that communicating organizations reside in a common geographic region, since EPHIE routinely exchanges between EncounterPRO EMRs and local clinical laboratories, state vaccine registries, and pharmacies.

There are a number of clinical messaging engines on the market that, similar to EPHIE and in an automated fashion, transport and translate patient specific data. Many EMRs rely on one of these expensive third party interface engines. That EHRI has developed its own proprietary interface engine has three important advantages.

First, since we maintain our own source code we can make EPHIE do things driven by our (and our customers') strategic priorities and not rely on or wait for a third party vendor. Second, software licenses for commercial clinical messaging engines tend to be expensive; EHRI owns the EPHIE software code, so there is no need to pass this additional license cost through to customers. Third, while EPHIE can work with any EMR or health information system that relies on HL7 and XML standards and uses standard transports such as Web services, EPHIE and the EncounterPRO EMR work together like a hand and glove. EPHIE “knows” about the EncounterPRO EMR’s workflow. As a result, clinical messages customized to our customers' purposes can flow out of and into an EncounterPRO EMR more automatically than would be possible without a workflow engine and workflow process definitions to facilitate.

4 Adding EHR Business Process Management Functionality

Pediatric EMR users are increasingly asking for means to systematically improve the effectiveness and efficiency of a wide variety of pediatric EMR mediated processes. Goals include improved pediatric clinical performance, more satisfied patients, and increased pediatric practice profitability. With respect to each of these dimensions, we are using business process management ideas and techniques to design a number of add-on BPM modules.

The *population management add-on module* detects at-risk patients and automatically triggers workflows to help manage that risk. If a patient is not (but should be) in compliance with a clinical protocol, is not having appropriate measurements gathered, or has clinical values that fall outside normal limits, then corrective workflows should be triggered that will improve compliance, ensure that measurements are taken, and improve clinical values. In preliminary work we have created an add-on module that detects these patient conditions, drives a summary dashboard, populates a patient list manager, and provides a means for users to set up condition-triggerable process definitions (which in turn automatically drive corrective workflows).

The *patient satisfaction add-on module* ties ratings back to specific process ids so as to explain rating differences in terms of specific process events. Patient satisfaction is also strongly influenced by short wait times and encounter lengths, both of which are amenable to analysis via process mining (see next module).

The *process mining add-on module* benchmarks process performance across practices and explains differences in performance in terms of differences between process model structures, activities and costs. These explanations in turn suggest specific workflow improvements. In

preliminary work we have exported from workflow logs process ids; task descriptions; date-time stamps for dispatched, started, and completed events; role and user ids; and a variety of other attribute data. We are currently comparing available commercial and open source process mining applications (including the PROM process mining toolkit [5]).

4 Conclusion

Workflow or process-aware information systems—workflow management systems, business process management, monitoring, mining, and modeling systems—have great potential to address the central issues of healthcare reform: identification of best practices, coordination of care amongst providers and patients, and consistency across healthcare delivery processes. We have provided details about a WfMS used to create EMR workflow systems that are currently installed at 300 practices and in use by 4000 users.

Three medical practices, two pediatric and one which combines obstetrics, gynecology and family medicine, have used EMR workflow systems based on the EncounterPRO EHR WfMS and won the annual Health Information and Management Systems Society’s Davies Award for Ambulatory Excellence [6, 7, 8], the most prestigious award given for use of EMR/EHR technology. The award winning applications acknowledge the importance of EncounterPRO’s underlying workflow management systems foundation to their success.

In each HIMSS Davies Award application the physician author specifically mentions the importance of workflow management system functionality:

Pediatrician Jeffrey Cooper, MD:

“EncounterPRO is the only EHR, of which I am aware, that is based on a workflow management system. This allows me to customize and streamline collaboration among providers and staff in ways that greatly improve practice efficiency. For example, while I am in the exam room with the patient, in addition to documenting, I am also directing and delegating. Staff members can prepare for procedures such as vaccines, aerosols, and injections before I even leave the room. We usually pass each other, me on the way out, they on the way in. I go immediately to the next patient, while they immediately perform their procedures. I don’t have to find them and I don’t have to tell them what to do. The EHR’s workflow management system takes care of that for me.” [6]

Pediatrician Armand Gonzalzes, MD:

“The main advantage to EHR users of getting both a workflow system and a workflow management system—together—is that they can further customize the EHR workflow system to reflect their clinical needs, personal preferences, and business requirements.” [7]

Obstetrics, gynecology, and family medicine physician Jeffrey Harris, MD:

“The EMR user interface is akin to the touch screen-oriented systems in restaurants: one screen at a time, with only the most relevant data displayed and op-

tions presented (although, of course, a user can always jump out of a particular screen sequence to accomplish an arbitrary task), and the sequences can be tweaked through the workflow management to make such occurrences infrequent...The workflow plans are tailored for each type of patient seen in the office (obstetrics, gynecologic, annual exams, family practice) assuring that key elements of the present illness, history and physical are addressed and documented. Workplans contain required laboratory tests for specific conditions, assuring that key tests are not forgotten.” [8]

That is the “Look Back,” “Look Under the Hood,” and “Look Forward.”

- Look back: Only existing ambulatory EHR workflow management system or pediatric EMR workflow system since first deployed in 1995, creation of the workflow-aware EncounterPRO Health Information Exchange, and three pediatric and primary care practices using the EncounterPRO EMR Workflow System and winning the HIMSS Davies Award.
- Look under the hood: Screen-by-screen explanation of means by which pediatric-specific workflow process definitions are created within the EncounterPRO EHR Workflow Management System in order to configure a pediatric EMR workflow system.
- Look forward: The benefits of business process management ideas and technologies applied to ambulatory care, primary care, and pediatric EMR workflow systems.

Current developments in business process management are relevant to where we intend to take the EncounterPRO EHR Workflow Management System and EncounterPRO Pediatric EMR Workflow Systems as products. A number of trends are converging. Workflow management and business process management system technologies have matured and proven their use in a variety of other industries, and are poised to diffuse throughout healthcare. Issues of EMR productivity, usability and workflow have come to the fore: too many traditional EMR implementations have failed due to problematic workflow and decreased productivity, the rate of EMR adoption has been too slow, and EMR professionals are beginning to realize that the user isn't the problem; it's the usability of the technology (although we acknowledge the honest debate on this topic). And productivity, usability, and workflow are inextricably intertwined.

EMRs without sophisticated workflow automation foundations, tools, and infrastructure are not up to the job. Non-workflow-management-system-based EHRs are difficult to optimize in a business process management sense. Their workflows are highly constrained by the initial design decisions of their respective programmers. Their lack of easily changed workflow process definitions makes it difficult to systematically improve their workflows with respect to the wide variety of goals that motivate use of ambulatory EMRs.

The EncounterPRO EHR Workflow Management System (and the workflow systems it creates and manages, including pediatrics, family medicine, obstetrics and gynecology) is an

example of a new class of workflow or process-aware ambulatory EHR/EMR software. This next step in the evolution of ambulatory EMRs is squarely at the intersection between two great software industries: electronic health records systems and workflow management/business process management systems. The hybrid EMR workflow systems that result will be more usable and more systematically optimizable than traditional EMRs with respect to user satisfaction, clinical performance, patient satisfaction, and practice profitability.

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