Integration of Clinical Decision Support with On-line Encounter Documentation for Well Child Care at the Point of Care.

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Abstract: Electronic medical record systems and clinical practice guideline (CPG) support applications are emerging in the clinical environment to document and support care. Applications which integrate on-line documentation with CPG are often complex systems bound to a proprietary infrastructure and as such, can be difficult to adapt to changing care guidelines. This paper describes integration of point-of-care clinical documentation to an Internet-based CPG system that was easily modified, utilized available software resources, and separated patient information from CPG. The system combined a text-based encounter documentation tool, Inbox, with a web-based CPG system, SIEGFRIED (System for Interactive Electronic Guidelines with Feedback and Resources for Instructional and Educational Development), which interactively presented care guidelines to providers. Age-specific well child care documentation templates were developed using Inbox for point-of-care documentation. SIEGFRIED contained the knowledge base of child safety education guidelines and executed independent of the program presenting the guidelines. The CPG were accessed from within the documentation template via an Internet hyperlink. Patient chart evaluation indicated that 77% of safety topics were reviewed and 32% of the charts contained documentation indicating all the safety topics were reviewed. Last, routine use of the Inbox-SIEGFRIED system was not realized due to the clinical time constraints and workload of the medical providers, and lack of data entry experience. A user survey indicated time cost (network access and software execution) were negative aspects of the system. However, the system function was highly regarded and the Internet-based patient education materials were described as useful and accurate. In summary, the system was functional, met original development goals, and provided valuable patient education materials; however, routine system use was prevented by time requirements. We recommend further development be oriented towards integrating the identified beneficial components of the system into clinician workflow.

Introduction: Paper medical record keeping has functioned effectively for decades in this country. They are easy to generate, offer reliable data retrieval, and are relatively permanent. However, as the structure of medical practice has evolved, generation of and access to patient medical records requires a more comprehensive approach. Previously, local clinicians provided the majority of care for their patients. They generated and utilized patient records at a few facilities. As the range of medical services has broadened and specialization has become routine, the current practice environment can involve multiple providers at different facilities for even modest medical problems. These changing practice patterns combined with advances in electronic technology have prompted development of new systems to generate, store and transfer patient information.

Electronic storage and retrieval of medical data offers several advantages compared to paper records in the current practice environment. Data can be formatted and categorized during data entry. Secure network communications allow production of, and access to, data by multiple approved users at different locations. The information can be analyzed for disease incidence, practice patterns, and for medical research purposes. However, the initial step of data entry remains a major hurdle. Medical providers are often unable to enter data due to time constraints and insufficient training. The potential advantages of data checking for accuracy and completeness are lost when electronic medical data is generated asynchronously by non-clinicians.

Clinical practice guidelines are 'systematically developed statements to assist practitioner and patient decisions about appropriate care for specified clinical outcomes'.[1] CPG have been developed by experts in their medical specialty after rigorous review and evaluation of the medical literature, and discussion of treatment options and management goals. There are currently over 1700 clinical guidelines available.[2,3] When utilized, CPG improve diabetes monitoring,[4] reduce cesarean section rates,[5] and reduce pneumonia treatment[6] and antibiotic[7] costs. However, widespread use of CPG has not been realized in the clinical environment.[8,9] Electronic-based CPG are often complex, proprietary components and can be difficult to access, implement or revise. Thus, integrating CPG into the busy daily workflow of practicing medical providers required rapid access and navigation.

For this project we applied CPG to child safety counseling during well child care. Childhood

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accidents and injuries comprise the majority of potentially preventable morbidity and mortality for this age group.[10] Age-appropriate, topic-specific verbal discussion and educational materials are effective techniques to inform parents of accident prevention techniques and early treatment. These techniques have reduced risks from burn injury[11,12] and poisoning effects with syrup of ipecac treatment.[13,14,15] Effective childhood accident prevention techniques should combine age-specific information provided on a perceived need basis.

This paper describes the system developed to link point-of-care electronic documentation with age and topic specific safety counseling CPG service. We proposed that a functional system could be developed, would increase safety review documentation, and improve patient counseling.

METHODS: Childhood Safety Knowledge Base: The Internet is a source of safety information which providers can use for safety counseling during well child care. Availability studies indicate over 37% of American households access medical information on the Internet.[16] Most Internet websites of child health and safety organizations provide safety oriented information.[17,18] These organizations include the federal government (Centers for Disease Control), professional medical associations (American Academy of Pediatrics), and private groups (National Safe Kids Campaign). These websites often provide the safety information formatted for printing as reference materials.

Identifying safety education websites: Internet resources in the knowledge base were used to develop the CPG support component of the system. Selection of the resources was based on several factors including the organizations history and reputation as a child health and safety resource, the information content of the web page, it's readability and appropriateness for patient distribution, commercial orientation, and the web page format for printing to distribute to the family. Therefore, the inclusion of the American Academy of Pediatrics (AAP) web site was based on their expertise providing health and safety services for children, their professional medical status, and the noncommercial nature of their web sites. The AAP site also provided direction to other quality Internet-based web sites containing child health and safety patient information. Some Internet web sites were located using a search engine such as Altavista.com.

Child Safety CPG Server: The safety education counseling component of the patient encounter was provided using the clinical guideline presentation software SIEGFRIED.[19] SIEGFRIED was originally developed to assist medical care providers navigate clinical practice guidelines, and offer clinical recommendations.[20,21] For this project the clinical guideline server SIEGFRIED executed a secure Internet-based applet using the Netscape Browser (version 3.x, Mountain View, CA) on DFMC (Duke Family Medicine Clinic) point-of-care workstation computers. It presented one or more clinical statements of age-appropriate child safety knowledge, evaluated and monitored the provider responses, and recommended topic specific safety education with hyperlinks to Internet-based patient education websites.

Individual knowledge bases of child safety education topics, patient education recommendations and Internet-based safety education websites were created to develop SIEGFRIED applets for the 6 well child checks at 2, 4, 6, 9, 12, and 15 months postnatal age. SIEGFRIED was written in PERL to create compile-ready java software code. The knowledge bases and thus the SIEGFRIED applet could be easily modified or expanded because it was loosely coupled to, and functioned independent of, the front-end programs that presented the guidelines to the providers. Each knowledge base contained 8-12 safety topics for review which were selected by consensus opinion of the DFM Department and extracted from the paper medical record. Well child visits were chosen as the clinical niche to develop and test the system because (a) injuries and accidents are the leading cause of childhood morbidity and mortality[22] (b) safety counseling is an important and effective component of the well child care, and (c) most infants have simple, uncomplicated health histories. SIEGFRIED monitored provider responses and provided a summary statement of patient safety knowledge and appropriate education recommendations. Each of the SIEGFRIED guideline server applets was linked to the age appropriate template via a hyperlink contained within the documentation software.

Paper Record System (Control Group): Physicians in the control group recorded patient data manually using a prepared well child care visit form. Patient information recorded included clinical history, anthropometric data, both normal and abnormal physical findings, and plans, including the need for medications, immunizations or follow up visits. One section of the paper record sheet reviewed age-appropriate safety and education issues. As these issues were reviewed, positive and negative comments could have been entered by hand describing review of the topic and whether patient education was provided.

Electronic Record System (Experimental Group): The experimental group created a patient encounter document using an online Lotus Notes editor (IBM, White Plains, NY) derived from an age-specific

Notes template. The patient medical record number was referenced to obtain demographic data. The remainder of encounter document was completed by key typing abnormal findings or 'charting by exception'. The encounter document also contained a hotspot button labeled 'safety & education applet' with the URL for an Internet-based age-specific CPG SIEGFRIED applet (Figure 1). Clicking the button executed the Netscape Browser and initialized the CPG safety counseling applet. Official medical records at Duke University Medical Center are paper based. Thus, the Lotus Notes patient encounter documentation and SIEGFRIED safety knowledge summary could be stored electronically, and printed to paper, signed and stored in the chart.

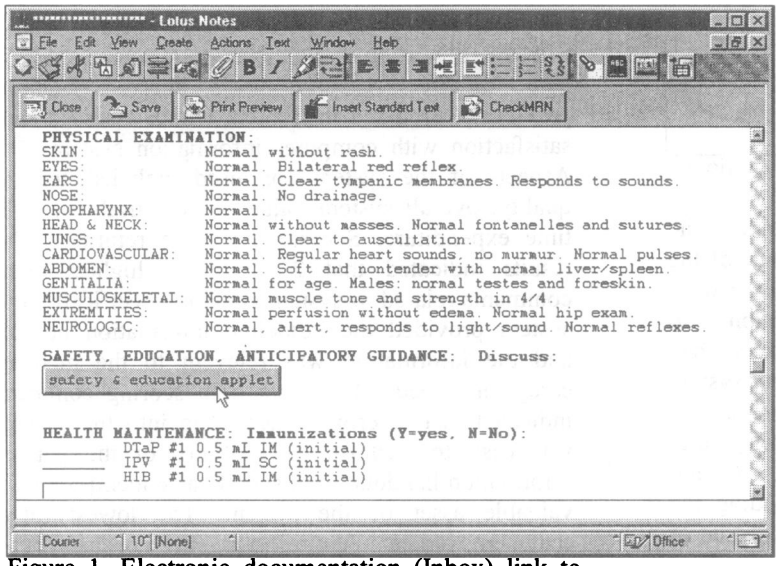

Figure 1. Electronic documentation (Inbox) link to CPG (SIEGFRIED).

Patient encounter documentation generated using the Inbox-SIEGFRIED system could be forwarded electronically to the Central Patient Data Repository (CDR). Inbox was developed by Duke Medical Center Information Systems[23] to support electronic patient data storage and retrieval. After reviewing the patient data, Inbox formatted the data using the HL7 protocol, and forwarded it to the CDR. Incorrect patient records were rejected. The CDR received patient data from multiple sources including Duke Hospital, on-site clinics, and affiliated facilities. Patient information was stored as free text in a DB2 database at 74 characters per line with parsing of the free text in a line-by-line format.

Template Development: Templates were developed to provide a framework for the clinicians to document the patient encounter and maintain consistency with the well child care documentation performed by clinicians using the paper medical record form. Standardized paper records for well child care were developed by providers of the DFMC following internal discussions, identification of important clinical care components and collaboration with the Department of Pediatrics. The standardized well child encounter forms were refined over years using an iterative process. The clinical components of the well child care encounter form were extracted to develop six age-specific well child care templates for visits at postnatal ages 2, 4, 6, 9, 12, and 15 months. The completed templates were stored in the Inbox Template Repository of the Notes Inbox Database and were accessible via the DFMC network.

To access the care templates DFMC providers were required to login to both the internal DFMC clinic network and the Notes network using unique login names and passwords. The clinician selected the age-appropriate template with which to create an electronic patient encounter record. Templates contained information describing a normal well child exam which was modified manually by the provider using 'charting by exception'. The electronic record also contained the link to the SIEGFRIED CPG safety education applet. After the electronic patient encounter was complete, a paper summary was generated via the network printer and the clinician could opt to forward a copy of the report electronically to the CDR.

Inbox-SIEGFRIED System Function: Figure 2 illustrates function at the workstation using the Inbox-SIEGFRIED online documentation CPG system. After DFMC and Notes network login (1), the clinician selected the age-appropriate well child care template (2) which was retrieved from the Inbox Template Repository and displayed for the clinician to complete (3). After the patient history and physical examination were documented, the clinician activated the clinical guideline support system, SIEGFRIED (4), which executed the age-appropriate safety counseling applet in the Netscape Browser (5). Within the applet, patient information websites were accessible via the Internet using built-in text hyperlinks (6). These hyperlinks connected to previously identified websites which contained topic-specific safety education information (7). The web page could have been forwarded to the network printer and provided to the family for reference (8). Also SIEGFRIED could have generated a safety topic review summary to print (9) and the Inbox patient encounter was printable (10a). Last, the Inbox patient encounter summary could have been forwarded to the Clinical Data Repository (CDR) for network storage

and retrieval by other providers within the clinical network (10b).

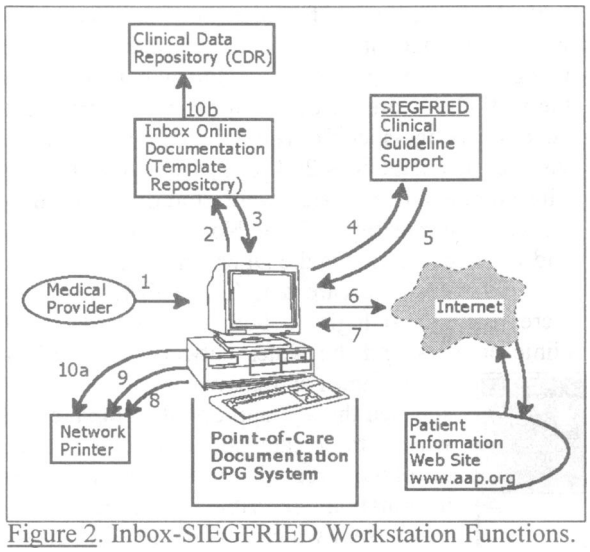

Figure 2. Inbox-SIEGFRIED Workstation Functions.

Inbox-SIEGFRIED System Evaluation: After the Inbox-SIEGFRIED system was installed, half of the DFM clinicians who provided well child care were selected for one-on-one tutoring sessions to demonstrate use of the system. These clinicians had the option to use either the electronic or paper system to document well child care during the 5 weeks of evaluation. Control group providers were obligated to use the traditional paper record system. Several layers of the system were evaluated including the frequency of system use by providers, the degree of safety counseling documentation in the patient medical chart, the quality of counseling defined by safety knowledge retained and the perceptions of the experimental group regarding aspects of the electronic documentation system such as content, usability and applicability for patient care.

During the 5 week testing period in March and April, 1999, 22 of 103 scheduled child care appointments were for well child care. Clinicians were provided with advance notice of scheduled child care visits by e-mail 1-2 days in advance. Despite the one-on-one training and email notification system, none of the experimental group chose to use the Inbox-SIEGFRIED system to document care and provide safety counseling. The paper medical records showed an average of 10.4 safety topics per chart with an average documentation rate of 8 per visit (77%). 32% of charts contained documentation that all the safety topics listed were reviewed.

Five families were contacted regarding their recall of safety counseling performed during the well child care visit. One patient had no safety topics documented as reviewed; whereas, the other 4 indicated all the safety topics on the paper record had been reviewed (8-12 topics). The verbal interview indicated that there was no recollection of safety counseling for either home hot water temperature or syrup of Ipecac for accidental poisoning despite chart documentation that safety counseling was provided. Likewise, most knew the age of their home but not the existence of a lead paint 'risk period'. While the verbal interview results are subjective, they consistently indicated that some of the safety counseling which was documented in the chart as provided was either not recalled by the family or incorrectly documented.

User Satisfaction Survey: A user survey to grade their experience with the system was provided to the 13 medical providers in the experimental Inbox-SIEGFRIED group. It contained 16 statements with a agree--disagree response scale adapted from a previously validated instrument which assessed user satisfaction with computer information systems.[24,25] Aspects of the system appraised included content quality, overall system value, system usability, and time expenditure. Six surveys were returned. The results indicated that 2 of the 3 highest rated comments related to system content; specifically, the system provided the guideline information needed and the information was relevant to the medical caregiver's needs. The other high scoring comment indicated that entering patient data into the system was easy to perform. Availability of the patient information handouts was specifically identified as a valuable asset of the system. The lowest rated statements indicated the response speed of the system was inadequate and information retrieval required excessive time. Specific written suggestions focused on shortening login time and faster manual data entry techniques. One user noted that while the system appears complete, available physician time to learn new skills or document care has been shrinking.

In summary, this paper describes a system designed to link electronic documentation to clinical practice guideline support for safety counseling during well child care at the point of care. Part of the goal of this project was to demonstrate development of such a system was feasible, and that goal was accomplished. That the two systems were loosely coupled allowed modification of one component with little effect on the other. We also discovered that clinical safety counseling is performed inconsistently and the majority of children do not receive full counseling of all safety subjects during well child care. Routine use of the Inbox-SIEGFRIED system was not realized; however, the reasons for disuse were mostly technical. The system content and the web links to safety topics were identified as valuable aspects of the system. Issues regarding time

expenditure could be addressed using new techniques or technology. Further development should be oriented towards integrating the beneficial aspects of the system into the clinical workflow.

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Abbreviations:
CPG: Clinical practice guideline
SIEGFRIED: System for Interactive Electronic Guidelines with Feedback and Resources for Instructional and Educational Development
DFMC: Duke Family Medicine (Clinic)
CDR: Clinical Data Repository