Understanding Why Clinicians Answer or Ignore Clinical Decision Support Prompts

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Summary

Introduction: The identification of key factors influencing responses to prompts and reminders within a computer decision support system (CDSS) has not been widely studied. The aim of this study was to evaluate why clinicians routinely answer certain prompts while others are ignored.
Methods: We utilized data collected from a CDSS developed by our research group – the Child Health Improvement through Computer Automation (CHICA) system. The main outcome of interest was whether a clinician responded to a prompt.
Results: This study found that, as expected, some clinics and physicians were more likely to address prompts than others. However, we also found clinicians are more likely to address prompts for younger patients and when the prompts address more serious issues. The most striking finding was that the position of a prompt was a significant predictor of the likelihood of the prompt being addressed, even after controlling for other factors. Prompts at the top of the page were significantly more likely to be answered than the ones on the bottom.
Conclusions: This study detailed a number of factors that are associated with physicians following clinical decision support prompts. This information could be instrumental in designing better interventions and more successful clinical decision support systems in the future.

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1. Introduction

There have been many studies that identify the key factors for developing and implementing computerized decision-support systems (CDSS) within the clinical setting [4, 18, 20]. These studies demonstrate that CDSS are most successful when they seamlessly integrate into the clinician's workflow, provide assessment of eligibility for services, and make recommendations using decision support at the time and place of clinician decision-making [4, 18]. There have also been numerous studies demonstrating that adoption of computerized decision-support systems (CDSS) can improve physician use of, and adherence to, recommended preventive or chronic disease care guidelines [10, 16, 17]. However we also know that physicians override or ignore clinical prompts more often that we would like [15]. The reasons behind this choice to override or ignore a prompt are not well understood. Therefore, the purpose of this study was to identify those factors that can predict why certain prompts within CDSS are ignored by clinicians while others are routinely answered.

Some initial work has been done in this area looking specifically at clinician acceptance of medication alerts [21, 23]. These studies have attempted to explore human factor principles as potential modulators of acceptance. Our study is different from these studies in that it focuses on factors that may influence a clinician's decision to respond to or ignore specific tailored advice to help take care of patients in the pediatric primary care setting.

We utilized data collected from a CDSS developed by our research group – the Child Health Improvement through Computer Automation (CHICA) system. The CHICA system has been in active operation since 2004 and is currently used in four pediatric clinics in our health care system. To date it has supported more than 155,000 pediatric visits for almost 32,000 patients. CHICA incorporates clinical decision support for pediatric guidelines in the form of dynamic risk factor assessment questionnaires for parents and prompts and reminders to physicians. There are 347 potential questions/prompts that can be asked of parents and physicians. The areas covered were drawn from Bright Futures, GAPS adolescent guidelines, American Academy of Pediatrics of guidelines, as well as some chronic disease management. CHICA uses adaptive turnaround document (ATAD) technology [6, 7]. ATADs are used to generate two tailored, scan-able paper forms: the pre-screener form, which is completed by the parent in the waiting room prior to seeing the clinician, and the physician worksheet. To determine what information needs to be printed on each ATAD, CHICA employs a library of computer interpretable rules (Arden Syntax medical logic modules [MLMs]) that evaluate the patient screening information and the underlying electronic medical record. CHICA also uses a global prioritization scheme to ensure the most important content is printed [12]. This scheme ranks prompt importance based on the prevalence of the topic covered, its severity, how effective an intervention might be, and how much evidence supports the intervention. CHICA determines the six highest priority prompts for each individual patient and prints them on the form.

The completed pre-screener form is scanned into CHICA prior to the physician encounter. After this form is scanned, the patient's information is sent to CHICA and analyzed along with the existing patient record. MLMs are applied to generate the physician worksheet, which will be completed by the physician during the encounter. The physician worksheet (▶Fig. 1) contains an area for the physician to write free text notes, assessment and plan and a section with 6 guideline based prompts. The prompts are printed in order of their priority in locations 1 through 6, as determined by the global prioritization scheme (▶Fig. 1). The prompt receiving the lowest priority (i.e., the prompt that is considered most important) is placed in location 1. Thus, physicians are presented with all six prompts at once, and not serially as with many computer based CDSS. There are over 135 possible physician prompts in the system, but only certain ones can appear in a given location, based on the age of the child at the time of the visit, which Arden rules conclude true, and the priority score assigned to that prompt. Each prompt has a "stem" which explains the reason for the prompt and up to 6 "leaves" with check boxes for the physician to document his or her response to the prompt. The physician worksheet is scanned into the computer after the encounter. Structured data are extracted from the physician worksheet form and stored along with an image of the physician worksheet in CHICA's database. Further details about the CHICA system have been described elsewhere [1, 2, 5–9, 12–15].

2. Methods

Data were extracted from the CHICA system for all patients seen between January 2007 and March 2011. The main outcome of interest was whether or not a clinician responded to a prompt. This was defined as a physician checking off boxes that indicated that he or she had acknowledged the issue and had taken suggested action. Other variables extracted included the clinic, the position of the prompt on the physician worksheet, the priority of the rule [MLM] that printed the prompt, the title of the rule, and the name of the clinician. Patient level variables included patient's sex, insurance category, and age in days.

The patient's age, recorded in days, was divided by 30 to approximate the patient's age in months. Medicare, Special Payer, and Pending were combined as one insurance category (named "combined") due to the low number of observations in these groups. Clinicians who received 500 prompts or less in the dataset were grouped together into one category (named "grouped"); otherwise the clinicians were left as individuals, and encoded as dummy variables in the analysis. The rule priority was a number between 0 and 999, with more important prompts having lower numbers. Due to the distribution and the ordered nature of rule priority, this variable was considered to be continuous in the analyses.

Descriptive statistics were computed for each of the variables. Odds ratios were computed for the categorical variables with the baseline levels being as follows: grouped for providers, Medicaid for insurance, Clinic D for clinic location, male for gender, 6 for position on form, and "WIC Verification PWS Reminder" for the prompt title.

Bivariate analyses were performed to predict response to a prompt. Response to a prompt is defined as marking one of the check boxes related to a particular prompt. As each patient had multiple records, generalized estimating equations (GEE) were used to create repeated measures logistic regression models with patient nested within the clinic location. Ninety-one visits had an "unknown" as a sex and were removed from the analysis. For the repeated measures models, if two or fewer visits included questions about a prompt title, then that prompt title was excluded from the analysis. Out of the 135 prompts, 5 were excluded for this reason.

If a variable was significant at a 15% significance level in the bivariate analyses, then it was included in a multiple-variable repeated measures logistic model [22]. Pair-wise comparisons were done for the significant categorical variables in the multiple-variable model. A Holm multiple testing adjustment was done to control for the multiple comparisons. Significance was at the 5% level for the pair-wise comparisons.

This study was approved by the Institutional Review Board of the Indiana University School of Medicine.

3. Results

Descriptive statistics for the prompts under study, and the patients they were created for, including sex, insurance category, location, and position on the form, can be found in ▶Table 1. The average age of the children included in the analysis was 53.2 months. On average, physicians responded to 54.6% of the prompts presented.

In the bivariate analyses, clinician, insurance category, clinic identifier, the prompt's position on the physician worksheet, rule priority of the prompt, prompt title, and patient age were all significant ($p<0.001$) in predicting whether or not there was a response to the prompt.

Rule priority was significantly related to prompt title ($p<0.0001$). The correlation between these two variables was such that they could not be put into a multiple variable model together due to multi-collinearity. We therefore chose to drop prompt title from the multiple variable models.

The multiple-variable model group comparisons are reported in ▶Table 2, along with odds ratios and 95% confidence intervals. Age was independently and significantly associated with the probability that a prompt was addressed. The odds that a prompt was addressed decreased by 0.006 for each month of a child's age. As the rule priority score decreased (i.e, importance of prompt increased), the likelihood that a physician would respond to a prompt increased. Insurance was also a significant predictor. Compared to prompts for patients without insurance, prompts were more likely to be ad-

dressed if they were for patients with either Medicaid (OR 1.07) or commercial insurance (OR 1.21). Clinic identifier and provider remained significant predictors of whether a prompt was addressed as well; data are not presented on individual providers because of the large number (68) of providers in this study.

Even after adjusting for the other variables in the model, the prompt position on the physician worksheet was a significant predictor of whether it was addressed. ▶ Figure 1 shows a graphical depiction of prompt location on the physician worksheet. Compared to the final position (6), prompts 1– 4 were significantly more likely to be answered. Prompt location #2 was the one most likely to be answered. Prompt location #5 did not differ significantly when compared to location #6.

4. Discussion

One of the most concerning aspects of CDSS is that many prompts, even those which are evidence based, are ignored by clinicians. Physician responses have been described at 50% or lower since the very earliest CDSS were deployed [19]. Some systems have overcome this issue by making it difficult or impossible to proceed without answering a prompt. Solutions like this are unpopular, however, and so better interventions are needed. A necessary first step is to understand better what makes a prompt more or less likely to be answered.

This study found that a number of factors are significantly associated with whether a prompt is addressed. It is not surprising that some clinics and some physicians are more or less likely to address certain prompts. The nature of our data, however, allowed for further exploration. Some may not be surprised to see that clinicians are less likely to ignore prompts when the prompt has a high priority (lower rule score) as determined by the global prioritization scheme utilized by the CHICA system. In other words, prompts which are considered more serious are more likely to be addressed. But we also found that prompts were more likely to be addressed when the patient being seen was younger. This could be because as patient age decreases, physicians' assessment of vulnerability increases. Prompts may be more "important" to them then. We also found that a prompt was less likely to be addressed for an uninsured patient when compared to patients having either public or private insurance. This could be related to differences in time spent with these patients, or because prompts involved ordering tests that could raise costs. However, our study was not designed to determine the physicians' motivations to answer prompts.

Another interesting finding was that after accounting for all the above factors, the position of a prompt on the worksheet was a significant predictor of whether it was addressed. This suggests that there is some measure of burnout as physicians move through prompts on the worksheet page. Those at the top are most likely to be answered, with prompts appearing in position #2 (top right) being the most likely to be addressed by clinicians. In general, as a physician moved towards the bottom of the worksheet, they became more likely to ignore a prompt, even after adjusting for importance and other factors. This, perhaps, relates to the concept of "alert fatigue" [3, 11].

As with any study, there are limitations to this work that warrant consideration. This is a retrospective study of one CDSS in a single healthcare system. It may not be entirely generalizable to all environments. However, this is the first analysis of its kind that we know of, and it contained data on a large number of patients over many years, cared for in a number of clinics by many different clinicians. It is also possible that the electronic interfaces employed by many EMRs would yield different results than the paper we use. Such electronic formats, though, are difficult to use in real time while seeing patients. Moreover, we have no evidence that there would be real differences if different formats were used. Our presenting prompts together may not be generalizable to systems that present them serially. However, some of the factors that we identified as associated with answering prompts are not related to positioning or format, and likely still of interest.

5. Conclusions

Encouraging physicians to employ evidence-based care and guidelines in their practice is the goal of many interventions. Understanding what factors might improve or hinder success is an important

step to achieving better results, and ultimately optimal care. This study detailed a number of factors that are associated with physicians answering clinical decision support prompts. Decision support delivered to children of certain demographics is more likely to be ignored, and thus needs to be somehow reinforced. Moreover, we found that "prompt fatigue" exists, so changes need to be made to reinforce decision support as more clinical guidance and information is provided. This information could be instrumental in designing better interventions and more successful clinical decision support systems in the future.

Clinical Relevance Statement

One of the most concerning aspects of computer decision support systems (CDSS) is that many prompts, even those which are evidence based, are ignored by clinicians. However little research has been conducted in order to identify what the key factors are that influence which prompts and reminders within CDSS elicit a physician response. This study details a number of factors that are associated with physicians following CDSS prompts, which could be utilized in order to design more successful clinical decision support systems in the future.

Conflict of Interest

The authors declare that they have no conflicts of interest in the research.

Human Subjects Protections

The study was performed in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects, and was reviewed by the Indiana University School of Medicine Institutional Review Board.

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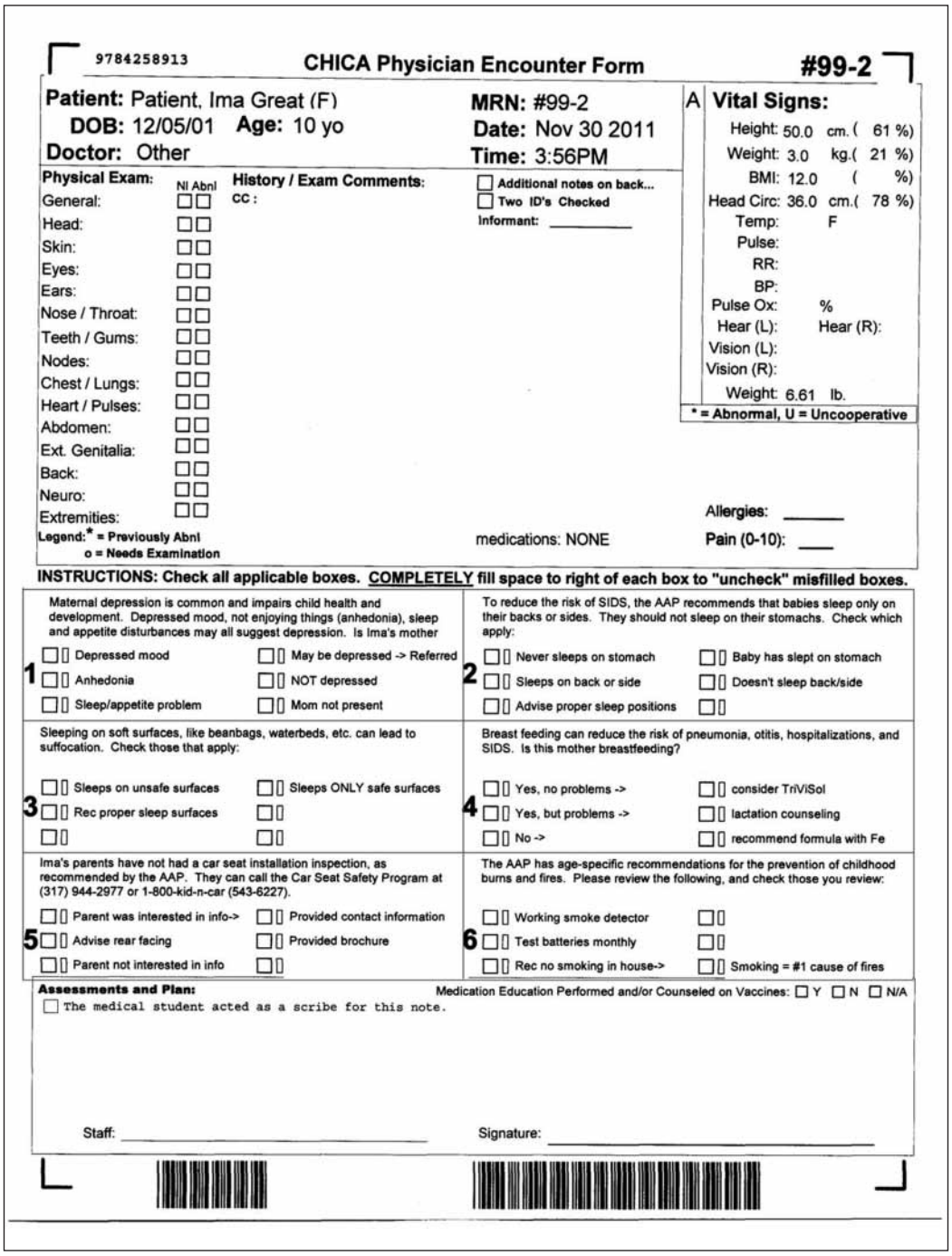

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CHICA Physician Encounter Form **#99-2**

Patient: Patient, Ima Great (F)
DOB: 12/05/01 **Age:** 10 yo
Doctor: Other

MRN: #99-2
Date: Nov 30 2011
Time: 3:56PM

Physical Exam: (Nl Abnl)
General: ☐☐
Head: ☐☐
Skin: ☐☐
Eyes: ☐☐
Ears: ☐☐
Nose / Throat: ☐☐
Teeth / Gums: ☐☐
Nodes: ☐☐
Chest / Lungs: ☐☐
Heart / Pulses: ☐☐
Abdomen: ☐☐
Ext. Genitalia: ☐☐
Back: ☐☐
Neuro: ☐☐
Extremities: ☐☐
Legend: * = Previously Abnl
o = Needs Examination

History / Exam Comments:
CC :

☐ Additional notes on back...
☐ Two ID's Checked
Informant: _____

medications: NONE

A **Vital Signs:**
Height: 50.0 cm. (61 %)
Weight: 3.0 kg.(21 %)
BMI: 12.0 (%)
Head Circ: 36.0 cm.(78 %)
Temp: F
Pulse:
RR:
BP:
Pulse Ox: %
Hear (L): Hear (R):
Vision (L):
Vision (R):
Weight: 6.61 lb.
* = Abnormal, U = Uncooperative

Allergies: _____
Pain (0-10): ___

INSTRUCTIONS: Check all applicable boxes. COMPLETELY fill space to right of each box to "uncheck" misfilled boxes.

1 Maternal depression is common and impairs child health and development. Depressed mood, not enjoying things (anhedonia), sleep and appetite disturbances may all suggest depression. Is Ima's mother
☐ Depressed mood ☐ May be depressed -> Referred
☐ Anhedonia ☐ NOT depressed
☐ Sleep/appetite problem ☐ Mom not present

2 To reduce the risk of SIDS, the AAP recommends that babies sleep only on their backs or sides. They should not sleep on their stomachs. Check which apply:
☐ Never sleeps on stomach ☐ Baby has slept on stomach
☐ Sleeps on back or side ☐ Doesn't sleep back/side
☐ Advise proper sleep positions ☐

3 Sleeping on soft surfaces, like beanbags, waterbeds, etc. can lead to suffocation. Check those that apply:
☐ Sleeps on unsafe surfaces ☐ Sleeps ONLY safe surfaces
☐ Rec proper sleep surfaces ☐
☐ ☐

4 Breast feeding can reduce the risk of pneumonia, otitis, hospitalizations, and SIDS. Is this mother breastfeeding?
☐ Yes, no problems -> ☐ consider TriViSol
☐ Yes, but problems -> ☐ lactation counseling
☐ No -> ☐ recommend formula with Fe

5 Ima's parents have not had a car seat installation inspection, as recommended by the AAP. They can call the Car Seat Safety Program at (317) 944-2977 or 1-800-kid-n-car (543-6227).
☐ Parent was interested in info-> ☐ Provided contact information
☐ Advise rear facing ☐ Provided brochure
☐ Parent not interested in info ☐

6 The AAP has age-specific recommendations for the prevention of childhood burns and fires. Please review the following, and check those you review:
☐ Working smoke detector ☐
☐ Test batteries monthly ☐
☐ Rec no smoking in house-> ☐ Smoking = #1 cause of fires

Assessments and Plan:
☐ The medical student acted as a scribe for this note.

Medication Education Performed and/or Counseled on Vaccines: ☐ Y ☐ N ☐ N/A

Staff: _____ Signature: _____

Fig. 1 Sample Physician Worksheet (PWS) with prompt position labeled

Variable	Level	N	Percentage
Gender	Female	159123	48
	Male	171253	52
	Unknown	26	0
Insurance	Advantage	8642	3
	Other	302	0
	Commercial	11673	4
	Medicaid	280868	85
	Self Pay	27554	8
Location	Clinic A	39287	12
	Clinic B	42625	13
	Clinic C	191090	58
	Clinic D	57370	17

Table 1 Descriptive statistics for the prompts under study, and the patients they were created for

Table 2 Multiple-variable model group comparisons

Variable	Variable Level	Estimate	Odds Ratio	95% CI for OR
Age (in Months)		–0.0060	0.9940	(0.9930–0.9940)
Rule Priority (Scaled)		–0.0180	0.9820	(0.9810–0.9830)
Clinic Identifier	A	0.1980	1.2200	(0.8920–1.6660)
	B	0.2030	1.2250	(0.4960–3.0240)
	C	0.6750	1.9640	(1.6650–2.3170)
	D	comparator		
Insurance	Debt Forgivenss	–0.0160	0.9840	(0.8720–1.1100)
	Commercial	0.1940	1.2140	(1.0960–1.3450)
	Medicaid	0.0690	1.0720	(1.0140–1.1330)
	Self Pay	comparator		
Position on Form	1	0.3900	1.4770	(1.3960–1.5640)
	2	0.5400	1.7160	(1.6410–1.7950)
	3	0.3080	1.3610	(1.3070–1.4180)
	4	0.1850	1.2040	(1.1620–1.2470)
	5	–0.0080	0.9920	(0.9580–1.0270)
	6	comparator		

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