An Electronic Health Record-Based Strategy to Address Child Tobacco Smoke Exposure

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Abstract

Introduction—A high proportion of children presenting to pediatric urgent cares are exposed to tobacco smoke. An electronic health record-based clinical decision support system for nurses to facilitate guideline-based tobacco smoke exposure screening and counseling for caregivers who smoke was designed and evaluated.

Design—A mixed-methods, 3-month, prospective study that began in November 2015, data were analyzed in June 2016.

Setting/participants—Five urgent cares that were part of a large children's hospital in Cincinnati, OH. Participants were urgent care nurses.

Intervention—The clinical decision support system prompted nurses to Ask, Advise, Assess, and Assist caregivers to quit smoking. Monthly feedback reports were also provided.

Main outcome measure—Clinical decision support system use rates, nurses' attitudes towards tobacco smoke exposure intervention, and percentage of children screened and caregivers counseled.

Results—All nurses used the clinical decision support system. Compared with Month 1, nurses were twice as likely to advise and assess during Months 2 and 3. There was significant

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improvement in nurses feeling prepared to assist caregivers in quitting. Nurses reported that feedback reports motivated them to use the clinical decision support system, and that it was easy to use. Almost 65% of children were screened for tobacco smoke exposure; 19.5% screened positive. Of caregivers identified as smokers, 26% were advised to quit, and 29% were assessed for readiness to quit. Of those assessed, 67% were interested in quitting, and of those, 100% were assisted.

Conclusions—A clinical decision support system increased rates of tobacco smoke exposure screening and intervention in pediatric urgent cares. Rates might further improve by incorporating all components of the clinical decision support system into the electronic health record.

Clinical trial registration—Clinicaltrials.gov NCT02489708.

INTRODUCTION

Each year, >400,000 deaths in the U.S. are attributable to smoking.[1–5] In addition, exposure of nonsmokers to tobacco smoke is a serious health hazard. More than 40% of U.S. children aged 3–11 years are exposed to tobacco smoke.[6] Tobacco smoke exposure (TSE) places children at increased risk for illnesses including asthma and bronchiolitis.[1–5] TSE-related illnesses result in increased pediatric visits to emergency settings including the pediatric emergency department and urgent cares (UC).[5] Low-cost cessation interventions delivered in emergency settings are urgently needed to impact public health.[7–11]

A large percentage of caregivers who are smokers accompany their children in the emergency setting and their children have high rates of TSE-related morbidity.[12–17] When caregivers are educated about TSE effect's on their child's illness, they may be more motivated to quit smoking.[15,18,19] An adult emergency visit is a teachable moment in which cessation interventions are feasible and may be effective in helping smokers quit[20,21]; thus, cessation interventions may also be effective in the pediatric emergency setting.

The American Academy of Pediatrics exhorts practitioners to help eliminate TSE by advising caregivers to quit smoking at every patient encounter.[22] The approach is based on the "5As" of the Clinical Practice Guidelines—Ask about tobacco use, Advise to quit, Assess willingness to quit, and Assist/Arrange with follow-up and resources.[7] However, emergency practitioners do not routinely screen or advise caregivers about ways to reduce a child's TSE[7]; citing barriers including lack of training, time, standardized protocols, materials, and self-efficacy.[23,24]

Clinical decision support systems (CDSS) may overcome these barriers and facilitate standardized TSE screening and counseling, and can be triggered from patient-specific data.[25–28] Successful CDSS are integrated with the electronic health record (EHR), and dynamically interact with practitioners and existing systems.[28–30] Clinical workflow integration remains a major challenge.[31–33]

An EHR-based TSE reduction CDSS was designed and implemented for use by registered nurses in pediatric UCs.[34,35] The CDSS implemented guideline-based assessments of child's TSE and smoking cessation counseling for caregivers. Nurses were enlisted in the design and implementation of the CDSS. The primary objective is to assess changes in use of the

CDSS over time. Secondary objectives are to assess changes in self-reported attitudes and barriers towards TSE intervention in the UC, and the demographics of patients and caregivers who were screened for or received TSE intervention.

METHODS

Study Population

This study was conducted at five separate outpatient UCs, which are part of an academic, pediatric medical center, Cincinnati Children's Hospital Medical Center (CCHMC). The UC sites had >73,000 visits in 2016. CCHMC has used an enterprise EHR (Epic™)[36] since 2009. The study was approved by the CCHMC IRB. All nurse participants completed written informed consent.

Nurses who worked at least one shift per month were eligible to participate; the authors examined all visits (N=14,218) in which study nurses cared for patients during the study period.

The study was conducted in three phases. In Phase I, the CDSS was developed using a mixed-methods approach.[35] During Phase II, the CDSS was implemented and its impact on nurses' assessment of TSE and caregivers' tobacco use, and delivery of the intervention components was assessed. Nurses may have participated in both of these Phases. In Phase III, the effect of the CDSS on caregivers' tobacco use was assessed. Herein, the results of Phase II are reported.

The CDSS was added to nursing documentation after the chief complaint to ensure smooth workflow integration. The CDSS contained non-mandatory prompts for the nurse to screen (Ask) if the child was exposed to tobacco smoke (Figure 1). Screening only occurred per visit; if multiple caregivers or children were present, they were screened as a unit; and the same caregiver and child could be screened again in a subsequent visit. If the caregivers said *yes* to the question: *Do any of the primary caregivers smoke inside or outside of the home?* and that caregiver was present, then an alert was triggered for the nurse to provide smoking cessation education (Advise). Nurses were given options for when to counsel or to give opt-out reasons (e.g., too busy, parent refused). Counseling prompts were provided outside of the EHR in a research database, REDCap.[37] This was to ensure that no caregiver data were stored in the child's record. Following the Advise step, nurses completed the Assess step, and then Assist/Arrange steps with options of fax referral to the Quitline; links to smokefree.gov or smokefreeTXT; and provision of a packet of written TSE and cessation materials. If a primary caregiver smoked but was not present, then an information packet was offered to give to the caregiver. Full details are available elsewhere.[34,35]

Monthly feedback reports were designed and provided.[38] Feedback reports displayed individual and aggregate compliance with each of the intervention components.

A 3-month, prospective cohort study was conducted, starting in November 2015. Follow-up assessments occurred at 1 and 3 months after implementation, and exit interviews with nurses were completed by March 2016. Nurses were required to complete a 30-minute

webinar before using the CDSS that included information about the effects of TSE in children, the importance of screening and counseling caregivers, and instructions on how to use the CDSS. The webinar was available to nurses for up to 8 weeks prior to the implementation, and remained accessible throughout the study period.

Measures

Nurses completed a baseline questionnaire covering demographics and current and former smoking status. Nurses' practice behaviors related to providing caregivers with the 5As were measured by 16 items.[24] At baseline, 1, and 3 months post-training, nurses completed a 17-item assessment of attitudes and perceived barriers related to TSE screening and counseling. All items were measured using 5-point Likert scales (i.e., behaviors, 1=never to 5=always; attitudes, 1=strongly agree to 5=strongly disagree; and barriers, 1=a large barrier to 5=not a barrier; Appendix).

Usability ratings of the CDSS (e.g., ease of use, amount of time), were collected at 3 months, and were based on a 3- or 5-point Likert scale (Appendix). Prompts to complete the follow-up assessments were sent via email at 1 and 3 months.

Exit interviews were conducted within 1 month of study completion with six study nurses to assess their views on the CDSS; verbatim responses were audio-recorded, transcribed, and evaluated. Two investigators (MMG and JG) individually reviewed and performed content analysis of the transcripts before manually structuring the data into major themes. Coding was conducted within each theme. Coding was compared and discrepancies were resolved through discussions and review of raw data. The themes, suggestions, salient points, and supporting quotations were reviewed and used to make decisions about how to enhance the CDSS and make its use sustainable in the future.

Nurses received gift cards of $50 for each survey plus $40 for the exit interview.

The primary outcome was change in rates of each of the 5As. EHR and REDCap data was extracted from all children seen in all UC sites during the 3-month study period. Multiple visits were included.

Secondary outcomes were changes in nurses' self-reported attitudes and barriers towards TSE intervention. Frequencies and sociodemographics of children whose caregivers were screened and were eligible to receive intervention components are reported.

Statistical Analysis

Analyses were conducted in June 2016. Descriptive statistics were calculated for all variables, including means with associated standard deviations or medians with interquartile ranges for continuous variables and frequencies with percentages for categorical variables. Histograms and box plots were used to evaluate distributions for normality. Generalized estimating equations examined changes in study nurses' behavior regarding the 5As over time, and differences by child characteristics; appropriate link functions were used based upon the dependent variable of interest. Generalized estimating equations models were used to include all encounters by nurses, while accounting for the clustering effect, and to

examine changes over time. To examine the changes in use of the CDSS over time, a first order autoregressive correlation structure was used. Nurse identifier was included as a repeated effect in the model. ORs with 95% CIs and *p*-values for the differences in least square means were adjusted for multiple comparisons using the Tukey–Kramer method. For ratings of nurse self-efficacy and perceived barriers, the first two levels of each Likert scale were combined and compared with the lowest three levels. Statistical significance was set at α<0.05. SAS, version 9.4, was used to conduct all analyses.

RESULTS

A total of 43 eligible nurses were approached; 98% were white, non-Hispanic; 100% were female; 37 (86%) consented, and 35 (81%) participated at baseline. The mean age was 36.9 (SD=9.2) years. Twenty-six (74.3%) had been in practice >5 years. Twenty-seven (77.1%) were never smokers, and all were current nonsmokers.

At baseline, ten (28.6%) respondents indicated that they always/often asked about child TSE, six (17.1%) reported that they always/often asked caregivers about their smoking status, and seven (20.0%) always/often documented caregivers' tobacco use on pediatric charts. Almost 23% (*n*=8) reported that they always/often advised caregivers to not smoke around their child; four (11.4%) always/often advised caregivers to quit smoking. Five (14%) indicated that they provided specific assistance to caregivers; three (8.6%) had given educational materials; and two (5.7%) had ever recommended pharmacotherapy. Most (94%) were interested in learning cessation intervention techniques.

All cessation attitudes and barriers are summarized in Table 1. At baseline, 30 (85.7%) strongly agreed/agreed that nurses should advise caregivers to quit, and 97% reported that nurses can be effective in helping caregivers to quit smoking. Nurses reported that caregiver resistance (*n*=18; 51.4%), lack of caregiver materials (*n*=17; 48.6%), caregiver disinterest (*n*=15; 42.9%), and lack of training (*n*=15; 42.9%) were the highest barriers.

All (100%) and 94% of the nurses completed the 1- and 3-month assessment, respectively. Compared with baseline: there was significant improvement in nurses feeling very prepared to assist caregivers in quitting smoking at Month 3 (14% vs 85%, *p*<0.001); and decreased odds of rating caregiver anger (OR=0.24 [95% CI=0.07, 0.77]), lack of training (OR=0.06 [95% CI=0.01, 0.26]), lack of materials (OR=0.02 [95% CI=0.003, 0.09]), and lack of referral resources (OR=0.05 [95% CI=0.01, 0.22] as large barriers to incorporating cessation activities into their routine care at Month 3.

There were 19,749 visits over the 3-month study period; 14,218 of these visits were seen by study nurses (median, 366 [interquartile range,150–647] per nurse). All nurses used the CDSS more than once; 9,209 (65%) children were screened for TSE and 1,801 (19.5%) screened positive.

Of children whose caregivers smoked, the median age was 4 [interquartile range, 1–9] years; 52% were female; 56% were non-Hispanic white, 31% were non-Hispanic black, and 4% were Hispanic; 75% had Medicaid; 1,267 (70%) of the caregivers were daily smokers; 1,002 (56%) reported that one caregiver smoked; 395 (22%) reported that two or more caregivers

smoked; 174 (10%) reported that the child was exposed to other smokers besides the primary caregivers. Of children seen by non-study nurses, 278 (5%) were screened for TSE, and 52 (19%) screened positive.

An alert was displayed for 1,782 of the UC visits. Of these, nurses acknowledged 1,490 (83.6%), selected open order set in 222 (12.5%), and took no action in 70 (3.9%). The highest response rate was for "Yes, I'll counsel now" (n=888; 50%).

Nurses were more likely to screen children who: were aged >2 years (OR=1.1 [95%CI=1.0, 1.2]); were Hispanic (OR=1.6 [95% CI=1.4, 1.9]); and had commercial insurance (OR=1.2 [95%CI=1.1, 1.4]). Nurses had greater odds of Advise and Assist/Arrange step for blacks compared with whites (both OR=1.3 [95% CI=1.0, 1.7]). There were no differences on the 5As steps by sex of the child (Table 2).

Of the 1,801 children identified as being exposed to tobacco smoke, 473 of their caregivers (26.3%) were advised to quit, and 516 (28.6%) were assessed for readiness to quit. Of those, 346 (67%) said they were interested in quitting in the next 30 days, and all 346 (100%) were assisted as follows (may have received more than one): written information: 83.5%; smokefree.gov: 52%; smokefreeTXT:16.2%; quitline: 7.5%; and not specified: 40%.

Across all follow-up periods, the total practice-level use of the CDSS for Ask, Advise, Assess, and Assist/Arrange was 65% (range, 59%–69%), 26% (range, 20%–32%), 29% (range, 21%–35%), and 67% (range, 61%–81%), respectively, of all eligible visits (Table 3). Over time, there were increases in Advise and Assess, but decreases in Ask and Assist/ Arrange. Specifically, compared with Month 1, nurses were almost twice as likely to advise during Month 2: OR=1.7 (95% CI=1.0, 2.8) and Month 3: OR=2.0 (95% CI=1.0, 3.8), and twice as likely to assess during Month 2: OR=1.9 (95% CI=1.1, 3.1) and Month 3: OR=2.2 (95% CI=1.2, 4.1). However, they were 1.4 times less likely to Ask in Month 3 compared with Month 2: OR=0.7 (95% CI=0.56, 0.91) and about 2.5 times less likely to Assist/ Arrange in Month 2 compared with Month 1: OR=0.4 (95% CI=0.24, 0.61) and Month 3: OR=0.4 (95% CI=0.28, 0.62). UC volumes were progressively busier over time, with a 14% increase in patient volume during Month 3 compared with Month 1.

All study nurses completed usability assessments of the CDSS (Appendix) at 3 months. Nurses rated the CDSS four out of five for: "easy to use" (56%); "how easily it will fit into the UC workflow" (50%); "useful in helping to address smoking" (63%); "usefulness of feedback reports" (50%); and "likely to continue using the CDSS in daily workflow" (48%). The majority (54%) rated the CDSS a score of three for "length of time to use," indicating it was neither too long nor too short.

Nurses said that the CDSS was easy to use, user friendly, and took under 3 minutes to complete. All nurses stated that the CDSS increased the number of caregivers they counseled and that it prompted them to assess for TSE. Nurses felt most caregivers were receptive, and that the CDSS facilitated conversations. Nurses reported that caregivers were not interested in the Quitline, but many seemed open to smokefree.gov and smokefreeTXT, and all were receptive to information packets.

All nurses agreed that the CDSS should continue to be used. However, they felt that the research database was inconvenient, and the intervention components should be integrated into the EHR. Most nurses (83%) said the feedback reports were helpful.

DISCUSSION

This study adds to the growing literature supporting the use of CDSS to increase standardized TSE screening and interventions in the pediatric healthcare setting.[39–41] This model has the potential to improve the delivery and outcomes of evidence-based TSE screening and treatment in the UC setting. The use of the CDSS resulted in the identification of large numbers of children who were exposed to tobacco smoke and there were increases in the proportion of caregivers who were advised to quit and assessed for readiness to quit. However, the absolute rates of the 5As behaviors was lower than expected which may be because the prompts were not mandatory. Prior studies demonstrate that rates of tobacco treatment by pediatric practitioners are higher when there are mandatory prompts and treatment algorithms in the EHR, standardized TSE education for practitioners, and availability of educational materials.[23,42,43] Contrary to prior studies that found an increase in the Assist step by nurses and physicians,[38,44,45] there were decreases in rates of compliance with the Assist/Arrange step by nurses over the study period. This may have been because of increased patient volumes and tighter time constraints on the nurses. Assist/Arrange rates may be improved by placing all 5As steps within the EHR as suggested by the nurses during the exit interviews.

The reported findings that children were more likely to be screened if they were older, Hispanic, and had commercial insurance is consistent with other research,[40] but because children who were exposed were more likely to be non-Hispanic white and Medicaid recipients, these results indicate that all demographic groups need to be screened.

Encouragingly, the nurses provided information and resources to 100% of caregivers who were interested in quitting. The CDSS was acceptable to nurses, although the use of an external database was seen as a deterrent. Data from the exit interviews indicated that nurses wanted continued use of the CDSS. Future research should evaluate whether the incorporation of the full CDSS within the child's EHR improves Assist/Arrange rates.

Limitations

The current study has several limitations. First, this pilot study was conducted with a small convenience sample of UC nurses in one urban tertiary care children's hospital. The results may not be representative of larger populations of UC nurses. Second, the UCs have a large, comprehensive EHR system, and therefore nurse practice, recommendations and suggestions may be skewed towards the capabilities of this clinical setting. Third, the timeframe allowed for the intervention was limited because of administrative reasons; thus, the sustainability of changes in practice beyond the pilot period was assessed. Finally, lower than expected rates of positive TSE screens (prior work in the pediatric emergency department setting shows rates of as high as 48%) was observed[14–17]; although this may have been because of differences in the screening questions used between studies.

CONCLUSIONS

This study demonstrates the feasibility of a CDSS in the pediatric UC setting for reducing TSE. The EHR modification for screening, and the integration of an interruptive alert led to increases in TSE screening and counseling during UC visits. Rates of CDSS use were lower than expected, but there is need for screening of all demographic groups. Rates of use may be improved by incorporating all CDSS components into the EHR. Future research is warranted to modify the CDSS, and assess how the use of CDSS affects clinical outcomes for children exposed to tobacco smoke, and cessation rates in caregivers.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Figure 1.
Smoking cessation screening.

Table 1

Nurse Attitudes and Barriers

Attitudes/Barriers	Baseline	Month 1	Month 3	3 month vs baseline
	Strongly agree/Agree N (%)	Strongly agree/Agree N (%)	Strongly agree/Agree N (%)	OR (95% CI)
Attitudes				
I am interested in learning new ways	33 (94.3)	28 (80.0)	23 (69.7)	**0.13 (0.02, 0.72)**
Appropriate for nurse to assess and document	32 (91.4)	30 (85.7)	27 (81.8)	0.42 (0.08, 2.24)
Nurses should advise parents	30 (85.7)	25 (71.4)	28 (84.8)	0.96 (0.20, 4.66)
It is the doctors' job to advise	5 (14.3)	5 (14.3)	9 (27.3)	2.31 (0.74, 7.23)
Doctors, nurses and respiratory therapists work together	35 (100)	31 (88.6)	31 (93.9)	NE
Nurses can be effective	34 (97.1)	28 (80.0)	31 (93.9)	0.46 (0.02, 9.1)
Barriers	Large (1–2) N (%)	Large (1–2) N (%)	Large (1–2) N (%)	3 month vs baseline
Parent resistance	30 (85.7)	28 (80.0)	25 (75.8)	0.53 (0.12, 2.41)
Amount of time	25 (71.4)	18 (51.4)	17 (51.5)	0.43 (0.16, 1.20)
Resistance by doctors	3 (8.6)	1 (2.9)	2 (6.1)	0.66 (0.10, 4.12)
Concerns about effectiveness	11 (31.4)	11 (31.4)	8 (24.2)	0.31 (0.26, 2.15)
Parent anger	26 (74.3)	19 (54.3)	13 (39.4)	**0.24 (0.07, 0.77)**
Parent disinterest	28 (80.0)	30 (85.7)	27 (81.8)	0.37 (0.29, 4.37)
Feat will change relationship	14 (40.0)	10 (28.6)	10 (30.3)	0.74 (0.28, 1.92)
Lack of training	28 (80.0)	12 (34.3)	6 (18.2)	**0.06 (0.01, 0.26)**
Lack of parent materials	30 (85.7)	3 (8.6)	3 (9.1)	**0.02 (0.003, 0.09)**
Lack of referral resources	23 (65.7)	3 (8.6)	3 (9.1)	**0.05 (0.01, 0.22)**

Notes: Boldface indicates statistical significance ($p<0.05$).

NE, non-estimable

Table 2

Differences in Nurses' Ask, Advise, Assess, Assist/Arrange Behaviors by Child Characteristics

Characteristics	N (%)	Ask OR (95% CI)	Advise OR (95% CI)	Assess OR (95% CI)	Assist/Arrange OR (95% CI)
Child age, years					
>2	8,429 (59.3)	**1.08 (1.00, 1.16)**	0.88 (0.72, 1.06)	0.98 (0.80, 1.21)	0.99 (0.83, 1.17)
0 − 2	5,789 (40.7)	ref	ref	ref	ref
Child sex					
Female	6,976 (49.1)	1.00 (0.95, 1.06)	0.99 (0.82, 1.19)	1.03 (0.88, 1.20)	1.0 (0.83, 1.20)
Male	7,242 (50.9)	ref	ref	ref	ref
Child race	Of 11,842[a]				
African American	4,164 (35.2)	0.93 (0.82, 1.06)	**1.32 (1.03, 1.70)**	1.11 (0.92, 1.34)	**1.31 (1.00, 1.72)**
Caucasian	7,678 (64.8)	ref	ref	ref	ref
Child ethnicity	Of 13,963[b]				
Hispanic	956 (93.2)	**1.64 (1.40, 1.92)**	1.29 (0.50, 3.32)	1.65 (0.75, 3.63)	1.77 (0.81, 3.89)
Non-Hispanic	13,007 (6.8)	ref	ref	ref	ref
Child insurance	Of 14,173[c]				
Commercial/Self-pay/Other	6,173 (43.6)	**1.23 (1.11, 1.37)**	**0.64 (0.45, 0.90)**	**0.30 (0.23, 0.40)**	**0.31 (0.18, 0.50)**
Medicaid/Government	8,000 (56.4)	ref	ref	ref	ref

Notes: Boldface indicates statistical significance (*p*<0.05).

[a]Child race: Other N=1,728, Missing N=648.

[b]Child ethnicity: Missing N=255.

[c]Child insurance: Missing N=45.

Table 3

Changes in Nurses' Ask, Advise, Assess, Assist/Arrange Behaviors

Behavior	Month 1 N=4,788	Month 2 N=4,712	Month 3 N=4,718	Total	AOR (95% CI) p-value[a]		
					Month 2 vs Month 1	Month 3 vs Month 1	Month 3 vs Month 2
Ask	3,290/4,788	3,121/4,712	2,798/4,718	9,209/14,218	0.95	0.68	**0.71**
	(68.7%)	(66.2%)	(59.3%)	(64.8%)	(0.65, 1.38)	(0.44, 1.04)	**(0.56, 0.91)**
					0.94	0.08	**0.003**
Screened positive	692/4,788	577/4,712	532/4,718	1,801/14,218	–	–	–
	(14.4%)	(12.3%)	(11.3%)	(12.7%)			
Advise	137/692	167/577	169/532	473/1,801	**1.70**	**1.99**	1.17
	(19.8%)	(32.0%)	(31.8%)	(26.3%)	**(1.01, 2.84)**	**(1.04, 3.8)**	(0.79, 1.73)
					0.04	**0.04**	0.61
Assess	143/692	187/577	186/532	516/1,801	**1.87**	**2.19**	1.17
	(20.7%)	(32.0%)	(35.0%)	(28.6%)	**(1.12, 3.1)**	**(1.17, 4.08)**	(0.79, 1.75)
					0.01	**0.009**	0.61
Assist/Arrange	116/143	114/187	116/186	346/516	**0.38**	**0.41**	1.08
	(81.1%)	(61.0%)	(62.4%)	(67.1%)	**(0.24, 0.61)**	**(0.28, 0.62)**	(0.64, 1.82)
					<0.0001	**<0.001**	0.94

Notes: Boldface indicates statistical significance (*p*<0.05).

[a]*Tukey-Kramer Adjustment for Multiple Comparisons