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Research and Applications

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Application of a user experience design approach for an EHR-based clinical decision support system

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Abstract

Objective: We applied a user experience (UX) design approach to clinical decision support (CDS) tool development for the specific use case of pediatric asthma. Our objective was to understand physicians' workflows, decision-making processes, barriers (ie, pain points), and facilitators to increase usability of the tool.

Materials and methods: We used a mixed-methods approach with semi-structured interviews and surveys. The coded interviews were synthesized into physician-user journey maps (ie, visualization of a process to accomplish goals) and personas (ie, user types). Interviews were conducted via video. We developed physician journey maps and user personas informed by their goals, systems interactions, and experiences with pediatric asthma management.

Results: The physician end-user personas identified were: efficiency, relationship, and learning. Features of a potential asthma CDS tool sought varied by physician practice type and persona. It was important to the physician end-user that the asthma CDS tool demonstrate value by lowering workflow friction (ie, difficulty or obstacles), improving the environment surrounding physicians and patients, and using it as a teaching tool. Customizability versus standardization were important considerations for uptake.

Discussion: Different values and motivations of physicians influence their use and interaction with the EHR and CDS tools. These different perspectives can be captured by applying a UX design approach to the development process. For example, with the importance of customizability, one approach may be to build a core module with variations depending on end-user preference.

Conclusion: A UX approach can drive design to help understand physician-users and meet their needs; ultimately with the goal of increased uptake.

Lay Summary

Computers can help health providers make care choices. This helps providers spend more time with patients talking about their health. One problem is health providers may not use these computer tools because the tools are hard to learn. Also, providers might not think they help. Sometimes, the tools are designed by people who do not know how clinics run.

As researchers and designers of computer tools, our goal is to better know what providers want. This is so providers are more likely to use these tools in their practice. We used design approaches that could help understand the providers more, such as interviews. Through interviews, we found 3 different persona types. Each persona has different needs that would help them use the computer tools. This more personal approach to design helped us understand the providers more. Our next steps are to use these lessons to further design, test, and adjust the computer tool in the clinics.

Key words: user centered design; asthma; electronic health record; clinical decision support; implementation science.

Introduction

Pediatric asthma is one of the most common chronic conditions in children resulting in substantial health and financial burden worldwide.[1–4] Comprehensive national and international guidelines for management exist, but their incorporation into practice is low.[5–7] To address this, clinical decision support (CDS) systems—assistive tools to provide relevant knowledge or data to improve patient care—have been created to help incorporate guidelines and potentially increase time for practitioners to spend on the visit rather than information gathering.[8–13] Often built into the electronic health record (EHR), these systems have demonstrated improvement in practitioner action (eg, guideline adherence, appropriate medication management) and asthma outcomes (eg, decreased exacerbations, healthcare utilization).[9]

Despite CDS tool effectiveness, there is low adoption by physicians related to suboptimal workflow integration, lack of functionality, and negative physician-user attitudes.[9,13–17] Our group's previous review of facilitators and barriers for asthma CDS tool adoption found that involving the physician-user in the development process facilitated designers to understand variability in decision-making processes

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and different physician user needs.[18] This is essentially user experience (UX) design, an interdisciplinary field that creates products or services focused on "quality and enjoyment of the user's total experience" of the end-user by understanding user needs.[19] This approach is frequently seen in business and software industries but is applicable to healthcare. Applying UX and continuous process improvement methodology (eg, iterative development and agile approaches) framework to the design of EHR-based tools can improve workflows and perception of the EHR.[20–23] Addressing EHR-specific friction (eg, increased effort or frustration) is also important because the EHR is cited as a leading contributor to physician burnout, which negatively impacts workforce health, patient care, and healthcare cost.[22,24,25]

We applied UX design (through qualitative user interviews and surveys) to gain insight into features and implementation strategies most relevant for the development and adoption of our pediatric asthma management CDS tool. To do this, we performed journey mapping (ie, depicting a physician end-user's experience to accomplish an asthma clinic visit) and created physician personas (ie, qualitative data-informed representations of physician attitudes and preferences to understand target population variability).[26,27]

Methods

Participants

We recruited a range of potential physician-users of our asthma management CDS module within the University of California, Los Angeles (UCLA) David Geffen School of Medicine, including general pediatric, medicine-pediatric, pediatric pulmonology, and pediatric allergy attendings, as well as pediatric residents. Participants were each compensated with a $75 Amazon gift card.

Protocol

The research team included E.G., a female undergraduate pre-medical research assistant with user-design experience and an asthma digital health background; I.R., a female undergraduate pre-medical research assistant with qualitative research experience; E.C. a female pre-medical health services research coordinator with a health sciences background; G.R. a male professor of Health Systems Science and medical anthropologist; and M.K.R., a female pediatrics pulmonology and clinical informaticist attending with business training.

Our semi-structured, individual interviews (Table S1) were guided by a framework based on the team's experience with a typical workflow that included 3 temporal steps: pre-visit (scheduling, pre-charting), visit (waiting room, encounter), and post-visit (documentation, follow-up), with a systems-level framework around the patient visit (Figure S1). During each step, the research team reported interactions between the physician, staff, patient, and EHR (Figures S2-S4), the physician-user experience, and design or workflow ideas to increase adoption of a CDS tool. Interviews were conducted via Zoom video conferencing, audio-recorded, and transcribed.[28] After the interview, participants were sent REDCap (Research Electronic Data Capture) surveys via email about demographics as well as attitudes toward technology and evidence-based medicine (EBM) to understand our participants' relevant baseline characteristics and backgrounds which may affect their use of a potential EHR-based CDS tool population's baseline characteristics and backgrounds which including (eg, age, prior experience with EHR and relationship with technology and EBM).[29–31] Participants were recruited until data saturation. Protocol was approved but the UCLA Institutional Review Board IRB#20-000347.

Analysis

Journey maps and personas were chosen as the approach because they serve to promote empathy for the user within the design team and inform decisions to improve overall experience.[26,27] While journey maps and personas may not capture all individual permutations of user preferences and workflows, they can identify a broad range of experiences and offer useful UX generalizations that designers can understand, empathize with, and ultimately design for. We modeled an industry approach to develop our journey maps and personas by using themes identified from interviews. First, 2 team members independently coded the interview transcripts based on pre-determined macro themes (eg, touchpoints with the EHR, thoughts, highlights, pain points/friction, emotions, improvement opportunities). Then, team members collaborated to create affinity diagrams (ie, clustering of similar ideas into representative sub-groups based on commonalities) using a virtual collaboration tool (Google Jamboard) to inductively determine newly identified themes.[32] The macro themes along a physician's steps through the visit process (pre-, during, and post-visit) constitute the journey map. Finally, each physician persona was developed based on themes from interviews related to goals and motivations, EHR interactions, patient care approach, and friction/pain points.

Reporting

We followed the Standards for Reporting Qualitative Research (SRQR) and the Consolidated criteria for Reporting Qualitative Research (COREQ).[33,34] Our study focused on the physician perspective navigating the pediatric asthma CDS tool, as physicians are the primary end-users.

Results

Demographics and baseline information

Fifteen participants were recruited and interviewed: 11 attendings (4 general pediatrics, 1 medicine-pediatrics, 4 pediatric pulmonology, 2 pediatric allergy and immunology) and 4 pediatric residents. Most (86%) participants had >5 years of experience with the EHR, and had generally positive attitudes toward technology ($\mu = 4.03 \pm 0.95$; 1 = strongly disagree, 5 = strongly agree) and evidence-based medicine ($\mu = 4.18 \pm 0.25$; 1 = strongly disagree/very unwelcoming, 5 = strongly agree/very welcoming). Further demographic information, technology, and evidence-based medicine attitude scores are highlighted in Table 1 and Tables S2 and S3. See Table S4 for detailed themes and representative quotes.

Physician journey map

Physician-user journey map is depicted in Figure 1. Pre-charting was reported as a challenge because there was often not enough patient information for new patients or too much detail to parse through for return patients. Some participants reported skipping pre-charting: "I don't always pre-chart because it's a waste of time, and patients don't show up." To improve this experience, multiple participants suggested a

Table 1. Participant demographics and technology attitude scores.

	$N = 15$ (100%)
Age	
25-29	1 (6%)
30-39	5 (31%)
40-49	3 (20%)
50-59	3 (19%)
60-69	1 (6%)
Prefer not to answer/unanswered	2 (13%)
Gender	
M	6 (40%)
F	7 (44%)
Other	0 (0%)
Prefer not to say/unanswered	2 (13%)
Ethnicity	
Hispanic/Latino/a	3 (19%)
Non-Hispanic/Latino/a	6 (40%)
Other	2 (13%)
Prefer not to answer/unanswered	4 (25%)
EHR use (years)	
1-5	1 (6%)
6-10	8 (50%)
11-15	4 (27%)
16-20	1 (6%)
Prefer not to answer/unanswered	1 (6%)
Field	
Pediatric allergy/immunology	2 (13%)
Pediatric pulmonology	4 (27%)
Pediatrics/medicine-pediatrics	9 (60%)
Technology attitude scores	
1 = strongly disagree; 5 = strongly agree	mean±SD
Positive attitude total score	4.03 ± 0.95
Negative attitude total score	3.24 ± 0.96
Evidence-based medicine total attitude score	
1 = strongly disagree/very unwelcoming; 5 = strongly agree/very welcoming	4.18 ± 0.25

centralized EHR location for asthma data (eg, medication, action plan): "It would be nice to have an 'asthma ID' for every patient, including what their pulmonologist thinks, what they're classified as, and what they should be on."

The patient visit itself was reported as the highlight of the physician's workflow. Excellent patient care was a guiding focus; however, it was difficult to balance building patient rapport with notetaking given time constraints. Participants reported that clinics were understaffed with limited space causing delays in patient rooming. Some of the most emphasized sources of friction were related to health system operational inefficiencies and limited support. Participants preferred forms to be collected before visits, but most clinics were unable to provide paper intake forms to patients at check-in or if they did, patients often lacked time to complete them. If forms were completed, they needed to be manually entered into the EHR and one participant noted that manual entry was impossible due to time constraints. Most participants were not enthusiastic toward the EHR yet understood its value: "It's really cool to know the spectrum we've gone from the days of paper charts." Notably, all participants indicated a willingness to try an EHR CDS tool to support their patient care, and many suggested collecting information electronically before the visit to increase their time with the patient. Post-visit documentation and follow-up were reported the most challenging due to time constraints and lack of systemic support: "It's about staffing. We need more staff to manage our InBasket." One physician noted they often have dozens of open charts and "have to take an afternoon and just crank through them, which is [only temporary]."

There were notable differences in the proportion of asthma patient visits and workflows across physician specialty and

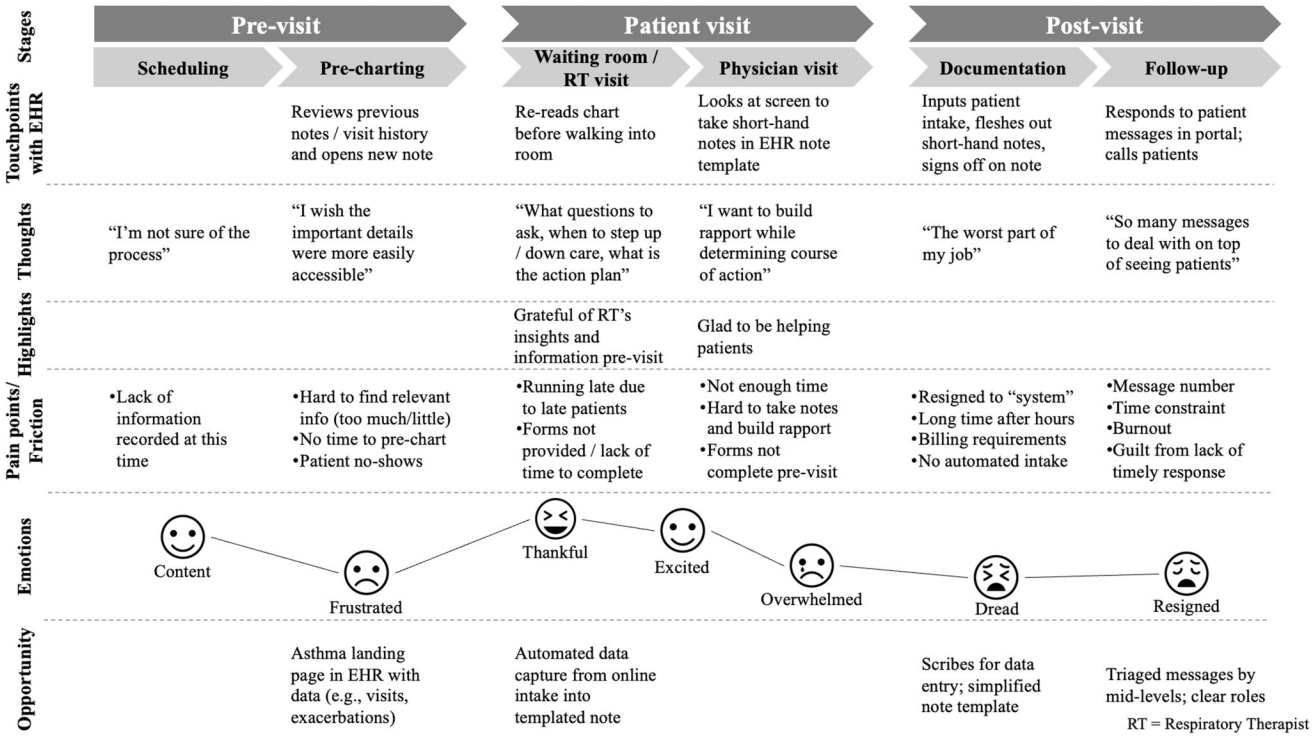

Figure 1. Physician journey map.

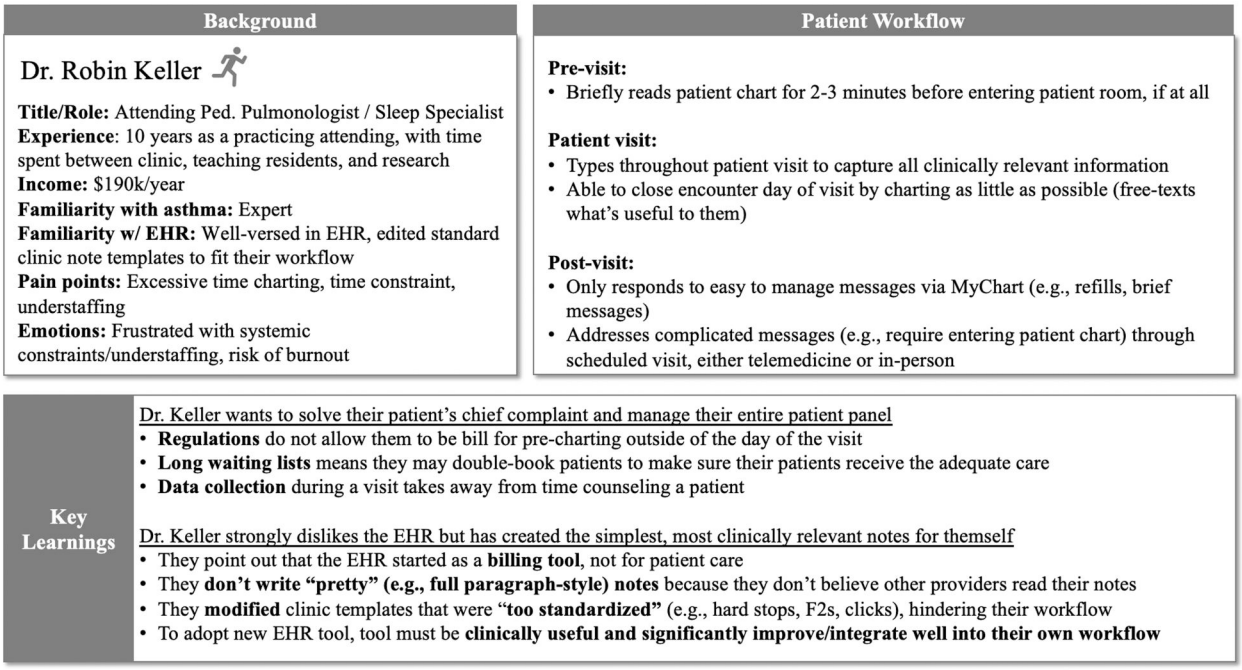

Figure 2. Efficiency attending physician persona.

experience. Specialists reported a higher percentage of asthma patient volume (30%-70%) than generalists (5%-20%). Pulmonologists had the benefit of respiratory therapists who performed lung function testing and provided asthma education. In contrast, general practitioners noted that often asthma is "just one piece among the other 10 things we're addressing for that visit." Specialists also preferred more detailed notes than generalists. To improve care coordination between the teams it was suggested the action plan could be a "shared communication tool."

Physician personas

While there were unifying experiences (eg, providing excellent patient care, belief in evidence-based medicine), there was a wide variability of goals, motivation, and interaction with the EHR within the larger system. We identified 3 physician-user personas: efficiency (attending physician), relationship (attending physician), and learner (resident physician), Figures 2–4.

Efficiency persona

One of the primary goals of this physician-user persona was to be efficient with processes and documentation, such as closing notes during or immediately after the visit. If not, this affected whether "I'm going to miss my children's events, stay up late, not get sleep or work through a meal."

The efficiency persona tended to have more EHR dexterity, and knowledge about features located within the system. They preferred customization of tools and likened this preference to being an Android user, "Android users go for customizability; iPhone users go for stability and standards. I would invest more time in customizability." They were more likely to report concerns with standardization in medicine: "I'm not an automaton; my training is to elicit the proper information," and were less likely to adopt a group practice's standardized note template. They would be more likely to modify or remove "unhelpful" features. These physicians would trust auto-populated histories from a portal-based patient questionnaire because the history was "not up to physician interpretation in that section anyway."

Efficiency physicians were more likely to have a higher threshold to learn or try a new tool. The new approach would have to be "at least better than neutral, not have a steep learning curve, be a real challenge, or take a long time to learn." One participant mentioned that beyond "making my life easier, the only other motivation for using an EHR tool would be if I was required to, and there was no way out." Another participant thought that someone "stubborn" may not be interested in the tool but perhaps could be persuaded if designed with the user in mind. Opinions varied about the preferred approach to navigate through a note template; for example, some identified "mouse-clicking" as more efficient, while others preferred "F2-button" navigation. Participants were aware of differing preferences, as participant noted a disagreement with a colleague over the best way to design a patient note. Finally, the efficiency persona would be comfortable learning new tools from step-by-step screenshot guides leveraging their existing EHR familiarity.

Relationship persona

The relationship-building aspect of patient care was one of this persona's primary goals and would sacrifice efficiency to achieve it: "I have a hard time documenting while trying to build rapport and be a good listener, so I tend to take very cursory notes in the room and write my full note after the visit." They emphasized being present with families and noted that they "wouldn't like it if [I was] a patient, and the doctor [was] just staring at the computer."

This persona pre-charted more to improve their patient knowledge, which encroached on their personal time. Yet even this persona would limit themselves due to frequent last-minute patient cancellations. The motivation to use any type of decision support was "if it improves patient care," and they would tolerate more inefficiencies or difficulties to learn.

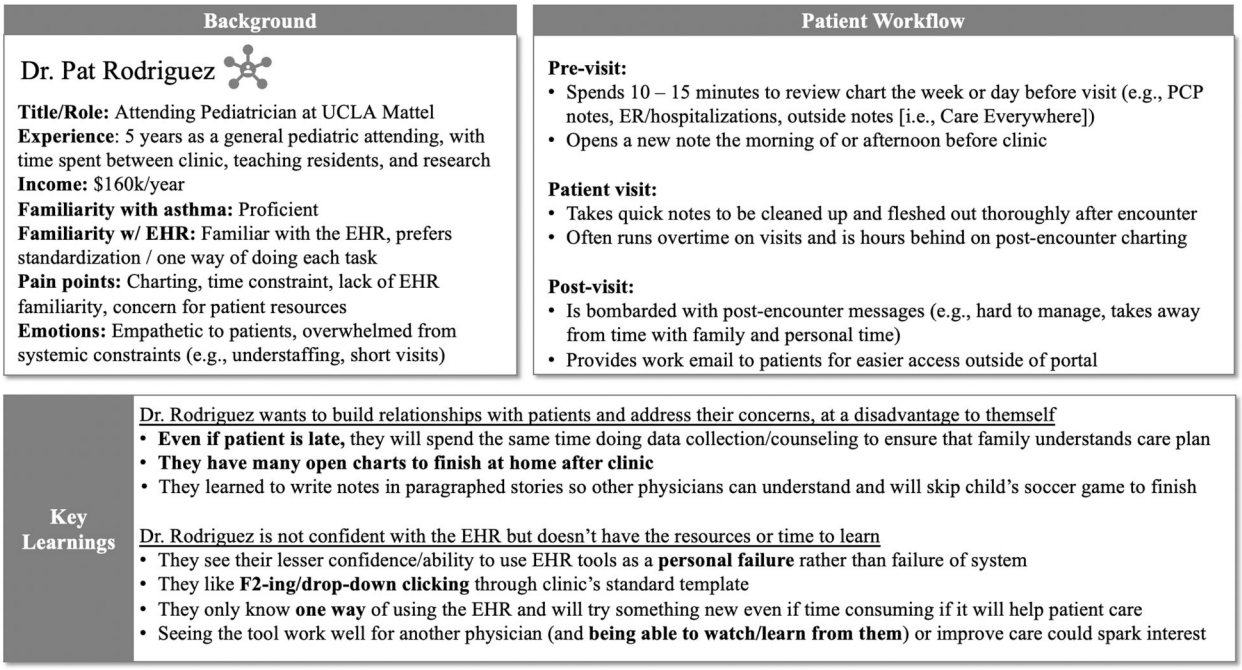

Figure 3. Relationship attending physician persona.

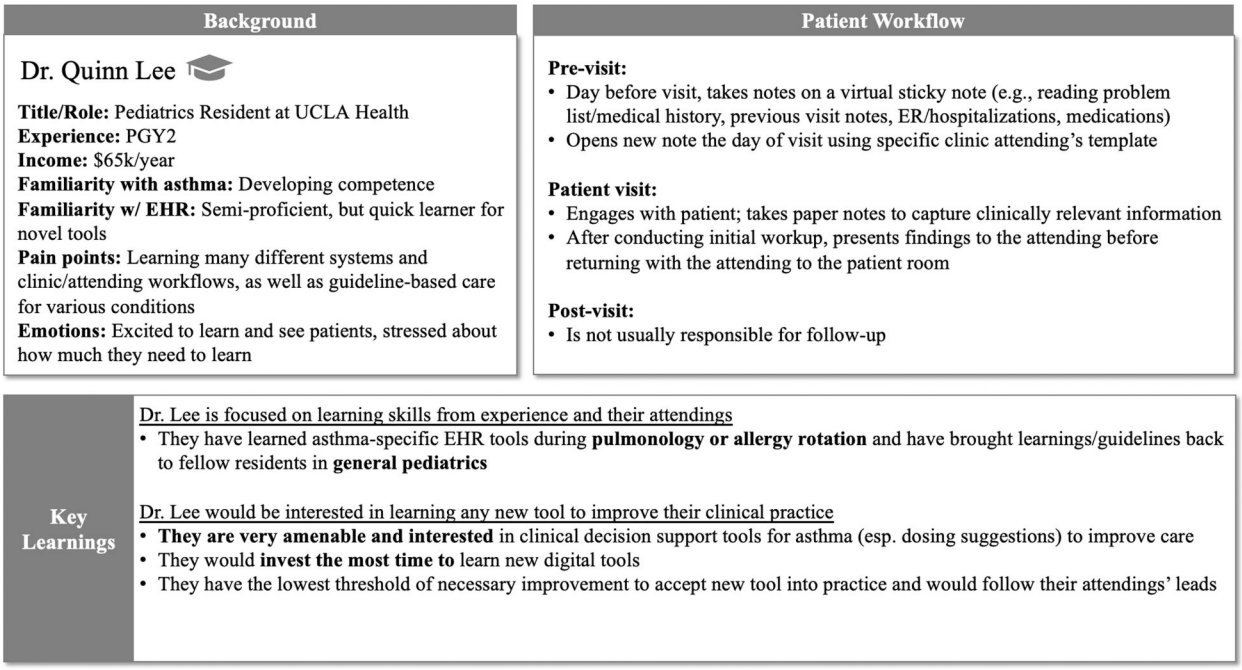

Figure 4. Resident learner physician persona.

They would question portal-based patient-reported information automatically entered in the note template because "something described as moderate or severe may not be as severe in reality and vice versa."

The relationship attendings preferred standardization, as customizability was not a priority and could be a source of friction when learning to use the tool. They also appreciated direction from the EHR, including automatic pop-ups with decision support because it helped "anticipate the next step in the protocol." This persona seemed to be less comfortable navigating the EHR and preferred learning from watching physician champions, applying the "see-one, do-one, teach-one" framework, and asking their colleagues questions in real time.[35]

Learner persona

The learner persona was defined by goals to learn patient care while balancing building patient relationships and documentation efficiency. This was illustrated by the resident participants' desire to be "patient-facing and make sure families

feel heard." They noted the importance of "locking eyes with the patient" even if it hindered efficient notetaking.

In general, residents were very adept with the EHR, could easily acquire new skills, and were accustomed to learning multiple documentation systems. Of the 3 personas, they appeared most open to the idea of a new pediatric asthma CDS tool. They view the CDS as a teaching tool, as one participant noted: "It would be good to have a checklist guide to understand all the different steps for managing asthma." The residents used attending-provided templates and preferred standardization because "unless the attending starts the note, there [were] still too many confusing options." They might remember a tool's existence "but have no idea where to find it" so preferred clinic-wide standardization to "know exactly which ones to use."

As a learner, residents interact with various health systems, EHRs, and institutional cultures, with attendings as the main educational source. One participant noted they learned to step-down asthma medications from pulmonology attendings and were provided literature and guidelines as support. Other than managing various workflows, their primary constraint was time. The residents were supportive of using the patient portal to gather information prior to the visit to "help probe more important questions and optimize short visit times."

Discussion

Overall, participants were interested in trialing the proposed pediatric asthma CDS tool and noted 3 primary avenues it could demonstrate value: (1) lower workflow friction, (2) improve the environment surrounding physicians and patients, and/or (3) as a teaching tool. Ideally, one tool would be standardized enough to guide patient care and be scalable, yet flexible enough to accommodate various user personas.

If a new asthma CDS tool could reduce clinic workflow friction and EHR burden for all personas, it could help gain traction for adoption. Without smooth integration, the tool becomes another challenge within a physician's already difficult workflow, with less chance for use and possibly contribute to burnout.[8,36,37] Also, due to differing values and personas, some practitioners insist on customizability despite the importance of standardization (care quality, consistency, reproducibility, scalability). Without mandates to use a particular tool version, different tool builds may be needed to capture the nuances of stakeholders and enhance end-user uptake. Determining the specific persona for every possible user is not feasible, however if designers have a basic understanding of identified relevant personas through UX design methods, it would perhaps facilitate an approach such as building a core module with slight variations depending on persona preferences. However, this may be more challenging for learners who note friction from many variations of templates and tools. Another key aspect to workflow adoption is that the tool is easy to learn. Even if a tool will eventually improve the status quo for the practitioner and patient, the perceived (or actual) investment to learn can be a potential barrier.[38] Different educational approaches may be needed for various personas to adopt the tool, as all physicians have individual cost-benefits analyses driven by their goals and motivations.

To improve the environment surrounding physicians and patients, CDS tools can automate processes for data gathering patient-reported information and allow physicians to focus on patient counseling and care. However, if pre-visit intake questionnaires do not have high levels of completion, the overall value proposition for a CDS tool may be diminished.[39,40] Investing in infrastructure, such as technologies or staffing to ensure questionnaires are completed can help adoption. It is also important to consider the type of clinic the tool will be used in because of differing volumes and specificity of asthma patients in clinics. There may be more hesitancy justifying the time spent to learn an asthma-specific tool in general clinics, given the lower volume of asthma patients.[41] Or pediatric allergists may prefer a CDS tool that includes more about the patient's atopy.

Our findings are largely transferable from pediatric asthma to a more generalized environment including adults and conditions other than asthma. However, there are considerations about the differences between pediatrics and adult medicine such as the patient-facing aspect of CDS tools. For example, the primary end-user for younger children will be the parent or caregiver, but this ownership of care will vary into adolescence as the adolescent ideally becomes more involved and responsible for their own healthcare. This also applies to the adult realm for patients who are unable to care or interact with the EHR or physician and have a medical caregiver or conservator on their behalf. In addition, medical intake questionnaire terminology may need to be adapted based on age, relationship to the patient, or other factors.

Our study also highlighted the potential of pediatric asthma CDS as a bi-directional teaching tool for learners and attendings. Learners do not have, or expect, much agency in the selection or modification of tools so it is not as much of a barrier to adoption. They are also amenable to more standardization and less variation to support learning and less tools and templates to memorize. In addition, the attending role at an academic institution includes the responsibility of training learners, so incorporating CDS tools into teaching can also help to keep attendings up-to-date with evolving guidelines.[42]

While our study provided insights about barriers and facilitators to pediatric asthma CDS tools, there were limitations. Even for a single physician-user, workflows are often variable and non-linear (eg, last-minute cancellations, late arrivals, or visits running long). These environmental constraints may affect whether a physician can achieve the workflow they reported in their interview and intend to follow. Despite the linear nature of journey maps, we were still able to capture variations due to the nature of the qualitative interviews of a variety of physicians. Because there are nuances that may not be captured in this type of research, user interviews are only an early component of the larger design process, which includes iterative user testing of prototypes from low (eg, non-clickable mock-ups) to high fidelity (eg, working prototypes).[19] This iterative (or agile) approach, rather than a traditional "waterfall" design approach, is more conducive to success due to the variability in this work. Designers would benefit from flexibility and understand that once a tool is built at any stage, especially early stage, there will likely be changes due to the unpredictable nature and complexity of clinical environments. Thus, through this approach, designers will gradually develop a more nuanced and empathetic understanding of user needs and workflows, including the differences between intended and actualized workflows, resulting in an improved CDS tool. Additionally, this was a qualitative study at a single academic institution. Despite a

small number of participants, we intentionally sampled a diverse group with different experience levels to obtain various perspectives related to work environment, and we were able to reach thematic saturation during the interviews suggesting our findings are likely generalizable.[43,44] Although areas of homogeneity were that participants had overall favorable baseline opinions about technology and evidence-based guidelines. The principal investigator also had an existing relationship with participants, which may have influenced participation or feedback (eg, less forthcoming or too favorable). UX design has some inherent subjectivity and designers must recognize sources of bias (eg, existing relationships, their own experiences, etc.).

Conclusion

Applying a UX design approach to a pediatric asthma CDS tool in an academic healthcare system is feasible and provided actionable insights into physician-user needs. While standardization is important to streamline processes and allow for greater scalability, our study highlights the need for customizability and flexibility to encourage adoption. A UX approach to CDS tool design can raise empathy and garner trust, which has greater potential to foster rapport between administrators, the information technology (IT) development team and physician-users. This UX approach can be applied to any product design for physicians, and the learnings about our physician-users are broadly applicable to CDS tools in other specialties, especially those focused on chronic diseases, but should be explored to capture specific nuances. Our next steps are to continue to develop and iterate our asthma CDS tool, and to test the tool in practice.

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Author contributions

E.G. significantly contributed to the conception and design of the work, the acquisition, analysis, and interpretation of data, and drafting of the manuscript; I.R. significantly contributed to the analysis and interpretation of data; E.J.C. significantly contributed to the acquisition of data; G.W.R. significantly contributed to the design of the work and interpretation of data; M.K.R. significantly contributed to the conception and design of the work, acquisition, analysis, and interpretation of data, and drafting of the manuscript. All authors critically reviewed the manuscript for intellectual content and approved the final version to be published.

Supplementary material

Supplementary material is available at *JAMIA Open* online.

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Conflicts of interest

None declared except funding sources as above.

Data availability

The data underlying this article cannot be shared publicly in its entirety due to privacy of the individuals that participated in the study. The data underlying this article were shared as much as possible in the article and in its online supplementary material.

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