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Barriers and facilitators of electronic patient portal uptake for asthma management

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Abstract

Objective: An active patient-practitioner partnership is a key aspect of asthma management and patient-reported data helps with shared decision making. Technological advances such as the electronic patient portal can facilitate partnership, with the goal of improved asthma outcomes. However, uptake of portals by end-users for asthma management has been low. We studied portal-based asthma interventions to understand barriers and facilitators to its use.

Data Sources: We searched within the PubMed, Web of Science, Scopus, MEDLINE, and Google Scholar databases.

Study Selections: We used the PRISMA extension for scoping reviews to guide our analysis of studies related to asthma and patient portals. We summarized relevant studies in terms of barriers and facilitators as well as study characteristics.

Results: Sixteen studies were included in our final analysis. Common barriers to patient portal use for asthma management were lack of perceived value by the end-user, low end-user technological literacy, and limited resources. Facilitators of portal use included ease of use, personalization, and adequate technical support. Patient portals in these studies were used for a variety of applications related to core asthma management concepts of assessment and monitoring, education for a partnership in asthma care, environmental factors, co-morbidities, and medications.

Conclusions: Patient portal use for asthma management can be encouraged by ensuring the portal is easy to access and navigate, demonstrates values, as well as has readily available technical support. Involving end-users closely in the design process and implementation may help address barriers. Special attention is needed for groups with technological resource limitations.

Introduction

The World Health Organization predicts an upward trend of asthma diagnoses, reaching 400 million cases by 2025 (1). Uncontrolled asthma contributes to substantial morbidity and

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healthcare cost. Approaches to improve asthma control, as informed by asthma guidelines, include four key components of care: symptom monitoring, education for partnership in asthma care, environmental and comorbidities, and medication therapy (2–4). Particularly for those with severe asthma, frequent patient-practitioner interactions as well as increased patient knowledge and self-management of asthma are important (5, 6). To prevent respiratory exacerbations and deaths, researchers and clinicians have sought to improve the quality of disease management in a manner that allows both physicians and patients to easily track illnesses and participate in a partnered care model (2, 3).

Rapidly evolving technological advancements allow for this partnership through electronic patient portals. Patient portals are web-based interfaces that connect the patient with their electronic health record (EHR) and contain a wide-range of features including personal health information, lab results, appointments, and messaging to communicate with physicians and the medical care team (7). Collection of patient-reported outcomes can be specialized to the needs of individuals with a particular chronic disease and have shown promise with illness control and management, including asthma (8). Portal functionalities for asthma include symptom and goal tracking, feedback between visits, identification of risk factors and triggers, medication side effects and adherence monitoring, as well as educational handouts or videos based on patients' needs.

Though patient portals specifically for asthma management exist and have demonstrated improved clinical outcomes (e.g., better control, less exacerbations and missed parental work days) (9, 10), their use in practice remains low (11). The range of factors contributing to patient portal engagement for asthma management is not well known. Understanding and addressing these factors may allow for increased uptake to achieve widespread adoption. We reviewed studies of electronic patient portals for asthma management with the aim to understand barriers to and facilitators for end-user adoption.

Methods

Data sources and search strategy

Our approach was informed by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) scoping review extension (12). We searched PubMed, Web of Science, Scopus, MEDLINE, Google Scholar databases using Medical Subject Heading (MeSH) terms as able. With librarian guidance, our searches included (“Asthma”[Title/Abstract] OR “Asthma”[MeSH Terms] OR “pulmonary disease”[Title/Abstract] OR “respiratory”[Title/Abstract]) AND (“humans”[MeSH Terms] OR “patient”[Title/Abstract]) AND (“portal”[Title/Abstract] OR “electronic health record”[Title/Abstract] OR “web-based”[Title/Abstract] OR “patient reported outcomes”[Title/Abstract] OR “EHR-linked”[Title/Abstract]) and (“patient portal” or “ePHRs” [electronic personal health records] “shared medical record”) and our screening process began by independent review of title and abstract.

Selection of evidence sources

We included studies with participants of all ages that had a diagnosis of asthma and met the definition of patient portal as defined by [HealthIT.gov](https://www.healthit.gov) (13). Specifically, we required the patient portals to be EHR-linked or have a platform that allowed patients to access an aspect of their health records; and allowed them to interact with their healthcare professionals. We accepted all peer-reviewed original study designs – qualitative, quantitative, and mixed-methods – including pilot studies and feasibility assessments. We excluded review articles and articles without full text in English. There was no restriction regarding the timeframe in which the studies were published.

To determine our final set of articles, we first eliminated manuscripts with nonrelevant subject matter based on titles and abstracts. Next, we discarded manuscripts that were review articles or abstracts. Finally, we reviewed the full article text of each manuscript to determine if it met our inclusion criteria definition of a “patient portal” in the asthma domain. Discrepancies were adjudicated through discussion. We also reviewed references of relevant articles to capture studies outside our search terms.

Data charting process and data analysis

Our narrative analysis focused on portal barriers and facilitators of use along with general study features. We abstracted information from the final articles into a structured document with fields for barriers, facilitators, suggestions for implementation, type of study, participant demographics, portal application and features. We then used an inductive approach to label specific barriers and facilitators and categorized them into themes for visual depiction.

Results

Literature search results

Our final analysis included 16 studies from 2007-2020. The selection process is shown in Figure 1. Table 1 contains the content of studies in detail, with highlights summarized below. The studies were conducted in Canada (14–18), the Netherlands (19), Portugal (10, 20), Taiwan (21), and the United States (9, 11, 22–26) from eight unique research teams. Seven studies were randomized crossover or controlled trials (9, 10, 14, 15, 20, 23, 25) and the rest were longitudinal observational cohort/time series (16, 17, 26), mixed methods (11), or qualitative (18, 19, 21, 22, 24). Sample sizes varied from 7 to 1,272 with child and adult participants including asthma patients, parents of pediatric asthma patients, and healthcare professionals. Three studies examined portal use among historically marginalized populations (23, 25, 26). The length of the studies ranged from hours to 33 months. All studies included participants or parents of participants with asthma; several studies included moderate to severe/uncontrolled asthma.

Portal Functionalities

All 16 studies used EHR-connected patient portals as per inclusion criteria. Overall, the objectives of each study were similar in that they sought to determine the perceptions of patients about the portal in general, along with other factors that affect use of the

portals and patient outcomes. Several of the portal systems had common functionalities that addressed all key aspects of asthma management in the NIH guidelines (2, 3) including methods of communication and the ability to create appointments, access to health records, environmental factors, medication management, and educational resources as detailed in Table 2.

Barriers and Suggestions

Though patient portals were generally found to improve asthma care for patients, there were many barriers or deterrents identified by the studies that hindered portal use (Figure 2). The most reported barrier was that the graphical user interface (GUI) was difficult to navigate (14, 18–21, 24, 26); specifically, users found the layout or design of the portal complex and/or had trouble locating features and understanding the menu options presented on the home screen and throughout. In one study, researchers successfully improved the interface by incorporating end-user feedback about difficulty locating educational material into subsequent tool iterations (22). End-users also had difficulty adjusting to new or different interfaces and portal features (11, 21, 22). For instance, Fiks *et al* mentioned how parents experienced difficulty locating navigation menu labels to access different parts of the portal and were confused with what section of the portal was solely for educational purposes as informational videos and handouts were located on distinct pages.(22) Eschler *et al* was able to address potential barriers by pre-emptively interviewing end-users during the design phase about what features were familiar or unfamiliar with and obtain their opinion as to which features were useful to their everyday workflow (24).

Another common barrier for end-user adoption of the portals was related to technology limitations. The barriers pertaining to technological issues were variable, but the most common reported barriers that prevented access and regular use of the portal were participant's lack of digital devices (14, 15, 17, 23, 25), limited internet access (14, 17, 20, 23, 25, 26), and/or lack of computer technical skills (15, 17, 19, 20, 23, 25, 26). Researchers such as Apter *et al*, emphasized that healthcare interventions involving technology to resolve such issues would be more effective if underlying social needs (e.g., housing, safety, etc.) are addressed first (25).

In addition to technology limitations, patient medical and general literacy were other factors that prevented portal use (18–20, 22, 23). The availability of the portal in only English prevented those who were either non-native speakers or lacked proficiency in English from using the portal (25). Another common theme was concern about portal privacy and vulnerability to data breach and loss (18–20, 22, 23, 26). Participants expressed concern about using the portal on public devices involving their health information. Yamada *et al* suggested that institutions address these concerns upfront by providing end-users with data policies and privacy terms to help provide reassurance (18). In general, the importance of teaching end-users about the portal itself was emphasized and institutions may experience success if easily-accessible technical support is available (17–19, 26).

Multiple studies identified that the portal would likely be used less by patients with mild or controlled asthma; they also reported lower use and less interest of the portal if patients did not appreciate its benefit to manage their asthma (10, 11, 14, 16–18, 20, 24,

26). Specifically, lack of new information on the portal or participants feeling as if they “solved” how to care for their asthma led to the lower engagement with the portal; therefore, continual portal engagement (e.g., staff reminders to use the system during in-person visits, electronic reminders and notifications, updated or new educational information, etc.) was encouraged to help users adapt, maintain their interest, and actively participate in the online environment (24).

Facilitators and Suggestions

All studies reported patient portals for asthma care had more uptake if they were efficient, engaging, and/or convenient for end-users. It was very important for users that the portal was simple and easy to use (11, 16–19, 23, 24). While technological literacy and access can be a barrier, those who were able to use the portal preferred multiple options to access the portal (i.e., cellular devices, personal computers, and/or tablets) (17, 18, 21, 25, 26). Another aspect that users thought would enhance their experience of the portal was if it was personalized or customizable (10, 11, 14, 16–20, 23–26). For instance, Eschler *et al* found that mothers of children with asthma preferred their child’s picture and name be visible on the home screen as they appreciated seeing their image on the portal (24); and Kouri *et al* explained how the electronic asthma management questionnaire implemented included personalized asthma action plans for self-management.

Several studies noted the participants’ desire for the portal to serve as an educational tool to provide supplemental asthma resources along with a personalized management plan (9, 11, 15, 17, 19, 20, 24). One method recommended to achieve this functionality was to include external links directing users to websites with additional guidance or knowledge about asthma and its management (19). Ahmed *et al* details how their asthma portal allowed patients to access general asthma information through links that were provided on the portal for outside educational websites (14). Studies found the portal helped increase both practitioner and patient awareness of their asthma status, which motivated patients to control their asthma and gain a deeper understanding of their condition and how to better control it (9, 11, 18).

Participants preferred to use the portal when it enabled symptom monitoring and the ability to doublecheck information about their asthma (11, 20). In general, the ability to track information, such as patients’ symptoms of control and seasonal variation of asthma, medication side effects, and their overall progression towards their set goals was a desired feature (9, 22). Additionally, the portal was perceived as useful because it allowed patients to interact with their physicians about their asthma concerns outside of the clinic (18, 23). The patient portal increased patient-physician communication through email reminders and recommendations about symptom control (11, 15, 19, 22); and sending reminders via email or text can be useful to encourage or motivate users to log on and use the portal (9, 15). Other portal features that encouraged future use were the ability to schedule appointments and request refills (15). Overall, the increased communication with the care team provided via the portal allowed participants to feel recognized as partners in their or their child’s asthma care.

Discussion

We found barriers and facilitators to portal use for asthma related to its navigability, perceived value (e.g., increased patient-practitioner communication, educational material, reminders), technical/literacy ability, and training. Below, we extrapolate our findings to discuss suggestions and approaches for future asthma management portal development.

To discover valued features (e.g., easy-to-navigate, education/communication, alerts, etc.) and facilitate use, we advocate that a successful approach would be to apply the concept of “user-experience (UX) design,” which ensures end-user involvement in product development at all stages, including after launch. UX design approach has been discussed but not widely deployed in academia, although some of the included studies did incorporate aspects of UX design (27–30). The typical UX process cycle steps include: analysis of the domain (i.e., empathize), design conceptualization, prototyping, implementation, and evaluation (31–33). These steps are iterated (i.e., repeated) until the product has met the proposed goals. Ideally the design process includes patient portal users and non-users to integrate feedback and implement suggestions to improve desired features (34). These concepts also overlap with the domains of quality improvement, agile methodologies, and implementation science (35, 36).

By involving end-users closely, this can help develop portals for all users including those with less education, lower literacy ability, and language barriers who may face challenges with medical terminology, especially with medical notes easily available to end-users (i.e., “open note” functionality) (19, 37, 38). If the patient portal intake questionnaires are not at an appropriate reading level or have too much medical jargon, it may disadvantage patients and risk an inaccurate picture presented to the healthcare team. Understanding these needs leads to inclusion of features in the portal such as providing medical terminology definitions or allocating extra resources for families who have follow up questions. With reference to technological limitations, studies such as Apter *et al*/highlight the “digital divide” of patients lacking access to a computer and reliable internet connectivity (11, 15, 18, 20, 24). Technological access is vital, especially in crises such as the current COVID-19 pandemic (39) where those without lack technology may be left behind or put at risk without the same opportunity to manage their health remotely (40). More specifically, technological access is of specific concern in underserved and rural communities where certain technology may be unavailable due to financial constraints and/or lack of technological infrastructure in the community (23, 25, 26). Thus, greater attention is needed for these areas to provide their residents with the same opportunity to control their asthma and other medical conditions. In the United States, healthcare inequity due to systemic racism and inequitable social infrastructure has increased discussion surrounding the government’s role and responsibility to provide reliable internet access as a basic necessity and has included approaches to help those at risk obtain broadband access (41–43)

In addition to incorporating UX design, a key facilitator of a successful launch is to provide adequate training prior to use and beyond (11, 44). For all users, easily accessible (in-person and/or remote) technical support is central to sustain the product after launch and ensure end-users remain engaged; and including members of the technical support and training

teams in the design phase is an important component (45). Unfortunately, this may not be a realistic resource for all types of offices and practices; however, it is hopeful that awareness of this need motivates patients and practitioners to advocate for this and that institutions and EHR vendors will continue to invest in and provide more of these resources. Also, offering more community digital literacy training in addition to more training from the healthcare systems may provide the skills and knowledge to successfully access and navigate the portal (46). Ideally the environment is such that patients feel comfortable asking their medical team questions about certain words they are unfamiliar with or reaching out to technical support resources if available. In addition, some users may not feel comfortable with possible security risks of digital technology so during training, end-users can be reassured of data safety by requiring security protection offered by safeguards such as two-factor authentication and dedicating adequate resources to IT security across the healthcare system and explaining this technology to end-users.

While we identified barriers and facilitators to portal use, there were limitations with this study. Our study question was focused specifically on portals for asthma use and most were through academic centers, which may or may not generalize to other practices. Also, there was a small number of studies and participants overall, which may not be representative of wider perceptions of portal use. The study lengths were relatively short with the longest being 33 months; making it potentially difficult to draw definite conclusions as views may have changed after a lengthier time of usage. Lastly, our approach was a qualitative analysis of a variety of studies (focus groups, semi-structure interviews, etc.).

In summary, successfully implementing a patient portal that addresses all the barriers and facilitators will be a difficult task to achieve in the “real world.” While end-users would benefit from customization and direct integration of the portal with the EHR, they are also limited by the functionality of the vendor product and institutional versions and culture. The first step in creating an efficient portal for user engagement is to receive feedback from patients and practitioners of their experiences and attitudes of the tool. Secondly, learning the benefits it provides for both groups in practice will help inform its development. It may not be feasible to include all features desired but explaining to users about systems limitations and alternate approaches, as well as including features that are otherwise most practical should help promote its use. In addition, feedback can be given to EHR vendors about end-user needs that are unmet in hopes they will enhance the functionality of their tools. Moreover, overcoming technological barriers, such as access to technology for patients who lack access is important on an individual, institutional, and societal level but will be challenging due to issues related to resource allocation and likely requires governmental support.

Conclusions

When considering future portal development for asthma management, a UX design approach may facilitate addressing barriers. Factors that make the portal easy to use, informing end-users of the portal’s purpose and functionality, as well as providing technical support may increase chances of uptake and sustained use. In addition, awareness of historically marginalized populations and systemic barriers is important to reduce disparities in access.

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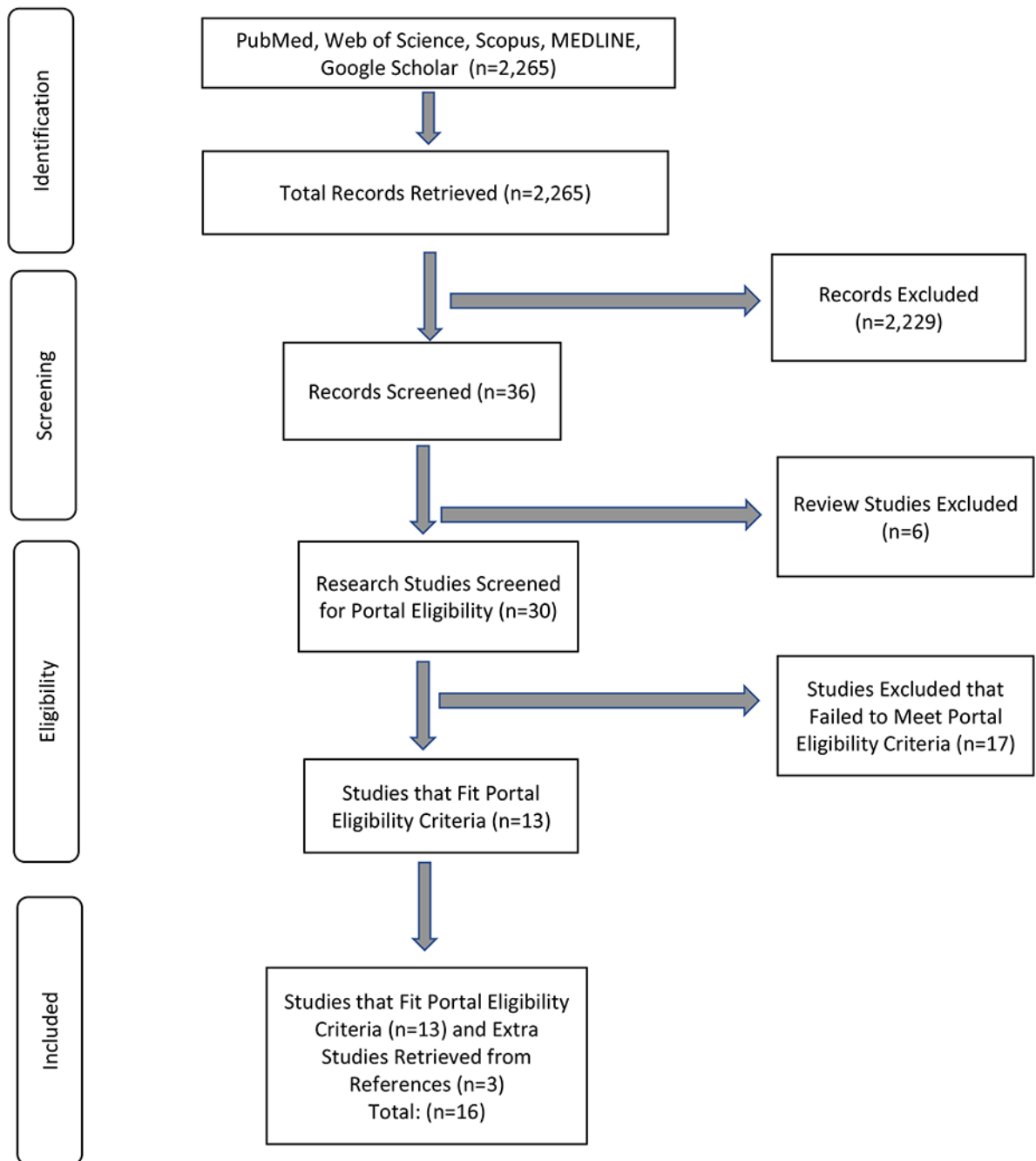


Fig. 1.
PRISMA flow diagram of selected articles

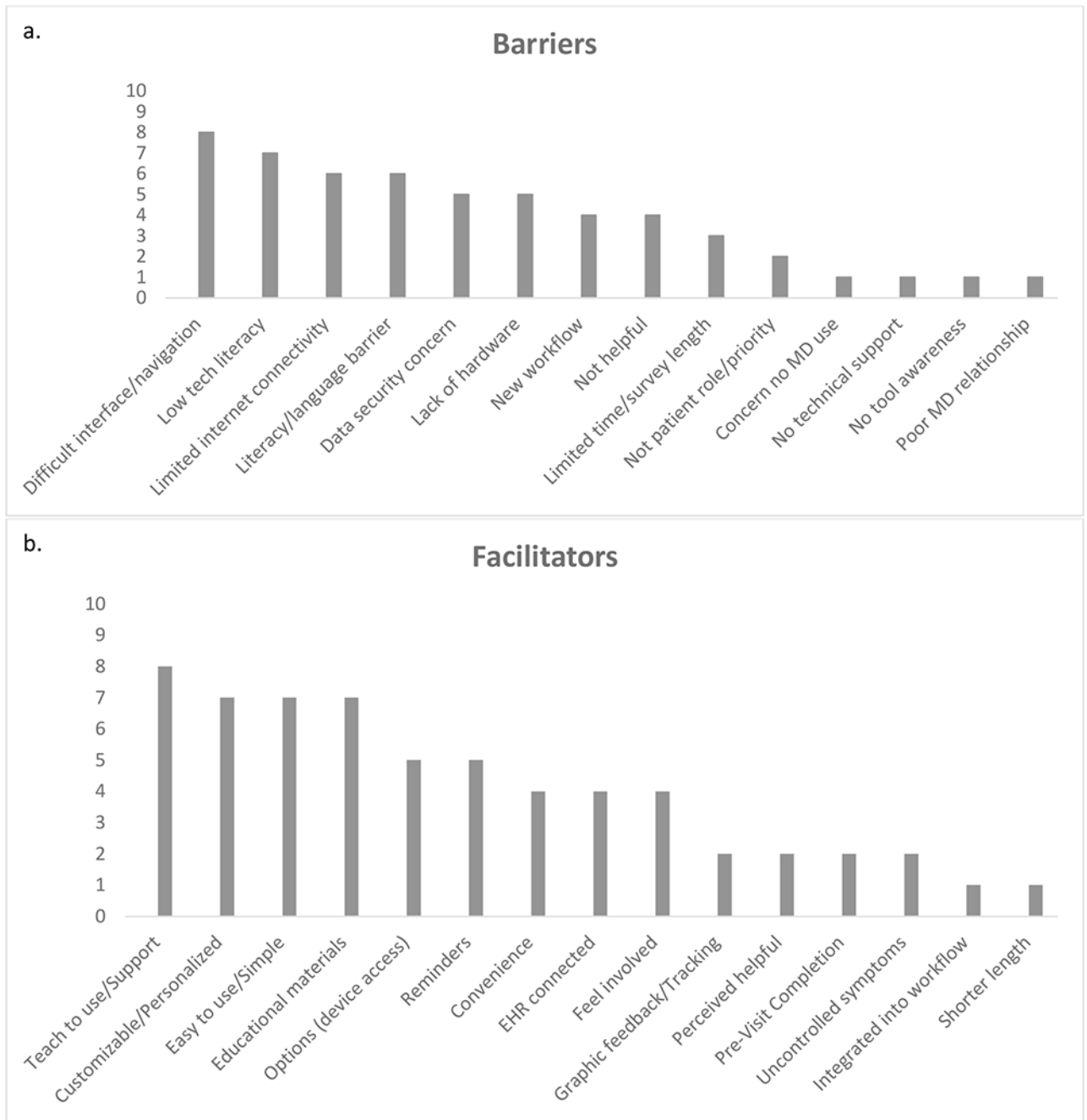


Fig 2. Counts of barriers and facilitators reported in the 16 included articles

Table 1.

Summary table of study characteristics, barriers, facilitators, and recommendations

| Authors | Study Design | Setting/ Duration/ Participants | Tool/Intervention | Barriers/ Negatives | Facilitators/ Positives | Findings/ Recommendations |
|-------------------------------|--|--|---|---|--|---|
| Cruz-Correia et al, 2007 (20) | Randomized crossover (n=21) | <ul style="list-style-type: none"> • Porto, Portugal • Allergy clinic • 1-month duration • 18-62 years old | <ul style="list-style-type: none"> • Patient Portal for Assessment and Self-Management of Asthma (P'ASMA), a web-based asthma management tool: symptom, peak flow, and quality of life monitoring with graphical trends and treatment advice. • Measured end-user opinion and P'ASMA use versus paper | <ul style="list-style-type: none"> • Low medical literacy • Difficult graphical user interface (GUI) • Internet connectivity issues | <ul style="list-style-type: none"> • Ability to communicate with physicians • Collected prior to appointment • Educational content • Convenience of internet-based | <ul style="list-style-type: none"> • Automated emails or text reminders to increase use • Needs to be easy for users to input data • Incorporate graphic feedback/data summary • Should be customizable |
| Araujo et al, 2012 (10) | Randomized crossover (n=21) | <ul style="list-style-type: none"> • Porto, Portugal • Allergy clinic • 1-month duration • 18-62 years old | <ul style="list-style-type: none"> • Patient Portal for Assessment and Self-management of Asthma (P'ASMA), a web-based asthma management tool: symptom, peak flow, and quality of life monitoring with graphical trends and treatment advice. • Measured quality of life outcomes of P'ASMA use | <ul style="list-style-type: none"> • Patients needed more education about tool | <ul style="list-style-type: none"> • Reliable capture of data electronically | <ul style="list-style-type: none"> • Create personalized asthma monitoring schedules |
| Fiks et al, 2014 (22) | Semi-structured interviews and focus groups (n=68) | <ul style="list-style-type: none"> • Philadelphia, PA • Primary care clinics • Interviewed parents, pediatricians, nurse practitioners, nurses, compliance, attorneys, risk management, pharmacists | <ul style="list-style-type: none"> • Patient portal (MyAsthma) to facilitate shared decision making: set goals, monthly survey of symptom, med adherence/side effects, goal progress, care plan, educational info • Conceptual prototyping | <ul style="list-style-type: none"> • Concern about information loss • Concern about physicians receiving and using data • Difficulty interpreting graphical results • Difficult navigation • Change in existing workflow | <ul style="list-style-type: none"> • Ability for parents to report and track concerns and goals • Families feel "heard" | <ul style="list-style-type: none"> • Test outside one institution • Expand to different age ranges |
| Lin et al, 2014 (21) | Survey (n=41) | <ul style="list-style-type: none"> • Lin Kou, Taiwan • Pediatric clinic • Parents of children with asthma | <ul style="list-style-type: none"> • Web-based asthma self-management system (AsthmaCare): symptom diary, assessment, alerts, education, quality of life and peak flow trends. • Design and development of system | <ul style="list-style-type: none"> • Children need parental supervision • Complicated interface • Difficulty learning new system | <ul style="list-style-type: none"> • Practitioners had more accurate reports of patient morbidity • Personalized care | <ul style="list-style-type: none"> • More user-friendly interface • Include access through mobile devices. |
| Apter et al, 2015 (23) | Randomized controlled trial (n=150) | <ul style="list-style-type: none"> • Philadelphia, PA • Underserved primary care and asthma clinics • 1-year duration | <ul style="list-style-type: none"> • Using the electronic patient portal with and without assistance of community health workers (CHWs) to review labs, upcoming | <ul style="list-style-type: none"> • No computer access • No/low computer literacy • Low literacy • Privacy concerns (home and/or public computers) | <ul style="list-style-type: none"> • Ability to request medication refills • Ability to schedule appointments | <ul style="list-style-type: none"> • Ensure portal is convenient • CHW available to educate and address barriers to portal use |

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|-------------------------|------------------------------------|---|---|---|---|---|
| | | <ul style="list-style-type: none"> • 49 years (mean age) | appointments, meds, immunization, request med refill, schedule appointments, send messages <ul style="list-style-type: none"> • Implementation experience | <ul style="list-style-type: none"> • Internet connectivity issues | | |
| Fiks et al, 2015 (9) | Randomized controlled trial (n=60) | <ul style="list-style-type: none"> • Philadelphia, PA • Primary care clinics • 6-month duration • Parents of children with asthma | <ul style="list-style-type: none"> • To evaluate impact of MyAsthma portal for shared decision making and user experience. Use portal to set goals, monthly survey of symptom, med adherence/side effects, goal progress, care plan, educational info | <ul style="list-style-type: none"> • Length of survey • Frequency of survey | <ul style="list-style-type: none"> • Used more if child had moderate-severe asthma • Centralized information • Easy communication with clinicians • More aware of asthma care importance • Educational content | <ul style="list-style-type: none"> • Shorter or less frequent surveys are preferable • Clinicians and parents should be actively involved in decision-making |
| Ahmed et al, 2016 (14) | Randomized controlled trial (n=98) | <ul style="list-style-type: none"> • Montreal, Canada • Pulmonary clinics • 6-month duration • 18-69 years old | <ul style="list-style-type: none"> • MyAsthma Portal (MAP), a web-based self-management system to view medication, diagnoses, asthma education, receive feedback about self-management progress • Compared use to usual asthma care | <ul style="list-style-type: none"> • Lack of internet access • Lack of computer • Too complicated • Too time consuming • Information was same over time/did not find value in use over time | <ul style="list-style-type: none"> • Individualized content and features based on needs and health | <ul style="list-style-type: none"> • Tailor recommendations and information as much as possible to individual • Target group behavior change techniques for an individuals' behavior • Integrate easily into daily function |
| Fiks et al, 2016 (11) | Mixed-Methods (n=237) | <ul style="list-style-type: none"> • Pennsylvania; New Jersey; Canada • Primary care clinics • Parents of children with asthma | <ul style="list-style-type: none"> • To analyze MyAsthma and decision support tool for barriers and facilitators to parent and practitioner use. Portal was used to set goals, monthly survey of symptom, med adherence/side effects, goal progress, care plan, educational info | <ul style="list-style-type: none"> • Unorganized flow • No results follow up • Lack of computer • Not used by families • Practitioner training time • Did not identify asthma patients correctly | <ul style="list-style-type: none"> • Specific coordinator for surveys • Increased awareness of child's asthma • More communication with care team • Encouraged parents to ask questions • Relatively easy to use | <ul style="list-style-type: none"> • Workflow redesign may be necessary • More utilization for uncontrolled or mod-severe asthma at baseline • Strong leadership and high staff engagement |
| Eschler et al 2017 (24) | Think aloud interviews (n=7) | <ul style="list-style-type: none"> • Seattle, Washington • Regional healthcare cooperative • Parents of children with asthma | <ul style="list-style-type: none"> • To obtain feedback about an asthma patient portal prototype as part of an effort to increase end-user engagement. Portal tasks included lab and medication lookup, flu vaccine reminder, and creating own care reminder | <ul style="list-style-type: none"> • Poor relationship with physician • High-use features not 1-click accessible • Performing new tasks • Unclear menu options • Preference for some tasks (i.e., results) to be in person or via phone • Feeling of bypassing clinic staff/medical team should be "in charge" of information | <ul style="list-style-type: none"> • Simple layout • Avoid redundancy • Child's image or avatar visible • Profile information on each page • Digital after-visit summary | <ul style="list-style-type: none"> • Recurring reminders for follow up tasks • Portal design should amplify positive aspects of practitioner relationship • Clinicians should find way to engage and encourage use • Customized for patients • Number for assistance available on every screen |

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|--------------------------|---|---|--|---|--|---|
| Metting et al, 2018 (19) | Focus groups (n=10) | <ul style="list-style-type: none"> Netherlands Dutch Lung Foundation 57-76 years old | <ul style="list-style-type: none"> Explore patient views about web-based portals related to symptoms, internet and health care use, medical record access, relevant apps, and physician-patient relationship | <ul style="list-style-type: none"> Low computer literacy Difficult login process Concern about privacy Information is too complicated | <ul style="list-style-type: none"> Convenience of portal access any time or location Connected to EHR Less costly than an appointment Involvement in their care and error prevention Educational content Increased transparency Digital after-visit summary | <ul style="list-style-type: none"> Allow access to health records Allow communication with practitioner Provide links to asthma education documents Able to print resources Explanation of what the medical records mean Easy to use, presented in "lay" language Physician promotion Technical support readily available |
| Apter et al, 2019 (25) | Randomized controlled trial (n=301) | <ul style="list-style-type: none"> Philadelphia, PA Underserved primary care and asthma clinics 12-month duration 36-62 years old | <ul style="list-style-type: none"> Evaluate asthma outcomes using a patient portal with and without assistance of community health workers (CHWs) to review labs, appointments, meds, immunization, request med refill, schedule appointments, send messages | <ul style="list-style-type: none"> Limited internet access Limited data plans Limited computer Not specific to asthma Only in English Texting preferred, but portal did not allow | <ul style="list-style-type: none"> Portals championed by Centers for Medicare and Medicaid Services | <ul style="list-style-type: none"> IT interventions may not be as effective without addressing social factors Living conditions may interfere |
| Morita et al, 2019 (15) | Randomized controlled trial (n=138) | <ul style="list-style-type: none"> Ontario, Canada Specialty and primary care clinics 12-month duration 45 years (mean age) | <ul style="list-style-type: none"> Assess the use of an asthma self-management platform (<i>breathe</i>). Features included symptom control, med list, environmental triggers, symptom journal, action plan | <ul style="list-style-type: none"> Low computer literacy Lack of computer Well-controlled asthma | <ul style="list-style-type: none"> Email reminders Educational content Appreciated that assessments were accurate Symptoms not controlled Upcoming appointment | <ul style="list-style-type: none"> Engage patients when they feel well; reengage them when unwell Use automated technology to log medication use Monitor end-user usage of the system |
| Apter et al, 2020 (26) | Longitudinal Observational Study (n=301) | <ul style="list-style-type: none"> Philadelphia, PA Underserved primary care and asthma clinics 33-month duration Adults >18 years | <ul style="list-style-type: none"> Estimate the association of portal use with asthma outcomes over time with and without assistance of community health workers (CHWs). Portal uses included reviewing labs, appointments, meds, immunizations; and requesting med refills schedule appointments, sending messages | <ul style="list-style-type: none"> Difficulties with log-in Limited confidence portal could improve communication Internet connectivity issues Limited data plans Low computer literacy Low patient-initiated EHR engagement Concern about privacy | <ul style="list-style-type: none"> Use of phone to access portal | <ul style="list-style-type: none"> Ensure patients have access to internet and computer equipment Educate users about purpose of the portal Interfaces that support patient-oriented outcomes Include older and more historically marginalized demographics |
| Gupta et al, 2019 (16) | Prospective interrupted time-series (n=1,272) | <ul style="list-style-type: none"> Toronto, Canada Primary care clinics 2-year duration | <ul style="list-style-type: none"> The Electronic Asthma Management System (eAMS) for patients to enter symptoms used in decision support for | <ul style="list-style-type: none"> Time constraints Aversion to controller medication (inhaled steroids) Affordability of medicine | <ul style="list-style-type: none"> Auto-populated asthma action plan (AAP) Personalized AAP Educational content | <ul style="list-style-type: none"> Perform formal usability and workflow analysis for optimization Address co-morbidities Tailor prompts/ |

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|-------------------------|---|--|--|---|---|---|
| | | <ul style="list-style-type: none"> • Patients 16+ years | care and asthma action plan <ul style="list-style-type: none"> • To understand major care gaps and measure impact on care in adults with asthma | | <ul style="list-style-type: none"> • Asthma control monitoring | advice preferences <ul style="list-style-type: none"> • Include references and explanations for recommendations |
| Kouri et al, 2020 (17) | Prospective interrupted time-series (n=612) | <ul style="list-style-type: none"> • Toronto, Canada • Primary care clinics • 1-year duration • Patients 16+ years | <ul style="list-style-type: none"> • An mHealth tablet questionnaire for patients to enter symptoms used in decision support for care and asthma action plan • Determine factors that influence the uptake and completion | <ul style="list-style-type: none"> • Patients did not consistently receive tablet • Internet connectivity issues • Low computer literacy, especially older adults | <ul style="list-style-type: none"> • Personalized self-management • Identifies medication use and adherence • Document asthma control | <ul style="list-style-type: none"> • Offer questionnaire on patient personal devices • Ensure patients have adequate time • Ensure technical support available |
| Yamada et al, 2020 (18) | Semi-structured interviews (n=12) | <ul style="list-style-type: none"> • Toronto, Canada • Academic and non-academic primary care clinics • 2-year duration • Patients 18+ years | <ul style="list-style-type: none"> • The Electronic Asthma Management System (eAMS) pre-visit questionnaire for patients to enter symptoms used in decision support for care and asthma action plan • Identify barriers and enablers to completion | <ul style="list-style-type: none"> • May not be a priority • Device too small • Difficult to navigate • Does not help to understand asthma or how to control it • Concern about security • Unsure if completing questionnaire correctly | <ul style="list-style-type: none"> • Easy to complete • Completion of form on own time • Primary care physician has more time to review questionnaire • Gives better understanding of how to control asthma • Reminders (via email, text, or phone) to complete form | <ul style="list-style-type: none"> • Larger device or paper • Telephone or in-person support when filling out questionnaire |

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Table 2.

Summary of the asthma patient portal features in the 16 studies categorized by key components of asthma management within the National Institutes of Health guideline (3,4).

| Component | Function(s) |
|--|--|
| <p>1: Measures of Asthma Assessment and Monitoring</p> <p>Patient portals allow patients monitor their asthma and how often they experienced asthma flares or a sudden worsening of symptoms along with hospitalizations and ED visits.</p> | <p>Home spirometry or peak flow (10, 15, 20), symptom monitoring (9–11, 15, 19–22, 24, 25), quality of life (18–20), healthcare utilization (9, 11, 21, 22)</p> |
| <p>2: Education for a Partnership in Asthma Care</p> <p>Patient portals provide educational videos and hand-outs for patients with asthma to learn about their condition along with a platform to communicate with their healthcare professionals.</p> | <p>Feedback to patient and physician ((10, 14, 19–21, 24–26), parent/child treatment goals (9, 11, 22), concerns about asthma (9, 11, 22), asthma education (9, 11, 14, 15, 20–23, 25, 26), 2-way communication (9, 11, 14, 15, 19–26), e-asthma action plan (10, 14–18, 20)</p> |
| <p>3: Control of Environmental Factors and Comorbid Conditions that Affect Asthma</p> <p>Patient portals enabled patients with asthma to track and consider any environmental triggers, such as exposure to smoke or air quality.</p> | <p>Home environmental factors (21, 25)</p> |
| <p>4: Medications</p> <p>Patient portals allow patients with asthma to review their lists of medications, allergies; and request refills and follow adherence.</p> | <p>Review medications (15, 23–25), side effects (9, 22), request medication refills (25), medication adherence (9, 15, 21, 22, 24)</p> |

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