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Pre-consultation history taking systems and their impact on modern practices: Advantages and limitations

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Abstract

The practice of gathering a patient's medical history has been a cornerstone of healthcare for centuries, providing the foundation for accurate diagnoses and effective treatment plans. However, traditional face-to-face consultations have limitations, including incomplete histories due to time constraints and potential communication barriers. To address these challenges, pre-consultation history taking systems emerged as a transformative solution, leveraging technology to optimize data collection and patient engagement. This review article explores the evolution, benefits, limitations, and impact of pre-consultation history taking systems on modern healthcare practices. These systems enable patients to respond to questionnaires or surveys before their scheduled appointments, empowering them to provide comprehensive medical histories at their own pace. Consequently, healthcare providers gain deeper insights into patients' health status, previous medical conditions, family history, lifestyle choices, and medication history. The significance of pre-consultation history taking lies in its potential to improve the quality of healthcare services. By obtaining more detailed and accurate medical histories before appointments, healthcare providers can optimize consultation time, enabling them to focus on addressing specific concerns and making informed decisions. Furthermore, patient engagement is enhanced, fostering a sense of collaboration between patients and healthcare professionals. Despite the advantages, the article addresses certain limitations, such as the digital divide and data accuracy concerns. Ensuring accessibility for all patient populations and maintaining robust data security measures are essential considerations. However, as technology continues to advance, pre-consultation history taking holds the promise of transforming the healthcare landscape and improving patient outcomes.

Keywords: pre-consultation history taking, telemedicine, telehealth, electronic consultation taking

Introduction

The acquisition of a patient's medical history has perennially stood as a pivotal element in healthcare, serving as the cornerstone for diagnostic processes and the formulation of treatment strategies. Traditionally, in face-to-face consultations with healthcare providers, patients would provide their medical history, but this method exhibited inherent limitations, including patients forgetting critical details, time constraints leading to incomplete histories, and potential communication barriers that could impact accuracy [1]. Furthermore, the improper sequencing of medical history and the introduction of fear or embarrassment during face-to-face interviews could contribute to distorted clinical assessments [1].

In recent years, technological advancements have revolutionized the process of gathering medical information, leading to the development of pre-consultation history taking systems. These systems offer patients the opportunity to respond to questionnaires or surveys before their scheduled appointments, allowing them to carefully consider and provide comprehensive details about their medical history [2]. The data collected through these platforms serves as a valuable resource for healthcare providers, furnishing them with profound insights into the patient's health status, previous medical conditions, family history, lifestyle choices, and medication history [3].

The significance of pre-consultation history taking systems lies in their potential to improve the quality of healthcare services. A study conducted in Japan evaluated the efficacy of a tablet-based pre-consultation history-taking system in optimizing appointment times for diabetic patients [4]. The results showed that the median pre-clinical time without a patient in a group of tablet-based questionnaire was 2 minutes and 45 seconds, while in a group of paper-based questionnaire, it was 5 minutes and 39 seconds (p=0.003). By obtaining a more detailed and accurate medical history prior to the patient's visit, healthcare providers can optimize the time spent during consultations. The same study demonstrated that the clinical time with a patient in a tablet-based group was 19 minutes and 37 seconds, while in paper-based group, it was 11 minutes 25 seconds (p=0.026) [4]. This efficiency empowers clinicians to concentrate on specific concerns, make well-informed decisions, and tailor personalized treatment plans. Additionally, these systems can facilitate a more patient-centered approach, empowering individuals to actively participate in their care and fostering a sense of collaboration between patients and healthcare professionals [4, 5].

The purpose of this article is to provide a comprehensive review of pre-consultation history taking systems and their impact on modern healthcare practices (Table 1). It seeks to delve into the advantages, challenges, and prospects of implementing such systems in clinical settings.

Table 1 Impact of pre-consultation history taking on healthcare.

Aspect	Key Points
Impact on Time Efficiency	• Tablet-based systems significantly reduce pre-clinical time before patient encounters. • Clinical time allocation is optimized for focused patient, leading to more in-depth consultations. • Studies show a notable reduction in consultation time with the adoption of tablet-based history-taking systems.
Evolution of History Taking	• Transition from face-to-face interviews to computerized history-taking systems. • Improved data collection through structured questionnaires or surveys completed by patients. • The history-taking process has evolved from manual entry to streamlined digital interactions.
Technological Advancements	• Integration of AI and NLP for efficient data analysis and interpretation. • Virtual triage assisting users in determining appropriate care levels, with a significant percentage finding it helpful. • The use of NLP applications in healthcare to interpret patient-reported data more effectively.

Evolution of history taking in healthcare

History taking during medical consultation mostly relies on direct, face-to-face interactions between patients and healthcare providers. Physicians typically conducted comprehensive interviews, employing open-ended questions to elicit information about symptoms, medical history, familial predispositions, lifestyle practices, and previous treatments [3]. This conventional approach was heavily dependent on the physician's expertise, communication skills, and ability to extract pertinent information from patients. However, inherent challenges such as patients forgetting crucial information, struggling to articulate complex medical details, or withholding sensitive information due to embarrassment or fear of judgment were prevalent [6-8]. The incompleteness of medical history information can lead to delays in clinical treatments as it plays a crucial role in the diagnostic and therapeutic decision-making process, thereby significantly impacting the quality of the diagnostic process [9, 10].

The traditional approach to history taking is time-consuming, imposing constraints on the number of patients a healthcare provider can effectively attend to within a given timeframe. The process of manually writing patient anamnesis into the medical practice system consumes a significant amount of consultation time for medical practitioners [3]. Furthermore, a report from ambulatory practice from USA reveals that approximately 53% of physicians' time is allocated to face-to-face interactions with patients in the examination room, leaving the remaining time for charting and desk work [11]. This highlights the substantial burden placed on the healthcare workforce due to non-examination tasks.

Emergence and development of pre-consultation systems

The emergence of digital technology prompted the healthcare industry to explore innovative approaches to enhance the history-taking process. Mayne and colleagues at the Mayo Clinic were pioneers in developing computerized history-taking programs, where patients were prompted to select their chief complaint from a predefined menu of complaints [12]. In a related study, Grossman et al. tested a similar clinical coverage program with a small group of in-patients, and the results demonstrated that computers recorded significantly more clinical information compared to physicians [13].

Subsequently, the system of history taking has evolved and improved significantly. Pre-consultation history taking systems empower patients to complete structured questionnaires or surveys before their scheduled appointments, enabling them to carefully consider their medical history and provide comprehensive responses [4]. This approach enables patients to furnish their medical histories at their own pace, thereby reducing the likelihood of overlooking crucial details.

The development of pre-consultation systems sought to enhance the accuracy and completeness of patient-provided information while optimizing the utilization of healthcare provider's time and reducing the burden of medical report documentation [14]. Healthcare providers could review the collected data before the consultation, enabling more informed and targeted discussions during the patient encounter. This approach served as a solution to address the challenges posed by limited physician time, concurrently maximizing the value of healthcare at a feasible cost [5].

Technological advancements and their role in shaping these systems

The evolution of pre-consultation history-taking systems has been significantly influenced by technological advancements, leading to the development of sophisticated and user-friendly platforms. Web-based questionnaires and mobile applications have become increasingly popular, catering to the convenience and preferences of patients in a digitally connected world [15, 16].

The integration of artificial intelligence (AI) and natural language processing (NLP) further streamlined these systems. AI algorithms can analyze patient responses, identify red flags, and prioritize critical information for healthcare providers, thereby facilitating efficient decision-making [17, 18]. AI is being applied in various medical tasks, including disease recognition, outcome prediction, and treatment. In the triage system, AI enhances decision-making and more accurately classifies patients based on symptoms, medical history, and other data. A multinational survey of patient utilization of triage system showed that in 75% of cases virtual triage assisted users in determining the appropriate care level [19]. Among 74.1% of participants, the recommended triage care differed from their initial healthcare intention, with 25.9% aligning their pre-triage intention with the virtual triage recommendation [19]. In addition, patient-facing NLP applications are under development in the healthcare domain. Natural language understanding (NLU) and natural language generating (NLG) chatbots are integral to these applications, with mobile phone applications and web platforms being the most commonly used means of interaction [20]. NLP capabilities empower systems to interpret patient-reported data, allowing for more contextually relevant follow-up questions and ensuring a personalized and time-efficient healthcare approach with improved predictive capabilities [21, 22].

The evolution of pre-consultation history-taking systems has been significantly influenced by technological advancements, leading to the development of sophisticated and user-friendly platforms. These innovative approaches have transformed the way medical information is collected, enhancing the quality of patient data, optimizing healthcare provider's time, and ultimately improving patient care and outcomes. Pre-consultation history taking systems have their own advantages and disadvantages (Figure 1).

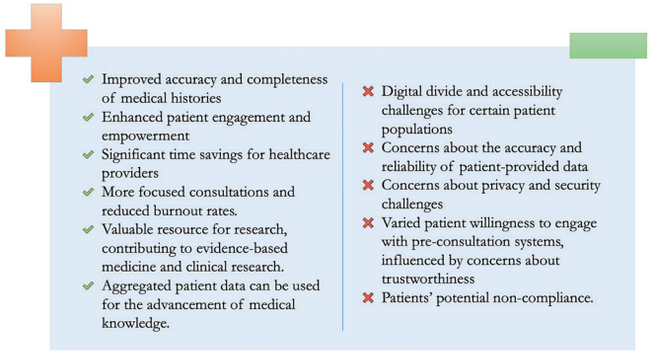

Figure 1 - Advantages and limitations of pre-consultation history taking systems.

Benefits and advantages

Improved accuracy and completeness of medical histories

Pre-consultation history taking systems play a crutial role in ensuring the accuracy and comprehensiveness of patients' medical histories. Incomplete information gathering during consultation can lead to diagnostic errors [23]. Clinicians are faced with the challenge of remembering numerous questions relevant to managing each medical condition and omitting crucial questions can significantly impact diagnosis and treatment outcomes. For instance, research reveals that approximately 50% of psychosocial and psychiatric problems go unnoticed [24], and a considerable portion of patient problems and concerns (54% and 45%, respectively) are not elicited by clinicians nor disclosed by patients [25].

The accuracy of diagnoses provided by physicians across various specialties ranges from 70% to 85% [26], while other research indicate that AI-based automated medical history-taking systems resulted in only 11% of diagnostic errors [27]. By providing patients with structured questionnaires, these systems guide individuals to provide relevant and detailed information about their health status, symptoms, and past medical conditions. This enhanced data collection results in a more precise and comprehensive medical history, reducing the likelihood of critical details being overlooked [2].

Zakim et al. (2021) conducted a study comparing the health records filled by physicians and computerized versions filled by the patients. The study was conducted in the emergency department and involved patients presenting with acute chest pain. The analysis revealed a lack of details in regard to the precise location of pain and its radiation in almost 50% of the records. In addition, the details in regard to alleviating factors and timing were different in those two types of records [28]. Although the data was collected from one hospital, the authors highlighted the advantages of standardized computerized historical records, not limited by human factors such as memory, expertise, and time devoted per case. The outcomes derived from the primary investigation assessing the impact of pre-consultation history-taking systems on healthcare administration, as employed in this manuscript, are delineated in Table 2.

Self-reported digital medical histories completed before visits can help foreigners with language barriers [32] or those with disabilities related to hearing or speech [33]. Furthermore, patients are more inclined to self-report sensitive information such as smoking or experiences of domestic violence [34]. This approach grants healthcare providers a more comprehensive understanding of the patient's health, ultimately enhancing diagnostic accuracy and facilitating more effective treatment decisions.

Enhanced patient engagement and empowerment

Active patient engagement is essential for improved health outcomes [29, 34]. The consensus is growing that patient engagement significantly enhances care quality and improves safety. When patients actively participate in their healthcare decisions and have a greater understanding of their conditions, treatment options, and preventive measures, it leads to better health outcomes and a safer healthcare experience [35]. Pre-consultation history taking systems empower patients empower patients to review and input their medical information at their convenience, fostering a sense of ownership and involvement in their care [36, 37]. This increased engagement often leads to higher patient satisfaction, better adherence to treatment plans, and a stronger patient-provider relationship.

Timesaving for healthcare providers

One of the most significant advantages of pre-consultation history taking systems is the time-saving aspect for healthcare providers. At the Congress of European Society of Cardiology, it was noted that doctors express concerns about spending increasing amounts of time dealing with computers and paperwork, which leaves them with less time for direct patient interaction and practicing medicine [38]. A Polish technology company, Infermedica, which develops a platform for digital medicine, reports that pre-visit interviews increase for 39% the

Table 2 Impact of Pre-Consultation History-Taking Systems on Healthcare Management

Study	Authors	Title	Year	Objective/ Purpose	Methodology	Key findings
1	Melms L, Schaefer JR, Jerrentrup A, Mueller T.	A pilot study of patient satisfaction with a self-completed tablet-based digital questionnaire for collecting the patient's medical history in an emergency department [1]	2021	The main objective of the study is to assess the effectiveness of a tablet-based questionnaire for non-urgent patients in the emergency department	The research employed a pilot study conducted in the waiting area of the central interdisciplinary emergency department of Marburg University Hospital. The participants were recruited through convenience sampling, approaching individuals randomly after the initial emergency triage and before their first contact with a physician. There were three questionnaires: 1 - demographic data, 2 - medical history, 3- user experience	86% of patients completed the questionnaires 91.9% had prior digital device experience. Computer skills varied, influencing completion time. High satisfaction and usability were reported Nearly all patients expressed confidence in using the digital questionnaire again. 91.7% trusted the data security. Positive impressions were reported by 93.0%, with 87.2% favoring digital questionnaires in the future.
2	Nishida A, Ogawa O.	The Effect of a Pre-consultation Tablet-Based Questionnaire on Changes in Consultation Time for First-Visit Patients With Diabetes: A Single-Case Design Preliminary Study [4]	2022	The study aims to assess the impact of pre-consultation tablet-based medical questionnaires completed by first-visit patients with diabetes in the waiting room on the consultation time with and without patients, exploring potential improvements in efficiency and time management in diabetes outpatient care.	The study employed a crossover design where paper- and tablet-based questionnaires were alternately used for diabetic patients visiting a physician at Kameda Medical Center. The medical questionnaire covered various aspects of diabetes history, lifestyle factors, and past medical information. Clinical time, pre-clinical time without a patient, post-clinical time without a patient, total clinical time, and total clinical time without a patient were measured using specific definitions, providing a comprehensive analysis of consultation times and efficiency.	20 patients participated in the study: 10 in the paper-questionnaire group, 10 in tablet-based questionnaire group Pre-clinical time without a patient was significantly shorter in tablet group (5:39 min vs 2:45 min, p = 0.003) Clinical time with a patient was significantly higher in tablet-based group (11:25 min vs 19:37 min, p = 0.026) Pre-consultation tablet-based questionnaires decreased the time spent on non-face-to-face medical care prior to consultations and increased the time spent face-to-face.
3	Harada Y, Shimizu T.	Impact of a commercial artificial intelligence–driven patient self-assessment solution on waiting times at general internal medicine outpatient departments: retrospective study [14]	2020	The main objective of the study is to assess whether the implementation of an AI-based automated medical history-taking device, AI Monshin, in lieu of handwritten self-administered questionnaires, can effectively reduce waiting times in a community hospital general internal medicine outpatient department.	The study employed a retrospective observational design, utilizing data from outpatients who visited the Department of General Internal Medicine at Nagano Chuo Hospital. Patients who visited the hospital between April 1, 2017, and April 16, 2020, were included in the study. The introduction of the AI Monshin tool, a tablet-based system for collecting patient data, was implemented on April 17, 2019. The primary outcome was the median waiting time per patient, and secondary outcomes included the median waiting time per month.	The study included data from 21,615 patient visits, with 15,000 visits before and 6,615 visits after the implementation of AI Monshin. The median waiting time was not significantly different between the two groups: 74.3 min before implementation, and 74.4 min after implementation In a supplemental analysis of data from 9054 of 21,615 visits (41.9%), the median examination time after AI Monshin implementation (6.0 minutes) was slightly but significantly longer than that before AI Monshin implementation (5.7 minutes) (p = 0.003). The implementation of an artificial intelligence–based, automated medical history–taking system did not reduce waiting time for patients visiting the general internal medicine outpatient department without an appointment, and there was a slight increase in the examination time after implementation

4	Gellert GA, Orzechowski PM, Price T, Kabat-Karabon A, Jaszczak J, Marcjasz N, et al.	A multinational survey of patient utilization of and value conveyed through virtual symptom triage and healthcare referral [19]	2023	To describe the use patterns, impact and derived patient-user value of a mobile web-based virtual triage/symptom checker.	Online survey of 2,113 web-based patient-users of a virtual triage/ symptom checker was completed over an 8-week period. Questions focused on triage and care objectives, pre- and post-triage care intent, frequency of use, value derived and satisfaction with virtual triage. Responses were analyzed and stratified to characterize patient-user pre-triage and post-triage intent relative to triage engine output.	During the study period, 93.9% of the 2,113 survey respondents using the virtual triage engine did so for themselves, with no incentives offered. The main motivations for using virtual triage were: to determine the need for a physician visit (44.2%), secure medical advice without visiting a physician's office (21.0%), or confirm/differ a diagnosis (14.2%). Virtual triage recommendations often differed from patients' pre-triage healthcare intentions; 74.1% had different recommendations, while 25.9% matched. The tool increased the likelihood of users changing their minds about the acuity level of care, with 51.2% changing to consulting a physician, 5.3% to an emergency department, and 20.7% to engaging in self-care. Virtual triage significantly increased the number of patients recommended for telemedicine or virtual consultations, from 16% pre-triage to 28% post-triage. Overall patient satisfaction with virtual triage was high, with 80.1% indicating they were likely or highly likely to use the application again.
5	Palermo TM, Valenzuela D, Stork PP.	A randomized trial of electronic versus paper pain diaries in children: impact on compliance, accuracy, and acceptability [25]	2004	The aim of this study was to compare two formats of a prospective daily diary (handheld computer=e-diary; paper diary=p-diary) on children's compliance, accuracy, and acceptability ratings.	Sixty children, ages 8–16 (M=12.3) with headaches or juvenile idiopathic arthritis, were randomized to receive either electronic diaries administered via home visits (n=30) or paper-based diaries (n=30) handed out during clinic visits for return by mail.	Children using electronic diaries (e-diaries) completed significantly more days of diary entries (M=6.6) compared to those using paper diaries (p-diaries) (M=3.8), indicating higher engagement with the e-diary format. Diaries returned by children in the p-diary group had significantly more errors and omissions compared to e-diaries, which had none, highlighting the greater accuracy of electronic diaries. Both diary formats were highly acceptable and easy to use according to children's ratings. A significant gender×diary format interaction was found for compliance, with boys demonstrating greater compliance with the e-diary format.
6	Kawamura R, Harada Y, Sugimoto S, Nagase Y, Katsukura S, Shimizu T.	Incidence of Diagnostic Errors Among Unexpectedly Hospitalized Patients Using an Automated Medical History–Taking System With a Differential Diagnosis Generator: Retrospective Observational Study [27]	2022	This study aimed to assess the incidence of diagnostic errors in an outpatient department, where an artificial intelligence (AI)–driven automated medical history–taking system that generates differential diagnosis lists was implemented in clinical practice.	The study employed a retrospective observational approach, using data from a community hospital in Japan. Patients aged 20 and older who utilized an AI-driven medical history–taking system were included, focusing on those with unplanned hospitalizations within 14 days of the index visit. The primary endpoint was the incidence of diagnostic errors, assessed by independent reviewers using the Revised Safer Dx Instrument. The study compared diagnostic error rates between cases where the AI system generated the final diagnosis and those where it did not, utilizing the Fisher exact test, and further explored contributing factors for confirmed errors through reviewer discussions.	Out of 150 cases using AI Monshin, 146 were analyzed. Most patients were elderly (median age 71 years). Among the cases, the final diagnosis was confirmed for 94.5% of patients. Diagnostic errors were confirmed in 11.0% of cases. The incidence was significantly higher in patients aged 65 and older (16% vs 2% in those under 65 years). Common contributing factors for diagnostic errors included problems ordering diagnostic tests, issues with data integration and interpretation, problems with the physical exam, and misinterpretation of performed tests. AI Monshin listed the final diagnosis in the differential diagnosis list in 7% of cases with diagnostic errors. Physicians made incorrect initial diagnoses in 6% of cases. Diagnostic errors resulted in harm in 88% of cases, with no deaths or permanent harm. Two cases (13%) required intervention, and 12 cases (75%) led to initial or prolonged hospitalization.

7	Kneuertz PJ, Jagadesh N, Perkins A, Fitzgerald M, Moffatt-Bruce SD, Merritt RE, et al.	Improving patient engagement, adherence, and satisfaction in lung cancer surgery with implementation of a mobile device platform for patient reported outcomes [29]	2020	The objective for this study was to understand the utility of a mobile application (App) platform to engage patients whilst gathering data on patient compliance, perioperative experience and satisfaction. Patient satisfaction was further examined through measures such as the ability to reach a provider and their perspective on the usefulness of the App.	Patients with suspected lung cancer undergoing robotic resection between January–May 2019, were offered the SeamlessMD App, which was customized to meet requirements of the thoracic enhanced recovery pathway. The App guided patients through preoperative preparation, in-hospital recovery, and post-op discharge care with personalized reminders, task lists, education, progress tracking, and surveys.	Fifty patients participated in the study. Among the participants, 40% completed the preoperative compliance survey, and 62% completed the hospital satisfaction survey. Postoperative health-checks were completed by 54% of patients, with a median of 3 completed surveys per patient. Patients reported a significant decrease in maximum pain level (P=0.002) and anxiety scores (P<0.001) up to 30 days after surgery. The app-enabled health-checks improved confidence and decreased worries in over 80% of patients. About 40.9% reported that the health-checks helped avoid one or more calls, and 18.2% reported that the app helped avoid one or more visits to the hospital. Over 74% of patients reported the app as very or extremely useful in each of the preoperative, inpatient, and post-discharge settings.
8	Jamal F, Zouaghi O, Leroux PY, Staat P, Garrier O, Sanchez I, et al.	Can digital pre-consultation save medical time and improve outcome in cardiology? [30]	2019	The study aimed to analyze the patient's risk profile before the medical appointment, to estimate the average time saved for each consultation, and to test whether this data could modify the medical decisions.	A web-based interface allowed patients to report their data and calculate a risk score. Seventy five patients were included. The total list of questions was composed of 48 items. The referent cardiologist timed the duration of each questionnaire and reported if the early analysis of patient's information would change the healthcare path (identification of an emergency or a need for an additional test prior to consultation).	The study involved patients with an average age of 54 years, of which 63% were male. On average, patients completed 56% of the total questions, taking approximately 5 minutes and 10 seconds for each questionnaire. Digital pre-consultation significantly reduced the time required for each medical examination, potentially freeing up 160 hours of extra medical time per cardiologist per year for 1800 consultations. Early data analysis identified 27% of patients who would benefit from additional tests prior to consultation, potentially influencing the care path and prognosis. This included 5 patients with suspected coronary disease.
9	Montazeri M, Multmeier J, Novorol C, Upadhyay S, Wicks P, Gilbert S.	Optimization of patient flow in urgent care centers using a digital tool for recording patient symptoms and history: simulation study [31]	2021	The main objective of the study is to evaluate the potential impact of introducing a patient self-symptom and history-taking app in an urgent care center (UCC) through a system simulation approach, aiming to reduce waiting times, decrease crowding, and enhance overall system efficiency compared to the addition of staff.	A discrete-event approach was used to simulate patient flow in a UCC during a 4-hour time frame. The baseline scenario was a small UCC with 2 triage nurses, 2 doctors, 1 treatment/ examination nurse, and 1 discharge administrator in service. We simulated 33 scenarios with different staff numbers or different potential time savings through the app. We explored average queue length, waiting time, idle time, and staff utilization for each scenario.	Introducing an additional nurse reduced the queue length for triage nurses by around 60% but led to an approximately 75% increase in the queue length for doctors. Adding an extra doctor resulted in a 67% increase in the mean idle time of doctors. Adding one extra triage nurse led to a 336% increase in triage nurses' idle time and a 44% decrease in the doctor's idle time. The median triage nurses' utilization dropped from 96.9% in the baseline case to 40.5% with the addition of one extra triage nurse. The time-saving impact of the symptom and history-taking app was equivalent to adding one triage nurse, reducing patient queue length for triage by 25.73% with 2.5 minutes per patient time savings. Waiting time for a triage nurse dropped by 54.88% when maximum app time saving was modeled.

operational efficiency of medical centers by reducing the number of unnecessary visits, improving quality of consultations, and saving the time of doctors from bureaucratic tasks [39]. Another platform, Bright.MD, outlines that their telehealth solution can reduce the administrative burden of doctors up to 2 minutes per visit and save 13 minutes of consultation for physical assessment and clinical decision-making process [40].

By having patients complete questionnaires before their appointments, healthcare providers can focus on interpreting the collected data and addressing specific concerns during the consultation. This streamlined process eliminates the need for spending a considerable amount of time during the appointment solely on history-taking, allowing physicians to allocate more time to critical medical assessments and personalized patient care. The study of Jamal and colleagues revealed that patients spend approximately 5 minutes and 10 seconds on pre-consultation questionnaires, which save 160 hours of cardiologist's work in a year [30]. Regarding patient wait time, Montazeri et al. in 2021 found that saving 5 minutes per patient can decrease patient wait time by half [31]. Reduced patient wait time can also improve patient satisfaction, and consequently, their compliance and rapport [31]. Pre-consultation history taking systems reduce documentation burden and give doctors more time with patients, potentially reducing burnout rates among medical specialists [41, 42].

Supporting evidence-based medicine and research

The digitalization of healthcare has introduced new perspectives in medical research. Nowadays, electronic health records have emerged as an asset, empowering researchers to access a wide range of comprehensive and diverse information, enabling them to conduct in-depth analyses and gain insights into various healthcare phenomena [43, 44]. Similarly, the comprehensive data collected through pre-consultation history taking systems can serve as a valuable resource for evidence-based medicine and clinical research. By aggregating anonymized patient data from diverse populations, researchers can analyze trends, identify risk factors, and highlight disease patterns [45]. The wealth of information collected through these systems contributes to the advancement of medical knowledge and the development of more effective treatment protocols.

Limitations

While pre-consultation history taking systems offer numerous benefits, they are not without limitations. Understanding these constraints is crucial for healthcare institutions and providers looking to implement such systems effectively (Figure 1).

Digital divide and accessibility

Pre-consultation systems relying on digital technology may pose challenges for certain patient populations. The rapid adoption of digital health technologies may inadvertently leave certain populations behind, particularly those who do not regularly use the internet or mobile devices, such as older adults, individuals in low-income regions, and those in remote areas with limited internet connectivity [46, 47]. Limited access to smartphones, computers, or internet connectivity may hinder their ability to participate, potentially exacerbating health disparities [48]. As the healthcare industry advances technologically, it is essential to address these inequalities and ensure that pre-consultation history taking systems are accessible and inclusive for all segments of the population, regardless of their age, income, or geographic location.

Usability of the system by hospitals

Limitations of pre-consultation history taking systems include challenges related to their usability by doctors and their implementation in healthcare facilities. Despite the availability of patient-provided data, some doctors might still opt to repeat the same questions during the consultation, potentially raising doubts about the accuracy and reliability of the information, and the quality of the collected data [49]. Digital apps also cannot read body language and can ask irrelevant questions, decreasing their usability for both doctors and patients [50].

The meta-analysis evaluating studies reporting digital systems collecting medical history before the hospital visit indicated that the majority of studies lack information on the usability of systems in real life. Despite being implemented and used in clinical practice, several barriers hinder the widespread use of digital systems. For instance, integration of systems takes time and effort, and there is no common and united system for reporting the information collected for medical records. Additionally, given the absence of evidence demonstrating improved health outcomes, physicians may not be inclined to adopt these technologies [51]. These factors could contribute to doctors' hesitation in fully embracing and utilizing these systems in their clinical practice, highlighting a potential barrier to widespread adoption.

Data accuracy and reliability

The accuracy and reliability of patient-provided data depend on the patients' understanding of medical terminology and their ability to recall and report relevant medical information [3]. Alongside pre-consultation questionnaires, up to 60% of electronic records may contain inaccuracies or omissions, encompassing errors in patients' diagnoses, medical history, medications, allergies, test results, procedures, contact information, and appointment details [52]. The inaccuracies can pose significant challenges to healthcare providers, potentially leading to incorrect treatment decisions, compromised patient safety, and hindrances in delivering optimal care. Therefore, the outputs of pre-consultation history taking systems should be considered as a tool for preparing patients, serving not only as a guide for facilitating discussions with the doctor but also as a comprehensive overview of the patient's condition for the physician.

Privacy and security concerns

Collecting and storing sensitive patient information electronically raises privacy and security concerns. Healthcare institutions must ensure robust data protection measures to safeguard patient data from unauthorized access, breaches, or cyberattacks [53, 54]. The protection of patients' data requires expensive antivirus software [55]. This additional cost burden places financial strain on healthcare institutions and organizations involved in data collection, as they must allocate resources to ensure the security and confidentiality of patient information. As a result, healthcare costs may increase to maintain robust patient and data security measures, prioritizing the protection of sensitive health records and preserving patient trust in the healthcare system. Balancing the need for data security with cost-effective solutions remains a significant challenge for the healthcare industry as it strives to uphold the highest standards of patient privacy and cybersecurity [54].

Patient engagement and compliance

Not all patients may be willing or motivated to complete pre-consultation questionnaires, leading to incomplete data or limited engagement with the system. Patients frequently do not utilize digital health tools as mobile apps and pre-consultation history taking platforms [56]. The review of patients' perspectives on health apps and platforms identified four reasons for non-compliance: lack of trustworthiness, appropriateness, personalization, and accessibility [57]. Main concerns regarding such apps and platforms can be related to privacy and security. Some apps request sensitive information for optimal performance, and certain apps enable providers to share personal data and findings through the app. Patients express worries about app security, data visibility, and the possibility of data breaches [58, 59]. Accessibility of the digital health system can be another factor influencing compliance. Some research identified that patients faced challenges with app connectivity and encountered user interface issues. This frustration was particularly common among older adults and the elderly, who often have poor eyesight and lower digital literacy compared to other age groups [60-62]. Additionally, many elderly patients may have no interest in improving their digital skills for this purpose [63].

In the evolving landscape of healthcare, the integration of digital innovations, particularly pre-consultation history-taking systems, has shown substantial benefits. However, it is crucial to acknowledge and address the preferences of specific patient demographics, notably the elderly and individuals experiencing loneliness, who may prioritize direct human interaction in their healthcare experiences [64]. These patients may often need not only medical assistance but also social connection and may prefer visiting healthcare facilities for human-to-human communication. While pre-consultation systems significantly contribute to efficiency, diagnostic accuracy, and patient engagement, they may not fully cater to the social and emotional aspects of healthcare-seeking behavior, particularly in this demographic.

Conclusion

In conclusion, the evolution of pre-consultation history taking systems has brought numerous benefits and advancements to modern healthcare practices. By enabling patients to provide comprehensive medical histories before their appointments, these systems improve the accuracy and completeness of patient data, enhancing diagnostic accuracy and treatment decisions. Moreover, they foster patient engagement and empowerment, leading to better patient-provider collaboration and improved health outcomes. The timesaving aspect for healthcare providers allows for more focused consultations, reducing burnout rates among medical specialists.

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References

1. Melms L, Schaefer JR, Jerrentrup A, Mueller T. A pilot study of patient satisfaction with a self-completed tablet-based digital questionnaire for collecting the patient's medical history in an emergency department. *BMC Health Services Research.* 2021;21(1):1-13. https://doi.org/10.1186/s12913-021-06748-y
2. Pappas Y, Anandan C, Liu J, Car J, Sheikh A, Majeed A, editors. Computer-assisted history-taking systems (CAHTS) in health care: benefits, risks and potential for further development. 2011;19(3):155-60. https://doi.org/10.14236/jhi.v19i3.808
3. Denecke K, Hochreutener SL, Pöpel A, May R. Self-anamnesis with a conversational user interface: concept and usability study. *Methods of information in medicine.* 2018;57(05/06):243-52. https://doi.org/10.1055/s-0038-1675822
4. Nishida A, Ogawa O. The Effect of a Pre-consultation Tablet-Based Questionnaire on Changes in Consultation Time for First-Visit Patients With Diabetes: A Single-Case Design Preliminary Study. *Cureus*. 2022;14(11). https://doi.org/10.7759/cureus.31624
5. Zakim D. Development and significance of automated history-taking software for clinical medicine, clinical research and basic medical science. *Journal of internal medicine.* 2016;280(3):287-99. https://doi.org/10.1111/joim.12509
6. Hall MA, Zheng B, Dugan E, Camacho F, Kidd KE, Mishra A, et al. Measuring patients' trust in their primary care providers. *Medical care research and review.* 2002;59(3):293-318. https://doi.org/10.1177/1077558702059003004
7. Agaku IT, Adisa AO, Ayo-Yusuf OA, Connolly GN. Concern about security and privacy, and perceived control over collection and use of health information are related to withholding of health information from healthcare providers. *Journal of the American Medical Informatics Association*. 2014;21(2):374-8. https://doi.org/10.1136/amiajnl-2013-002079
8. Campos-Castillo C, Anthony DL. The double-edged sword of electronic health records: implications for patient disclosure. *Journal of the American Medical Informatics Association.* 2015;22(e1):e130-e40. https://doi.org/10.1136/amiajnl-2014-002804
9. Kassirer JP. Imperatives, expediency, and the new diagnosis. *Diagnosis*. 2014;1(1):11-2. https://doi.org/10.1515/dx-2013-0004
10. Moonen P-J, Mercelina L, Boer W, Fret T. Diagnostic error in the Emergency Department: follow up of patients with minor trauma in the outpatient clinic. *Scandinavian journal of trauma, resuscitation and emergency medicine.* 2017;25:1-7. https://doi.org/10.1186/s13049-017-0361-5
11. Sinsky C, Colligan L, Li L, Prgomet M, Reynolds S, Goeders L, et al. Allocation of physician time in ambulatory practice: a time and motion study in 4 specialties. *Annals of internal medicine.* 2016;165(11):753-60. https://doi.org/10.7326/M16-0961
12. Slack WV. A history of computerized medical interviews. Buying Equipment and Programs for Home or Office: *Springer*. 1984; 138-45. https://doi.org/10.1007/978-1-4612-4708-1_22
13. Grossman JH, Barnett GO, McGuire MT, Swedlow DB. Evaluation of computer-acquired patient histories. *JAMA*. 1971;215(8):1286-91. https://doi.org/10.1001/jama.1971.03180210032006
14. Harada Y, Shimizu T. Impact of a commercial artificial intelligence-driven patient self-assessment solution on waiting times at general internal medicine outpatient departments: retrospective study. *JMIR Medical Informatics.* 2020;8(8):e21056. https://doi.org/10.2196/21056

15. Soekhai V, de Bekker-Grob EW, Ellis AR, Vass CM. Discrete choice experiments in health economics: past, present and future. *Pharmacoeconomics*. 2019;37:201-26. https://doi.org/10.1007/s40273-018-0734-2
16. Oliveri S, Lanzoni L, Petrocchi S, Janssens R, Schoefs E, Huys I, et al. Opportunities and challenges of web-based and remotely administered surveys for patient preference studies in a vulnerable population. *Patient preference and adherence.* 2021:2509-17. https://doi.org/10.2147/PPA.S327006
17. Kumar A, Joshi S, editors. Applications of AI in healthcare sector for enhancement of medical decision making and quality of service. 2022 International Conference on Decision Aid Sciences and Applications (DASA), *Chiangrai, Thailand.* 2022; 37-41. https://doi.org/10.1109/DASA54658.2022.9765041
18. Tang H, Huang H, Liu J, Zhu J, Gou F, Wu J, editors. AI-Assisted Diagnosis and Decision-Making Method in Developing Countries for Osteosarcoma. 2022;10(11):2313. https://doi.org/10.3390/healthcare10112313
19. Gellert GA, Orzechowski PM, Price T, Kabat-Karabon A, Jaszczak J, Marcjasz N, et al. A multinational survey of patient utilization of and value conveyed through virtual symptom triage and healthcare referral. *Frontiers in Public Health.* 2023;10:5267. https://doi.org/10.3389/fpubh.2022.1047291
20. Locke S, Bashall A, Al-Adely S, Moore J, Wilson A, Kitchen GB. Natural language processing in medicine: a review. *Trends in Anaesthesia and Critical Care.* 2021;38:4-9. https://doi.org/10.1016/j.tacc.2021.02.007
21. Kolanu N, Brown AS, Beech A, Center J, White CP. OR29-02 natural language processing of radiology reports improves identification of patients with fracture. Journal of the Endocrine Society. 2020;4(Supplement_1):OR29-02. https://doi.org/10.1210/jendso/bvaa046.1619
22. Lin SY, Mahoney MR, Sinsky CA. Ten ways artificial intelligence will transform primary care. *Journal of general internal medicine*. 2019;34:1626-30. https://doi.org/10.1007/s11606-019-05035-1
23. Goyder CR, Jones CHD, Heneghan CJ, Thompson MJ. Missed opportunities for diagnosis: lessons learned from diagnostic errors in primary care. *British Journal of General Practice.* 2015;65(641):e838-e44. https://doi.org/10.3399/bjgp15X687889
24. Davenport S, Goldberg D, Millar T. How psychiatric disorders are missed during medical consultations. *The Lancet.* 1987;330(8556):439-41. https://doi.org/10.1016/S0140-6736(87)90970-6
25. Palermo TM, Valenzuela D, Stork PP. A randomized trial of electronic versus paper pain diaries in children: impact on compliance, accuracy, and acceptability. *Pain*. 2004;107(3):213-9. https://doi.org/10.1016/j.pain.2003.10.005
26. Semigran HL, Levine DM, Nundy S, Mehrotra A. Comparison of physician and computer diagnostic accuracy. *JAMA internal medicine.* 2016;176(12):1860-1. https://doi.org/10.1001/jamainternmed.2016.6001
27. Kawamura R, Harada Y, Sugimoto S, Nagase Y, Katsukura S, Shimizu T. Incidence of Diagnostic Errors Among Unexpectedly Hospitalized Patients Using an Automated Medical History-Taking System With a Differential Diagnosis Generator: Retrospective Observational Study. *JMIR Medical Informatics*. 2022;10(1):e35225. https://doi.org/10.2196/35225
28. Zakim D, Brandberg H, El Amrani S, Hultgren A, Stathakarou N, Nifakos S, et al. Computerized history-taking improves data quality for clinical decision-making-Comparison of EHR and computer-acquired history data in patients with chest pain. *Plos one*. 2021;16(9):e0257677. https://doi.org/10.1371/journal.pone.0257677
29. Kneuertz PJ, Jagadesh N, Perkins A, Fitzgerald M, Moffatt-Bruce SD, Merritt RE, et al. Improving patient engagement, adherence, and satisfaction in lung cancer surgery with implementation of a mobile device platform for patient reported outcomes. *Journal of thoracic disease.* 2020;12(11):6883. https://doi.org/10.21037/jtd.2020.01.23
30. Jamal F, Zouaghi O, Leroux PY, Staat P, Garrier O, Sanchez I, et al. Can digital pre-consultation save medical time and improve outcome in cardiology? *Archives of Cardiovascular Diseases Supplements.* 2019;11(1):153-4. https://doi.org/10.1016/j.acvdsp.2018.10.341
31. Montazeri M, Multmeier J, Novorol C, Upadhyay S, Wicks P, Gilbert S. Optimization of patient flow in urgent care centers using a digital tool for recording patient symptoms and history: simulation study. *JMIR Formative Research*. 2021;5(5):e26402. https://doi.org/10.2196/26402
32. Müller F, Chandra S, Furaijat G, Kruse S, Waligorski A, Simmenroth A, et al. A Digital Communication Assistance Tool (DCAT) to obtain medical history from foreign-language patients: development and pilot testing in a primary health care center for refugees. *International Journal of Environmental Research and Public Health*. 2020;17(4):1368. https://doi.org/10.3390/ijerph17041368
33. Spinazze P, Aardoom J, Chavannes N, Kasteleyn M. The computer will see you now: overcoming barriers to adoption of computer-assisted history taking (CAHT) in primary care. *Journal of Medical Internet Research.* 2021;23(2):e19306. https://doi.org/10.2196/19306
34. Graffigna G, Barello S. Patient engagement in healthcare: pathways for effective medical decision making. *Neuropsychol Trends*. 2015;17:53-65. https://doi.org/10.7358/neur-2015-017-bare
35. Schwappach DLB. Engaging patients as vigilant partners in safety: a systematic review. *Medical Care Research and Review*. 2010;67(2):119-48. https://doi.org/10.1177/1077558709342254
36. Delbanco T, Walker J, Darer JD, Elmore JG, Feldman HJ, Leveille SG, et al. Open notes: doctors and patients signing on. *American College of Physicians;* 2010. p. 121-5.
37. Mandel JC, Kreda DA, Mandl KD, Kohane IS, Ramoni RB. SMART on FHIR: a standards-based, interoperable apps platform for electronic health records. *Journal of the American Medical Informatics Association.* 2016;23(5):899-908. https://doi.org/10.1093/jamia/ocv189
38. Nicholls M. Cardiologists and the burnout scenario. *Oxford University Press.* 2019. https://doi.org/10.1093/eurheartj/ehy788
39. Intermedica. Diagnostikare: Operational efficiency increased by 39% with Infermedica technologies. 2023.
40. BrightMD. Unlock efficiency for hybrid care with asynchronous telehealth. 2023.
41. Berg S. Physician burnout: Which medical specialties feel the most stress. *AMA Physician Health.* 2020.
42. Gholamzadeh M, Abtahi H, Ghazisaeeidi M. Applied techniques for putting pre-visit planning in clinical practice to empower patient-centered care in the pandemic era: a systematic review and framework suggestion. *BMC Health Services Research*. 2021;21(1):1-23. https://doi.org/10.1186/s12913-021-06456-7
43. Cowie MR, Blomster JI, Curtis LH, Duclaux S, Ford I, Fritz F, et al. Electronic health records to facilitate clinical research. *Clinical Research in Cardiology. 2*017;106:1-9. https://doi.org/10.1007/s00392-016-1025-6

44. Gusmanov A, Zhakhina G, Yerdessov S, Sakko Y, Mussina K, Alimbayev A, et al. Review of the research databases on population-based registries of Unified electronic Healthcare system of Kazakhstan (UNEHS): possibilities and limitations for epidemiological research and Real-World Evidence. *International Journal of Medical Informatics*. 2022:104950. https://doi.org/10.1016/j.ijmedinf.2022.104950
45. Dash S, Shakyawar SK, Sharma M, Kaushik S. Big data in healthcare: management, analysis and future prospects. *Journal of big data.* 2019;6(1):1-25. https://doi.org/10.1186/s40537-019-0217-0
46. Veinot TC, Mitchell H, Ancker JS. Good intentions are not enough: how informatics interventions can worsen inequality. *Journal of the American Medical Informatics Association.* 2018;25(8):1080-8. https://doi.org/10.1093/jamia/ocy052
47. van Kessel R, Hrzic R, O'Nuallain E, Weir E, Wong BLH, Anderson M, et al. Digital health paradox: international policy perspectives to address increased health inequalities for people living with disabilities. *Journal of medical Internet research.* 2022;24(2):e33819. https://doi.org/10.2196/33819
48. Krouse HJ. COVID-19 and the widening gap in health inequity. *Otolaryngology-Head and Neck Surgery.* 2020;163(1):65-6. https://doi.org/10.1177/0194599820926463
49. Albrink K, Joos C, Schröder D, Müller F, Hummers E, Noack EM. Obtaining patients' medical history using a digital device prior to consultation in primary care: study protocol for a usability and validity study. *BMC Medical Informatics and Decision Making.* 2022;22(1):189. https://doi.org/10.1186/s12911-022-01928-0
50. Brandberg H, Sundberg CJ, Spaak J, Koch S, Zakim D, Kahan T. Use of Self-Reported Computerized Medical History Taking for Acute Chest Pain in the Emergency Department-the Clinical Expert Operating System Chest Pain Danderyd Study (CLEOS-CPDS): Prospective Cohort Study. *Journal of Medical Internet Research.* 2021;23(4):e25493. https://doi.org/10.2196/25493
51. Berdahl CT, Henreid AJ, Pevnick JM, Zheng K, Nuckols TK. Digital Tools designed to obtain the history of Present Illness from Patients: scoping review. *Journal of Medical Internet Research.* 2022;24(11):e36074. https://doi.org/10.2196/36074
52. Freise L, Neves AL, Flott K, Harrison P, Kelly J, Darzi A, et al. Assessment of patients' ability to review electronic health record information to identify potential errors: cross-sectional web-based survey. *JMIR formative research*. 2021;5(2):e19074. https://doi.org/10.2196/19074
53. Javaid M, Khan IH. Internet of Things (IoT) enabled healthcare helps to take the challenges of COVID-19 Pandemic. *Journal of oral biology and craniofacial research.* 2021;11(2):209-14. https://doi.org/10.1016/j.jobcr.2021.01.015
54. Almalawi A, Khan AI, Alsolami F, Abushark YB, Alfakeeh AS. Managing Security of Healthcare Data for a Modern Healthcare System. *Sensors*. 2023;23(7):3612. https://doi.org/10.3390/s23073612
55. Mukati N, Namdev N, Dilip R, Hemalatha N, Dhiman V, Sahu B. Healthcare assistance to COVID-19 patient using internet of things (IoT) enabled technologies. *Materials today: proceedings.* 2023;80:3777-81. https://doi.org/10.1016/j.matpr.2021.07.379
56. Becker S, Miron-Shatz T, Schumacher N, Krocza J, Diamantidis C, Albrecht U-V. mHealth 2.0: experiences, possibilities, and perspectives. *JMIR mHealth and uHealth.* 2014;2(2):e3328. https://doi.org/10.2196/mhealth.3328
57. Vo V, Auroy L, Sarradon-Eck A. Patients' perceptions of mHealth apps: meta-ethnographic review of qualitative studies. *JMIR mHealth and uHealth.* 2019;7(7):e13817. https://doi.org/10.2196/13817
58. Giunti G, Kool J, Romero OR, Zubiete ED. Exploring the specific needs of persons with multiple sclerosis for mHealth solutions for physical activity: mixed-methods study. *JMIR mHealth and uHealth.* 2018;6(2):e8996. https://doi.org/10.2196/mhealth.8996
59. Schnall R, Higgins T, Brown W, Carballo-Dieguez A, Bakken S. Trust, perceived risk, perceived ease of use and perceived usefulness as factors related to mHealth technology use. *Studies in health technology and informatics.* 2015;216:467.
60. Martinez PR. A qualitative study on patient perceptions towards mHealth technology among high risk, chronic disease patients: *Harvard University;* 2015.
61. Sebern MD, Sulemanjee N, Sebern MJ, Garnier-Villarreal M, Whitlatch CJ. Does an intervention designed to improve self-management, social support and awareness of palliative-care address needs of persons with heart failure, family caregivers and clinicians? *Journal of clinical nursing*. 2018;27(3-4):e643-e57. https://doi.org/10.1111/jocn.14115
62. Watkins JOTA, Goudge J, Gómez-Olivé FX, Griffiths F. Mobile phone use among patients and health workers to enhance primary healthcare: A qualitative study in rural South Africa. *Social Science & Medicine.* 2018;198:139-47. https://doi.org/10.1016/j.socscimed.2018.01.011
63. Morrissey EC, Casey M, Glynn LG, Walsh JC, Molloy GJ. Smartphone apps for improving medication adherence in hypertension: patients' perspectives. *Patient preference and adherence.* 2018:813-22. https://doi.org/10.2147/PPA.S145647
64. Pedell S, Vetere F, Kulik L, Ozanne E, Gruner A, editors. Social isolation of older people: the role of domestic technologies. In Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction (OZCHI '10). *Association for Computing Machinery,* New York, NY, USA, 164-167. https://doi.org/10.1145/1952222.1952255