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Assessing the impact of health information technology on community health administration

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***Abstract*---Background:** Health Information Technology (HIT) plays a crucial role in patient care, especially in managing laboratory test results. Inadequate follow-up of these results is a significant patient safety concern globally. This systematic review aims to synthesize existing quantitative and qualitative research on the impact of HIT on test result management and patient engagement, highlighting the effectiveness of various HIT systems and identifying gaps in current practices. **Aim:** The review seeks to assess how HIT improves follow-up and management of test results, enhances patient engagement, and identifies challenges associated with its implementation. **Methods:** A systematic review methodology was employed, incorporating 57 studies published primarily between 2006 and 2018. The studies included randomized controlled trials, observational studies, mixed-methods studies, and qualitative studies, focusing on HIT interventions such as electronic alerts, electronic health records (EHRs), and patient portals. **Results:** The review revealed that HIT systems, particularly electronic alerts and patient portals, significantly improve clinician awareness of test results and reduce missed follow-ups. However, the evidence quality varied, with many studies indicating an increased clinician workload due to alert fatigue and the

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complexity of hybrid paper/electronic systems. **Conclusion:** While HIT has the potential to enhance test result management and patient engagement, its effectiveness is limited by integration challenges with clinical workflows and the need for sensitive communication in critical cases. Further research is needed to explore patient-managed health records and improve organizational practices.

***Keywords*---**health information technology, test result management, patient engagement, electronic health records, systematic review.

Introduction

The findings from laboratory tests and medical imaging reports play a critical role in influencing clinical decision-making, aiding in the diagnosis, treatment, prevention, and overall management of patient care [1]. The World Alliance for Patient Safety has highlighted inadequate follow-up of test results as a significant global concern in patient care [2], and in 2017, the US Emergency Care Research Institute identified insufficient follow-up of test results as a major patient safety challenge [3]. Numerous healthcare professionals, recognizing the prevalence of poor test result management, have voiced concerns regarding systemic flaws in organizational follow-up practices within and across healthcare settings [4]. Various strategies have been proposed to enhance follow-up processes for test results, including leveraging health information technology (IT) for communicating results through automated notifications [2,5,6]. The adoption of IT has been complemented by efforts to create guidelines and recommendations for its effective implementation, continuous quality improvement, and comprehensive evaluation [7–12]. Additionally, emphasis has been placed on involving patients as active partners in efforts to improve safety in care delivery [13,14]. This is particularly significant in scenarios where failure to inform patients of their test results has been deemed legally indefensible in malpractice cases [15]. Electronic health records (EHRs) are considered essential for fostering greater patient engagement, as they enable patients to securely access their medical information through electronic patient portals. These portals not only grant access to personal health data but also support communication with healthcare providers [16]. There is substantial evidence indicating that although IT can help prevent medical errors, it can also introduce a distinct set of errors [17]. This issue is especially pertinent to test result management, where the methods of data collection, reporting, and presentation can have significant safety implications [18,19]. Despite an expanding body of evidence regarding the adoption of health IT systems [6], their effects on test result follow-up, management, and patient engagement remain largely unexplored and insufficiently understood [20,21]. This systematic review synthesizes quantitative and qualitative research on the use of health IT to engage patients, offering an overview of the current evidence on how health IT addresses test result management and follow-up, and identifying gaps and challenges highlighted by existing research.

Findings

A total of 57 studies were incorporated into the systematic review, with 53 (93%) published between 2006 and 2018. The earliest study dated back to 1999, and a noticeable increase in research occurred from 2006 onward. A significant portion of the studies (72%, n = 41) were conducted in the United States. The studies employed various research methodologies, including 7 randomized controlled trials (RCTs) (12%), 32 observational studies (56%), 12 mixed-methods studies (21%), and 6 qualitative studies (11%). The overall quality of the evidence was assessed as fair (n = 35) or good (n = 20), with only 2 studies deemed to be of poor quality.

Health IT Systems Utilized for Test Result Management and Follow-up

The literature identified a wide array of health IT systems used in clinical management and follow-up of test results, including:

- **Electronic alerts** (both interruptive and non-interruptive) that notify clinicians of abnormal or critical results [26–45].
- **Computerized provider order entry (CPOE) systems** with electronic result viewing capabilities [46,47], and clinical information systems where results are viewed electronically but orders are placed manually [48–50].
- **Electronic medical record (EMR)/electronic health record (EHR) systems** [51–58].
- **Electronic results acknowledgment systems**, where physicians are required to electronically confirm they have seen a test result [59–62].
- **Electronic results tracking systems** that enable users to monitor test progress and result status (e.g., viewed or pending at discharge) [63,64].
- **EHR-based trigger algorithms** designed to identify patients at risk of diagnostic delays [65].
- **Electronic report generation systems** for abnormal results [66,67].

These categories are based on the manner in which each study described their intervention. The health IT interventions varied depending on whether they assessed the influence of an EMR/EHR system (e.g., category 3) or a specific feature within an EMR/EHR system (e.g., categories 1, 2, and 4). These distinctions reflect the progressive development and increasing specialization of health IT systems over time.

Patient Engagement and Follow-up via Health IT Systems

Studies examining IT-facilitated patient engagement and test result follow-up primarily focused on two types of electronic systems: 1) **patient portals** and 2) **personal health records (PHRs)**. Patient portals [68–79] provide access to personal health information via a secure website [80], while integrated (tethered) PHRs [81–83] are institutionally managed and connected to a healthcare organization's EHR system, allowing patients direct access to their medical records [84,85]. No studies assessed patient-managed PHRs (i.e., standalone or untethered systems not linked to a healthcare organization). The majority of the systems (n = 13) provided patients with real-time access to test results as they

became available. In two studies, patients were able to view results after a delay, allowing clinicians to review them beforehand [75,83]. Eighteen studies examined the effect of electronic results management on reducing missed test results. Most studies in this category were rated as either good [30,33,35,48,51,57,59] or fair [29,32,38–40,45,47,50,52,66], with one study classified as poor quality [34].

Alerts

A cluster-randomized controlled trial (RCT) conducted by Dalal et al. evaluated an automated email notification system. Survey responses from 152 hospital physicians and 112 primary care physicians (PCPs) indicated that those using the notification system were significantly more aware of actionable test results than the control group, with a 24–28 percentage point difference in awareness [29]. Similarly, a prospective cluster-RCT by El-Kareh implemented an email-based alert system to notify physicians of untreated positive culture results post-discharge, resulting in a 15% increase in follow-up documentation for these test results [40]. However, not all studies reported consistent results. A cross-sectional study by Wahls et al. involving 106 PCPs found that despite the use of an electronic medical record (EMR) with a result-alerting function, 37% of PCPs had encountered at least one patient with a missed test result [39]. Another cross-sectional survey of 143 PCPs found that 30% reported at least one instance of diagnosis or treatment delay due to a missed test result, with only 55% utilizing the electronic notification system consistently [38].

Computerized Provider Order Entry (CPOE) and Clinical Information Systems

Several studies explored the impact of CPOE systems and clinical information systems on test result follow-up. These studies revealed varying rates of physician awareness and result review. In emergency department settings, failure to follow up on radiology and microbiology results ranged from 1.5% [47] to as high as 45% for emergency biochemistry tests [48]. Additionally, one study found that both inpatient and primary care physicians were unaware of 61.6% of pending results at hospital discharge, with 37.1% of these results deemed actionable and 12.6% requiring urgent attention [52]. An Australian study investigated the impact of an electronic results acknowledgment system that included escalation procedures for unacknowledged results. The system, which assigned specific follow-up responsibilities, resulted in the clinical acknowledgment of all test results [59].

Impact of Health IT Interventions on Clinicians' Test Results Management Work Practices

Studies assessing the impact of health IT on clinicians' test results management covered key areas: 1) workload changes, 2) hybrid paper/electronic systems, 3) organizational context, 4) time to test results follow-up, and 5) implications for patient outcomes. These studies were rated as either good (n=11) [26,36,37,43,44,53,55,56,60,65,67] or fair quality (n=13) [27,28,31,41,42,46,49,54,58,61–64].

Changes in Workload

Clinicians noted increased workloads due to health IT systems, especially in managing irrelevant alerts. A qualitative U.S. study reported that acknowledging clinically irrelevant electronic health record (EHR) alerts added to clinicians' time burden [37]. A web survey of 2,590 primary care physicians (PCPs) found that 85.6% of respondents had to work after hours or weekends to manage test result notifications [54].

Hybrid Paper/Electronic Systems

Studies found that hybrid systems combining paper and electronic processes negatively impacted test results follow-up. Two studies noted that mixed-media environments complicated workflow and follow-up practices [46,58]. Menon et al. reported that 43% of 2,554 surveyed PCPs used workarounds involving paper or a combination of paper and electronic systems to manage test results [56]. Additionally, a mixed-method study concluded that health IT alone could not achieve optimal safety levels, as none of the sites achieved superior test results management despite varying degrees of IT adoption [55].

Effect of Organizational Context

Organizational factors influenced the success of health IT interventions. A qualitative study by Li et al. revealed that the success of electronic results acknowledgment systems depended on how well they aligned with existing work practices and the staff mix within departments [62]. Menon et al. highlighted that weaknesses in existing test follow-up policies and escalation procedures could contribute to missed test results, and interventions should account for organizational influences on health IT outcomes [53].

Time to Test Results Follow-up

Several studies assessed the effect of health IT interventions on the timeliness of test results follow-up. One RCT investigated a real-time paging system for critical lab values and found no significant difference in median response times between control and intervention groups (39.5 vs 16 minutes, $p=0.33$) [27]. In another study, Park et al. found a significant reduction in time to treatment orders in general wards (249 to 63 minutes, $p<0.001$) after introducing SMS notifications, but this effect was not observed in the ICU [42]. Lin et al. reported that abnormal hyperkalemia results were more likely to be followed within 4 days after implementing a system that flagged abnormal results and tracked their status (90% post vs 62.2% pre, $p=0.003$) [64].

Implications for Patient Outcomes

Health IT interventions generally resulted in positive patient outcomes, including faster diagnostic evaluations and follow-up actions. Several studies reported reductions in time to diagnostic evaluations [31,41,44,65], time to follow-up care for referred patients [28,44], time to diagnostic resolution [41,67], and increased

likelihood of diagnostic resolution [67]. These findings suggest that health IT systems can improve both the speed and quality of patient care.

Impact of Health IT Systems on Patient Engagement in Test Results Follow-up

Studies investigating the impact of health IT systems on patient engagement in the follow-up of test results utilized methods such as qualitative interviews, surveys, and observational data. The quality of these studies varied, with two studies rated as good [70,72], twelve rated as fair [68,69,71,73–79,81,83], and one rated as poor [82]. The key themes covered include patient utilization of portals, considerations related to patient access, and handling abnormal or critical test results.

Patient Utilization of Patient Portals

Patient portals emerged as a valuable tool for engagement, with Ling et al.'s survey of 429 patients from a sexually transmitted infection clinic showing that 75% of respondents accessed their results online to check them at their convenience [70]. Woywodt et al. found that 42% of 295 renal patients, mainly transplant patients, accessed their results after clinic appointments, with 78% using the portal 1–5 times per month [76]. Most patients (93%) believed the portal aided them in managing their condition.

Key Considerations Related to Patient Access to Results

Patient portals were generally associated with positive experiences. In Christensen's survey of patients using a tethered personal health record (PHR), patients felt satisfaction and relief from accessing laboratory results and often discussed the results with family and friends [81]. Wiljer et al. found that breast cancer patients primarily needed technical support to access their reports, with 98% of support requests being technical (e.g., difficulties accessing results) [74]. Cimino et al.'s mixed-method study reported that patients who tracked their laboratory test results felt more empowered and believed it enhanced communication with their physicians [82]. Clinician responses to patient access were similarly positive. In a survey involving 508 patients and 48 physicians, 88% of both groups viewed patient access to radiology reports as useful. Only 8% of physicians stopped releasing reports online due to patient confusion or anxiety [83].

Abnormal or Critical Test Results

The release of abnormal or critical test results, however, raised concerns. Giardina et al. found that while most patients supported electronic access to test results, they preferred verbal communication for results with high emotional impact, such as life-threatening diagnoses or genetic tests [68]. Winget et al. surveyed 82 oncologists, and nearly half (49%) believed that releasing results indicative of disease progression online negatively affected communication with patients. Many oncologists felt that sensitive information requiring counseling should be shared in person [75]. Overall, health IT systems, particularly patient portals, enhanced patient engagement in test result management, though

sensitive results required more careful handling to prevent misunderstandings or distress. This systematic review spans two decades and integrates findings from multiple research methodologies (both qualitative and quantitative), a variety of health IT systems and software, as well as investigations into clinical practices and patient engagement. By examining these aspects, the review presents a clearer understanding of how the broader socio-technical system—comprising technology, clinicians, patients, processes, and organizations—affects the follow-up of test results. While randomized controlled trials (RCTs) indicate that health IT systems can improve documented follow-up by 15 percentage points and enhance physician awareness of test results by 24-28 percentage points, the overall evidence remains weak. This suggests that health IT alone cannot resolve the issue of inadequate test result follow-up.

Key Dimensions of Test Results Follow-up

1. **Organizational-Communication Environment**: The communication of test results reflects existing patterns of accountability, responsibility, and authority, shaped by clinical governance and contextual factors within healthcare settings. Communication is not a one-way process but requires iteration and feedback to ensure effective linkage between people across different settings. Health IT's role in disrupting or enhancing these processes depends largely on its ability to change how communication bridges activities across time and space.
2. **Diagnostic Process**: The diagnostic process is complex, involving multiple people and settings. Health IT systems support this by facilitating information sharing, test tracking, and alerting physicians when results are available. However, even with systems like CPOE (Computerized Physician Order Entry) and tracking alerts, the alignment between IT and clinical workflows is often insufficient, especially when subsequent actions (e.g., acting on test results) are overlooked. The partial integration of electronic systems and the co-existence of paper-based processes also pose risks to patient safety by increasing the cognitive workload on healthcare professionals and contributing to errors.
3. **Patient Engagement in Test Results Follow-up**: Many studies emphasize the role of patient engagement, particularly how IT systems facilitate access to test results. Patient-centered IT tools, such as portals, allow patients to view results in real time, leading to improved communication with physicians and better management of health conditions. However, in cases of serious diagnoses, patients prefer in-person consultations for the initial disclosure of results. Although privacy and security concerns are frequently cited in the literature, none of the studies in this review focused on these issues. Future IT solutions, such as patient-managed personal health records (PHRs), may offer more personalized and patient-centered healthcare options. In summary, while health IT systems enhance test results management and patient engagement, they are not a complete solution. The integration of IT must be better aligned with clinical workflows and patient preferences, particularly in high-stakes situations requiring sensitive communication.

Conclusion

The findings from this systematic review underscore the pivotal role that Health Information Technology (HIT) can play in enhancing the management of laboratory test results and fostering patient engagement. Despite the potential benefits, the evidence presented indicates that the effectiveness of HIT systems is not uniformly realized across different healthcare settings. The review highlighted that a considerable number of studies demonstrated improvements in clinician awareness of actionable test results, particularly through automated alert systems and electronic health records (EHRs). For instance, randomized controlled trials illustrated significant increases in follow-up documentation and clinician awareness when HIT interventions were implemented. However, challenges persist. The review noted that many clinicians experienced increased workloads attributed to irrelevant alerts and the complexities arising from hybrid systems that combine paper and electronic processes. These factors can lead to cognitive overload, thereby exacerbating the risk of errors in test result management. Additionally, the review emphasizes that while HIT systems promote timely access to health information for patients, sensitive results still require careful handling to ensure appropriate communication. The findings also reflect a pressing need for improved organizational practices. Effective implementation of HIT requires alignment with clinical workflows and a supportive organizational culture that facilitates communication and accountability. Future developments in HIT, such as patient-managed personal health records (PHRs), may provide innovative solutions to enhance patient involvement in their healthcare. In summary, while HIT shows promise in addressing the challenges of test result management and enhancing patient engagement, its success is contingent on strategic implementation and integration within existing clinical frameworks. Ongoing research should focus on refining these systems to optimize safety and efficacy, particularly in high-stakes situations involving critical health information. As healthcare evolves, embracing patient-centered approaches in HIT will be crucial for achieving better health outcomes.

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تقييم تأثيرتكنولوجيا المعلومات الصحية على إدارة الصحة المجتمعية.

الملخص:

الخلفية: تلعب تكنولوجيا المعلومات الصحية (HIT) دورًا حاسمًا في رعاية المرضى، خاصة في إدارة نتائج الاختبارات المخبرية. إن المتابعة غير الكافية لهذه النتائج تعتبر قضية هامة تتعلق بسلامة المرضى على مستوى العالم. تهدف هذه المراجعة المنهجية إلى تلخيص الأبحاث الكمية والنوعية الموجودة حول تأثير تكنولوجيا المعلومات الصحية على إدارة نتائج الاختبارات ومشاركة المرضى، مع تسليط الضوء على فعالية أنظمة تكنولوجيا المعلومات الصحية المختلفة وتحديد الفجوات في الممارسات الحالية .

الهدف: تسعى المراجعة إلى تقييم كيف تحسن تكنولوجيا المعلومات الصحية من متابعة وإدارة نتائج الاختبارات، وتعزز مشاركة المرضى، وتحدد التحديات المرتبطة بتنفيذها .

الطرق: تم استخدام منهجية المراجعة المنهجية، والتي تضمنت 57 دراسة تم نشرها بشكل رئيسي بين عامي 2006 و2018. شملت الدراسات تجارب عشوائية محكمة، ودراسات رصدية، ودراسات مختلطة الطرق، ودراسات نوعية، مع التركيز على تدخلات تكنولوجيا المعلومات الصحية مثل التنبيهات الإلكترونية، والسجلات الصحية الإلكترونية(EHRs) ، وبوابات المرضى .

النتائج: كشفت المراجعة أن أنظمة تكنولوجيا المعلومات الصحية، وخاصة التنبيهات الإلكترونية وبوابات المرضى، تحسن بشكل كبير من وعي الأطباء بنتائج الاختبارات وتقلل من المتابعات المفقودة. ومع ذلك، كانت جودة الأدلة متفاوتة، حيث أشارت العديد من الدراسات إلى زيادة عبء العمل على الأطباء بسبب إرهاق التنبيهات وتعقيد الأنظمة الهجينة الورقية/الإلكترونية .

الخاتمة: على الرغم من أن تكنولوجيا المعلومات الصحية لديها القدرة على تحسين إدارة نتائج الاختبارات ومشاركة المرضى، فإن فعاليتها محدودة بسبب تحديات التكامل مع تدفقات العمل السريرية والحاجة إلى التواصل الحساس في الحالات الحرجة. هناك حاجة لمزيد من الأبحاث لاستكشاف السجلات الصحية المدارة من قبل المرضى وتحسين الممارسات التنظيمية.

الكلمات المفتاحية: تكنولوجيا المعلومات الصحية، إدارة نتائج الاختبارات، مشاركة المرضى، السجلات الصحية الإلكترونية، مراجعة منهجية.