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When Positive is Negative: Health Literacy Barriers to Patient Access to Clinical Laboratory Test Results

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Abstract

Background: Health literacy is a multidimensional set of skills (e.g., narrative, numeracy, digital, medication) that patients need to access and understand health information timely and accurately to make evidence-based informed decisions.

Content: Multiple barriers prevent patients from effectively interacting with health information. The most salient barriers are poor overall health literacy skills and linguistic proficiency in English. As patients prefer direct access to laboratory test results, especially those of routine tests, contextualization and provider-directed interpretation of results are required to foster shared decision-making to address their healthcare issues and improve health outcomes.

Summary: The use of systematic approaches that account for poor health literacy skills and include culturally and linguistically appropriate planning and availability of resources is warranted at individual and population health levels (e.g., human-centered design of patient portals).

INTRODUCTION

Clinical laboratory testing is integral in current and future population health efforts, serving to proactively identify infectious and chronic diseases via predictive data analytics, multidisciplinary team building, and the development or enhancement of tools that support clinical decisions and targeted interventions (1, 2). Moreover, clinical laboratory testing services are essential healthcare components, supporting current and future surveillance, diagnosis, and treatment of diseases, both chronic and infectious, as the COVID-19

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pandemic showed (3). The availability of timely and accurate laboratory test results enables clinicians to make evidence-based clinical and therapeutic decisions (4). Making laboratory test results directly available to patients and their proxies (e.g., parents, legal guardians) offers benefits (e.g., contextualizing results and connecting patients with similar conditions), but presents challenges in understanding results and ultimately acting upon the information (5). The inclusion of terms such as “positive” or “negative” in laboratory results may lead to confusion among patients and healthcare providers as those terms are usually dependent on diverse testing and reporting methodologies (6). For example, a positive result in laboratory testing generally indicates the presence of a substance or disease (7). A pathology report with a positive finding indicates the presence of cancer cells (8). Such positive results have negative consequences for patients. This highlights the importance of clear communication of results to patients, which will also improve patient health and their healthcare experience (9).

In health communication technology, the “digital divide” represents the difference in information access between 2 populations (e.g., limited-English proficient and the general English-speaking US population). This divide is due to multiple factors, such as patient portal usability, digital literacy, internet access, and broadband costs (10). The digital divide constitutes a disparity in the context of Executive Order 13985 (April 2022) to advance racial equity and support for underserved communities (11). Additionally, Executive Order 13166 (August 2000) requires that organizations receiving federal assistance provide meaningful access to their services to individuals with limited English proficiency (12). In practical terms, the digital divide may hamper efforts in digital inclusion used to achieve healthcare equity (13). Equity in access to and understanding of laboratory results may require a thorough understanding of the patient participation in laboratory testing.

In 1981, Lundberg (14) described the Total Testing Process (TTP) in nine stages (ordering, collection, identification, transportation, preparation, analysis, reporting, interpretation, and action). The constant development of new technologies and evolving medical practice have challenged the TTP process as practitioners have called for emphasizing the role of the clinical laboratory in caring and advocating for the patient (15), reducing errors (16), and improving the diagnostic process throughout healthcare (17-19).

Several TTP stages require patient engagement (e.g., patient encounter and indication for testing, test selection, and clinical interpretation/follow-up at the end of the TTP). Test request submission (e.g., direct-to-consumer testing products), specimen collection, interpretation of laboratory test results (e.g., when results are not sent to the healthcare provider or the healthcare provider is not present), and reporting are arguably also points of patient engagement due to the evolving nature of laboratory and at-home testing (e.g., prescribed vs over-the-counter home tests, in-home sample collection), despite the predominant roles of technical expertise and clinician involvement.

Each TTP stage relies on effective communication—one of several competencies for patients and providers—during the decision-making process. Such communication assumes that patients are proficient in several skills collectively defined as literacy skills. This review

considers the definitions of digital and health literacies and their implications in clinical laboratory testing and healthcare.

HEALTH LITERACY FACTORS

Definitions and Models

In this review, health literacy includes literacy (narrative), numeracy (numerical/mathematical), and digital (electronic/digital media) factors.

Health literacy definitions have changed over time, with their focus ranging from cognitive (comprehension, critical thinking skills) to behavioral (e.g., search and application of information, agency) to affective (e.g., self-awareness, self-efficacy) factors (20). Due to the variability of definitions and factors, Sørensen (21) proposed an integrated health literacy model encompassing public health and medical views of health literacy (i.e., competence/skills/abilities, action, information, objective, context, and time). More recently, Healthy People 2030 (HP2030), the decade-long initiative to improve the nation's health through health promotion and disease prevention initiatives, updated the definition of personal health literacy to "the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for themselves and others" (22). HP2030 also updated the role of health literacy and presented it as one of its overarching goals (23). Such updates were necessary to assess health literacy as a social determinant of health and bring closer and more careful attention to the critical role that health literacy skills have over health, health care, and health outcomes (24-26).

Narrative

Narrative, as a concept of communicating in a written format, goes beyond such capacity and includes competencies that enable readers to acknowledge and understand structured textual elements and are fundamental to processing concepts and building meaning (27). Today, the written word is available to patients in paper, digital, and audio formats. Delivering information through digital media is more common, and its use is growing. Understanding this form of information delivery requires narrative and digital literacy skills. Such a combination may present additional challenges due to the parallel need for such skills. This may be evident in the disparities in activation of (e.g., accepting an electronic invitation) and access to patient portals by disproportionately affected populations, such as African American and Spanish-speaking Hispanic/Latino patients when reviewing their diagnostic tests (e.g., blood, urine, imaging) after emergency department visits (28). These disparities and the need to use multiple literacy factors mainly inhibit the accessibility and navigation of patient portals for patients with limited English proficiency due to a lack of multilingual options, internet access issues, and the complexity of a multistep process to activate an account by using an activation code found in discharge or visit summary papers or requesting an activation code (28).

Another factor impacting the successful understanding of health-related messages is the comprehension level at which the information is written. The general recommendation is to write health information at a sixth-grade level to match the general population's

reading level (29). However, Daraz et al. found in a systemic review (157 studies) that analyzed a total of 7891 US and Canadian websites (comprised of academic, government, non-profit, media, private/commercial, and other site types that included health information addressing/targeting the general public) that the mean readability grade level of the text (health information) presented in all websites ranged between grade 10 to 15, surpassing the recommended sixth-grade comprehension level (30). Presenting health information at a higher than the recommended readability grade level may make the information less appropriate for general public use and potentially impact the understanding of health information.

In 2022, Flores et al. argued that the value of health communication is negatively impacted if the needs of the intended audience (access to and understanding of messages) are not met while affecting the actionable nature of health communication (31). Thus, the narrative is a pillar of health communication. Patient-centered health communication would significantly benefit from systematically and consistently implementing the sixth-grade comprehension level in health communication publications allowing patients, regardless of their literacy level, to understand information the first time they read it. Communicating health information with simple messages benefits both low-and high-literacy individuals (32). Although the Plain Writing Act of 2010 indicates the use of plain writing in US federal documents providing information about government benefits or services, a new legislative initiative (Clear and Concise Content Act of 2023) would update the Plain Writing Act of 2010 and expand documents covered to nearly all information (except regulations) that public agencies post to the public (33, 34). Such an update may provide tangible options to address health literacy issues systematically.

A narrative factor to consider is the language in which information is communicated. The U.S. Census Bureau estimates that more than 350 spoken languages are represented in the US population (35), with more than 25.5 million people (8.2% of the US population) speaking English less than “very well” (36). Populations with such linguistic characteristics are categorized as having limited English proficiency (LEP). Anti-discrimination and enabling resources, guidelines, and regulations for these populations include Title VI of the Civil Rights Act (37), Executive Order 13166 (38), Executive Order on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government (8), Culturally and Linguistically Appropriate Service (CLAS) standards (39), [LEP.gov](#) (12), and the Clinical Laboratory Improvement Advisory Committee (CLIAC) Recommendation 5 from October 2020 (40), among others. Despite those protections and resources, Hispanic/Latino and populations with LEP tend to have less access to patient web portals and laboratory testing portals, lower health literacy, and are more prone to medical errors (28, 41, 42).

Although the direct release of test results to patients increases patient engagement for English speakers, it may also cause anxiety and confusion, especially when there is no provider interpretation of the results or contextualized medical advice (43-45). These circumstances make understanding laboratory test results especially challenging for native English speakers with limited health literacy skills (46). Adding a lack of English proficiency to the existing narrative with readability higher than the recommended sixth-

grade level may decrease access and understanding of health communication messages, including test results. The COVID-19 pandemic proved this effect on speakers of Spanish and Chinese (including traditional, simplified, and other languages from China), the 2 most commonly spoken languages in the US after English. Speakers of Spanish and Chinese languages were subject to disparities in 3 aspects: lack of receiving information consistently on protective health behaviors by public health and government agencies; instead, receiving that information from traditional (e.g., tv) and digital (e.g., social media), family and friends; and, facing challenges with information that was perceived as discriminatory toward Latinx and Chinese people (47).

Although narrative bears great importance, health communications, particularly laboratory test results, are presented or reported using numbers and reference intervals. The addition of digital components as part of the widespread availability of electronic health records and patient portal resources extends the need for digital literacy and potentially contributes to additional challenges. Addressing health literacy issues should account for the challenges arising from the interactions of all these factors.

Numeracy

Numeracy is the ability to read and understand numerical information. In the context of health literacy, it includes the ability to understand clinical and public health data (48). The 2 types of numeracy are subjective or self-identified “confidence in understanding mathematical data, and objective or measurement of a person’s actual math skills” (48). A patient’s specific numeracy type may affect their disease risk perception and health decisions. In the context of health literacy, numeracy plays a critical role in understanding public health, laboratory, clinical, and therapeutic assessments, recommendations, reports, and instructions. For example, numeracy can impact people’s understanding of data, decrease bias, and improve statistical information processing (49, 50). The COVID-19 pandemic offered the opportunity to prove the relevance of numeracy in health behavior and public health. For example, using epidemiological data about mask mandates, Hutmacher et al. studied how numeracy may interact with motivated reasoning to draw conclusions not necessarily based on rationale and objectivity (49). Similarly, Lau et al. conducted surveys in the US, United Kingdom, and Canada during the pandemic to understand basic numeracy, health numeracy in context, and health-related attitudes and behaviors. The authors found that basic numeracy was positively associated with health numeracy, but neither of those 2 factors were related to COVID-19 health-related attitudes and behavior in the 3 surveyed locations (50). The need for an unbiased understanding of public health information is paramount. This need became more evident during the COVID-19 pandemic in its association with greater susceptibility to misinformation in multiple countries, including the US (51).

Moreover, recent evidence in the context of the COVID-19 pandemic emphasizes the importance of numeracy for the population to understand the issues originating from a global pandemic (52). However, evidence also indicates that numeracy alone is insufficient to influence people’s attitudes toward health, disease severity, and their willingness to follow public health advice (50). Similar associations between numeracy and factors impacting

health outcomes were identified in different types of cancer studies, such as breast (e.g., less understanding of disease stage and difficulties in completing decision aid tools), colorectal (e.g., attitude toward screening), and prostate cancers (e.g., risk assessment and treatment choice), as well as heart failure and other conditions (53-55). The role of numeracy becomes more essential due to the immediate availability, number, and frequency of epidemiologic reports and data sharing through digital media. Thus, numeracy and health literacy are critically in need of a cohesive articulation with digital literacy.

Digital Literacy

Our ever-advancing technology requires specific technology-based factors and skills, such as broadband access, updated hardware, and foundational digital literacy skills. Formerly known as computer literacy, digital literacy involves skills to adapt to accessing and managing hardware (desktops, laptops, and mobile devices) and user interfaces (UIs) that require other forms of hardware (e.g., mouse, touchscreen, stylus, and voice activation) and software (e.g., voice activation, talk to text). Managing the hardware/UI combination may appear more intuitive to digital natives, those individuals who were born or grew up with such electronic and digital stimuli (56).

The digital divide limits affected individuals' ability to access, manage, and understand essential data points to make informed health decisions. This is particularly important for older patients with limited digital skills who have difficulty navigating mobile phone UIs (57). This confluence of factors may negatively impact the meaningful participation, access, and use of digital information and resources necessary to make informed health decisions (58).

Furthermore, the development and penetration of direct-to-consumer testing, wearable devices, and the Internet of Things (IoT) will likely change digital literacy skills from relevant to required (59, 60). Voice-activated IoT technologies may present challenges and opportunities in extending or addressing the disparities in overall language proficiency and health literacy, impacting the diagnosis and management of chronic diseases, such as diabetes and cardiovascular disease, that require laboratory testing where narrative and numeracy impact the interpretation of results and decision-making process to implement actions to improve health outcomes (45, 61, 62).

HEALTH LITERACY AND EQUITY: IMPACT AT A POPULATION LEVEL

How Does Health Literacy Impact Access to Laboratory Tests and Results?

In 2003, results of the first nationwide US assessment of adult literacy skills showed a concerning baseline for health literacy in adults: below basic level (14%), basic level (22%), intermediate level (53%), and proficient level (12%). The assessment levels increased the difficulty of 3 tasks primarily: locating, identifying, and analyzing information in text and documents, going from the most simple and concrete literacy skills in below basic to more complex and challenging literacy activities in proficient; and identifying and using quantitative information to perform mathematical calculations to solve problems, from identifying and performing simple mathematics in one-step problems in below basic to using

more abstract quantitative information to solve problems that require multiple steps (63). A more recent report using surveys from 2012 to 2014 from the Program for the International Assessment of Adult Competencies (PIAAC) showed overall improvement (64). However, updated PIAAC data (2012 to 2017) showed low literacy and numeracy patterns in US southern and southwestern states (46).

Although internet connectivity varies within the US and other countries, the influence of digital environments and the ubiquity of connectivity and access to information require that improvement efforts account for health literacy and the salient effects of its components (digital literacy and numeracy). The United Nations Sustainable Development Goals attempted to address the global deficiencies in literacy, particularly numeracy, via Target 4.6, which aims for youth and adults to achieve literacy and numeracy by 2030 (65). Although the effects of the COVID-19 pandemic are yet to be fully assessed, a report from the United Nations pointed out the disruptive effects of the pandemic as a global education crisis (66), likely impacting health literacy as well. The differences in literacy levels are critical to understanding the numerous epidemiologic data and reports developed during the pandemic. In 2021, Abel and McQueen proposed the development of Critical Health Literacy in a Pandemic, contextualizing and accounting for sociocultural factors to support patients and communities and their active and informed participation (67).

Moreover, critical literacy skills are required for patients to successfully access and interact with information containing clinical laboratory testing instructions and results. Disparities in access have been reported for laboratory testing and radiology results in the emergency department in adults and children (28, 68). Houston (69) found a significant association between language acculturation (more use of English, less use of Spanish) and health literacy. Similarly, language acculturation also influences the perception of discrimination and quality of care by Spanish speakers and their overall patient experience (70). Language acculturation is a process that takes years, sometimes decades. During this transitional period, Spanish speakers with LEP, and speakers of other non-English languages, are at a disadvantage when interacting with health information. Regarding laboratory test results, individuals with LEP face multiple factors that hamper their understanding (e.g., language access, digital literacy, narrative, numeracy). Diminished access or lack of effective access and understanding of health information puts individuals with LEP at higher risk of negative events in healthcare and other life aspects, such as financial, civic, and in the workplace (71, 72). Thus, addressing these issues provides a way to decrease multiple disparities that individuals with LEP face and enhance their equity.

When Positive Is Negative. Understanding Laboratory Results

Once access and digital literacy barriers are overcome, patients face the complexities of medical terminology, reporting using different systems of units (the international and imperial systems of units), and limited understanding of laboratory testing results and the reported ranges (e.g., numbers, formats) in which they are presented (45, 73).

Although evidence indicates that patient engagement increases and is preferred by patients, the need for help in understanding and interpreting results is essential (43, 45). Narrative and numeracy play essential roles in understanding results. However, the visual display of results

also plays an important role that may account for various learning styles and preferences (74).

Clinical testing results usually include reference intervals (RIs) to determine a comparison point and assist in the determination (quantification) of normal values, higher risk (pre-diagnosis), and diagnosis. RIs are generally determined using one of 2 ways. Through a direct method by gathering samples from healthy individuals representing the population to establish lower and upper-end references, and an indirect method by using research literature, information from equipment manufacturers, and data from other sources (75). Although the direct method may be ideal for establishing relevant RIs, it involves high costs, extended time, and logistics, making it a challenging route for most laboratory facilities to establish RIs (76). Transferring RIs from other sources (e.g., mining data from electronic health records and other large data sets) may also introduce heterogeneity (i.e., population representation different from the population where the RI will be applied), making it challenging to apply it to pediatric patient populations (77). Patients' assessment of risk and the need to take action when reading laboratory test results requires a design that combines RIs with simple graphic designs that facilitate the interpretation of results (78). Such design would have to be studied in instances that include pre-test selection (e.g., direct-to-consumer testing kits), clinical sensitivity, and specificity (false positives and false negatives).

Although mining data may seem like a promising solution, unless there is a realistic representation of the population diversity in the research study population, the RIs may not effectively reflect the population's needs and characteristics. Diversity in research remains an elusive reality with persistent barriers that require system-level changes in research recruitment, diversity of researchers, and buy-in from populations with multiple historical disappointments with research participation, both in voluntary and involuntary ways (79). An indirect method may continue existing disparities or create new ones by applying a "one size fits all" approach that does not account for biological and physiologic characteristics or mechanisms of underrepresented populations and overcoming recruitment barriers in biomedical research (80). A recent example is the removal of race from the estimated glomerular filtration rate (eGFR), given that race is a social construct, not a biological one. Using race to modify the eGFR in African American individuals rendered values that were 16% higher, potentially impacting diagnostic and therapeutic decisions, such as more aggressive treatment and less likelihood of getting a kidney transplant, among others (81). The American Association for Clinical Chemistry recently published a guidance document calling all laboratories for the immediate implementation of the creatinine-based eGFR equation in adults with chronic kidney disease (CKD). This equation, called CKD-EPI-2021, was developed without a race coefficient to provide a more accurate test, initial or confirmatory as appropriate in the clinical setting. The new CKD-EPI-2021 equation represents progress to achieve a more equitable management of kidney disease (82, 83). Accurate and timely methods to update RIs should account for the current and future changes in population demographics impacted by social determinants of health, immigration patterns, and global health needs.

Patients need to interact with laboratory test results with a minimum level of understanding of RIs to make informed health decisions and engage in health behaviors that are conducive

to achieving all levels of prevention. Positive is not always good, and negative is not always bad.

CLINICAL LABORATORIES AND HEALTH LITERACY: CAN ACCESS IMPROVE?

The role of the clinical laboratory is facing a paradigm change prompted mainly by the need for a more proactive role in predicting events of clinical importance. Additionally, wearable and IoT devices can contribute to remote health monitoring efforts that can lead to clinical laboratory testing. Voice-activated devices are now available in more than one language, and efforts to target populations (e.g., older patients) are underway with apparent easy-to-use bracelets to measure vital signs and inform clinicians and caregivers in making decisions to improve patients' health (84). For type 1 diabetes, use of continuous glucose monitoring (CGM) devices, a wearable device that measures glucose levels through interstitial fluid in subcutaneous tissue is well established and is paired, in some cases, with automated insulin delivery systems to facilitate managing blood glucose levels (85). The use of these devices offers patient self-monitoring opportunities and continuous data points for provider-driven decisions. More evidence is required to establish safety management of type 2 diabetes patients, particularly those with intensely insulin-treated patients, opening a new opportunity for surveillance and management of diabetes in primary care and specialty settings (86, 87).

There is a need to implement guidelines and innovative initiatives that foster equity through improved access and effective communication. These efforts must address health, digital, and numeracy literacy constructs and offer a systematic approach to providing resources and guidelines that reduce or eliminate misinformation. The clinical laboratory can provide opportunities to address such needs, especially when providing results (43). A multidisciplinary approach may include coordinated efforts to add notes in electronic health records (EHR) portals to patients, clinicians, or both, to prompt them to review informational resources and take actions. These efforts may benefit from existing websites, with clinical and laboratory information, to contextualize laboratory test results and to enhance patient education by incorporating resources and graphic designs to deliver results in patient portals to provide context to patients and enhance their understanding (see Table 1).

Particular attention to the use of plain language (e.g., plain writing, clear communication), information display, and availability of general and contextualized information to interpret results may provide opportunities to systematically address readability issues (e.g., documents written beyond the recommended sixth-grade level), build and improve patient-centered access and understanding of laboratory testing information, and foster evidence-based informed decisions by clinicians and patients.

Practice Implications: Partnerships to Achieve Health Equity

Equitable access to patient portals is only the first step. Presenting laboratory test results to the general public requires standardization and systematic inclusion of 3 critical aspects: (a) health literacy, (b) foundational use of culturally and linguistically appropriate resources,

and (c) tools to contextualize results to help patients understand laboratory test results and make decisions that lead to actions that prevent the onset of disease(s) or encourage patients to seek appropriate treatment(s).

Using culturally and linguistically appropriate resources provides a pathway to support the language acculturation process of individuals with LEP. For example, Spanish-speaking patients prefer in-person disclosure of results using their preferred language to understand and address concerns when receiving high-risk results involving complex concepts such as polygenic risk scores (96). Aside from the complexity of health-related concepts, preferences should be understood as ways to ensure understanding and learning concepts relevant to health and disease management processes. It is not feasible in healthcare, historical, social, cultural, and economic terms to ignore such needs if the goal is to offer a patient-centered system of care (97).

Current and future clinical and public health needs may lead to the rapid growth of direct-to-consumer (DTC) testing and wearable devices. Such growth may present opportunities to extend health communication outreach to disproportionately affected populations that may benefit from more affordable DTC testing. The challenges include avoiding the continuation of existing disparities that hamper understanding and an informed decision-making process based on health communication that does not fully account for low health literacy (60, 98).

Responding to multiple and diverse needs requires using design systems that innovate with enough flexibility to account for complex and changing needs, populations, and systems (e.g., testing, healthcare). The pillars of designing new approaches to healthcare benefit from human-centered designs and systems that focus on people's needs and concrete experiences (e.g., language proficiency, cultural, and social assimilation) (99, 100).

A call to action is warranted to laboratory professionals and clinicians to support the review and redesign of patient portals with a patient-centered perspective, through multidisciplinary work to ensure systematic implementation of clear communication through plain writing to achieve health equity through improved health literacy efforts. Similarly, federal and state organizations may also contribute by providing guidelines, resources, and legislative initiatives, such as the Digital Equity Act of 2021 and the Clear and Concise Content Act of 2023.

CONCLUSIONS

The COVID-19 pandemic exposed many critical issues in public and health systems. Among them is literacy's crucial role in ensuring the understanding of rapidly evolving public health messages. Literacy has great significance as a building block involving multidimensional skills that present challenges and opportunities. The combination of health literacy and digital literacy has the potential to make health data and communication reach an audience with diverse needs through effective health IT infrastructure, culturally and linguistically appropriate resources, and user-friendly interfaces.

Human-centered design, the first step of which is to identify the needs and objectives of the target population to build solutions, may be a suitable approach to anticipate

population health communication and digital health needs rather than keeping up with them. Human-centered design may also provide opportunities to build models that account for the challenges in the journey to patient safety, while fostering health equity through innovation and focusing on people's concrete needs and experiences while redesigning complex systems (99).

Health and digital literacies represent paths that lead to health equity by enhancing effective communication, empowering people to make informed health decisions, and addressing age-related health disparities, lower educational attainment, and socioeconomic status. Each literacy factor (narrative, numeracy, literacy) is essential. The need to communicate accurately and ubiquitously, using linguistic and cultural competence, is a need that will continue to grow in magnitude and complexity. Public health is global health, and literacy factors need to be articulated and synchronized with the current and upcoming needs we will face as a global society with infectious and chronic diseases. The foundational presence of laboratory testing and its iterative nature makes a case for clear communication regardless of patient demographics.

The evolving TTP model presents an opportunity to acknowledge health literacy's role in enhancing patient participation in the laboratory testing process. Accessing and understanding laboratory test results should enable patients to follow a decision-making process resulting in actionable behavior toward health and healthcare. The multidimensional nature of literacy skills demands fine-tuning the message and providing clear, actionable options for patients to customize their decisions and behaviors based on their needs and context.

Despite the recent progress in health literacy as a social determinant of health, the evolving nature of public health needs and challenges that lie ahead warrant more comprehensive solutions to foster measurable and lasting impacts.

Finally, the relevance of laboratory testing in the diagnostic and therapeutic processes is paramount. Thus, timely and accurate access to laboratory testing results is essential for both clinicians and patients. For patients, added layers of difficulties (e.g., digital divide, limited language proficiency) are compounded by the already low health literacy skills in the general population. Systematic approaches that respond to literacy needs ensuring effective communication through culturally and linguistically appropriate resources, as well as contextualized information to interpret laboratory data and potential actions, are warranted.

Nonstandard Abbreviations

TTP	Total Testing Process
LEP	limited English proficiency
RI	reference interval

REFERENCES

1. Shotorbani KR, Swanson KM, Bailey B. Future role of the clinical lab in population health. *Popul Health Manag* 2021;25:692–4. [PubMed: 34388356]
2. Swanson K, Dodd MR, VanNess R, Crossey M. Improving the delivery of healthcare through clinical diagnostic insights: a valuation of laboratory medicine through “Clinical Lab 2.0”. *J Appl Lab Med* 2018;3:487–97. [PubMed: 33636908]
3. Lippi G, Plebani M. The critical role of laboratory medicine during coronavirus disease 2019 (COVID-19) and other viral outbreaks. *Clin Chem Lab Med* 2020;58:1063–9. [PubMed: 32191623]
4. American Society for Clinical Laboratory Science. Value of clinical laboratory services in health care. *Clin Lab Sci* 2013 Winter 2013;26:8–9.
5. Zhang Z, Lu Y, Kou Y, Wu DT, Huh-Yoo J, He Z. Understanding patient information needs about their clinical laboratory results: a study of social Q&A site. *Stud Health Technol Inform* 2019;264:1403–7. [PubMed: 31438157]
6. Cohen JF, Korevaar DA, Altman DG, Bruns DE, Gatsonis CA, Hooft L, et al. STARD 2015 Guidelines for reporting diagnostic accuracy studies: explanation and elaboration. *BMJ Open* 2016;6:e012799.
7. MedlinePlus. How to understand your lab results. <https://medlineplus.gov/lab-tests/how-to-understand-your-lab-results/> (Accessed January 2023).
8. National Cancer Institute. Pathology reports. <https://www.cancer.gov/about-cancer/diagnosis-staging/diagnosis/pathology-reports-fact-sheet> (Accessed January 2023).
9. Sikaris KA. Enhancing the clinical value of medical laboratory testing. *Clin Biochem Rev* 2017;38:107. [PubMed: 29332975]
10. Turner K, Hong Y-R, Yadav S, Huo J, Mainous AG. Patient portal utilization: before and after stage 2 electronic health record meaningful use. *J Am Med Inform Assoc* 2019;26:960–7. [PubMed: 30947331]
11. The White House. Executive order on advancing racial equity and support for underserved communities through the federal government. <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government/> (Accessed October 2022).
12. U.S. Department of justice. *LEP.gov*. <https://www.lep.gov/> (Accessed October 2022).
13. Rodriguez JA, Shachar C, Bates DW. Digital inclusion as health care — supporting health care equity with digital-infrastructure initiatives. *N Engl J Med* 2022;386:1101–3. [PubMed: 35302722]
14. Lundberg GD. Acting on significant laboratory results. *JAMA* 1981;245:1762.
15. Lundberg G How clinicians should use the diagnostic laboratory in a changing medical world. *Clin Chim Acta* 1999;280:3–11. [PubMed: 10090519]
16. Plebani M, Laposata M, Lundberg GD. The brain-to-brain loop concept for laboratory testing 40 years after its introduction. *Am J Clin Pathol* 2011;136:829–33. [PubMed: 22095366]
17. Crawford JM, Shotorbani K, Sharma G, Crossey M, Kothari T, Lorey TS, et al. Improving American healthcare through “Clinical Lab 2.0”: a Project Santa Fe report. *Acad Pathol* 2017;4:2374289517701067.
18. Plebani M. Total testing process: roots and state-of-the-art. *Diagnosis* 2020;7:19–20. [PubMed: 31573957]
19. Lubin IM, Astles JR, Bunn JD, Cornish NE, Lazaro G, Marshall AA, et al. The clinical laboratory is an integral component to healthcare delivery: an expanded representation of the total testing process. [Epub ahead of print] *Am J Clin Pathol* April 27, 2023 as doi: 10.1093/ajcp/aqad038.
20. Rademakers J, Heijmans M. Beyond reading and understanding: health literacy as the capacity to act. *Int J Environ Res Public Health* 2018;15:1676. [PubMed: 30087254]
21. Sørensen K, Van Den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, Brand H. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health* 2012;12:80. [PubMed: 22276600]

22. Centers for Disease Control and Prevention. What is health literacy? <https://www.cdc.gov/healthliteracy/earn/index.html> (Accessed October 2022).
23. U.S. Department of Health and Human Services. Healthy people 2030 framework. <https://health.gov/healthypeople/about/healthy-people-2030-framework> (Accessed June 2022).
24. Nutbeam D, Lloyd JE. Understanding and responding to health literacy as a social determinant of health. *Annu Rev Public Health* 2021;42:159–73. [PubMed: 33035427]
25. Netemeyer RG, Dobolyi DG, Abbasi A, Clifford G, Taylor H. Health literacy, health numeracy, and trust in doctor: effects on key patient health outcomes. *J Consum Aff* 2020;54:3–42.
26. Stormacq C, Wosinski J, Boillat E, Van Den Broucke S. Effects of health literacy interventions on health-related outcomes in socioeconomically disadvantaged adults living in the community: a systematic review. *JBIEvidence Synthesis* 2020;18:1389–469. [PubMed: 32813388]
27. Talley J. Moving from the margins: the role of narrative and metaphor in health literacy. *J Commun Healthc* 2016;9:109–19.
28. Foster B, Krasowski MD. The use of an electronic health record patient portal to access diagnostic test results by emergency patients at an academic medical center: retrospective study. *J Med Internet Res* 2019;21:e13791. [PubMed: 31254335]
29. Weiss BD. Health literacy and patient safety: Help patients understand. Manual for Clinicians. 2nd Ed. Chicago (IL): American Medical Association; 2007.
30. Daraz L, Morrow AS, Ponce OJ, Farah W, Katabi A, Majzoub A, et al. Readability of online health information: a meta-narrative systematic review. *Am J Med Qual* 2018;33:487–92. [PubMed: 29345143]
31. Flores AL, Meunier J, Peacock G. Voices from the field “Include Me”: implementing inclusive and accessible communication in public health. *Assist Technol Outcomes Benefits* 2022;16:104–10. [PubMed: 37180816]
32. Meppelink CS, Smit EG, Buurman BM, van Weert JC. Should we be afraid of simple messages? The effects of text difficulty and illustrations in people with low or high health literacy. *Health Commun* 2015;30:1181–9. [PubMed: 26372031]
33. U.S. Department of justice. The Plain Writing Act of 2010. <https://www.justice.gov/open/plain-writing-act> (Accessed October 2022).
34. U.S. Congress. S.717 - Clear and Concise Act of 2023. <https://www.congress.gov/bill/118th-congress/senate-bill/717/text> (Accessed May 2023).
35. U.S. Census Bureau. Census Bureau reports at least 350 languages spoken in U.S. homes <https://www.census.gov/newsroom/archives/2015-pr/cb15-185.htm> (Accessed October 2022).
36. U.S. Census Bureau. DP02: selected social characteristics in the United States. <https://data.census.gov/table?tid=ACSDP5Y2021.DP02&hidePreview=true> (Accessed October 2022).
37. U.S. Department of Health and Human Services. Civil Rights Requirements- A. Title VI of the Civil Rights Act of 1964, 42 U.S.C. 2000d et seq. (“Title VI”). <https://www.hhs.gov/civil-rights/for-individuals/special-topics/needy-families/civil-rights-requirements/index.html> (Accessed October 2022).
38. U.S. Department of Justice. Executive Order 13166. <https://www.justice.gov/crt/executive-order-13166> (Accessed October 2022).
39. Office of Minority Health. National CLAS Standards. <https://thinkculturalhealth.hhs.gov/CLAS/> (Accessed October 2022).
40. U.S. Department of Health and Human Services. Clinical Laboratory Improvement Advisory Committee (CLIAC) October 28–29, 2020 Summary Report. https://www.cdc.gov/cliac/docs/summary/cliac_summary_oct2020.pdf (Accessed October 2022)
41. Grossman LV, Masterson Creber RM, Benda NC, Wright D, Vawdrey DK, Ancker JS. Interventions to increase patient portal use in vulnerable populations: a systematic review. *J Am Med Inform Assoc* 2019;26:855–70. [PubMed: 30958532]
42. Madison B, Lazaro G, Scott M, Greene LD, De Jesús V. Effective access to laboratory test results: a health equity issue that enhances diagnostic excellence. *J Appl Lab Med* 2023;8:635–44. [PubMed: 36722002]

43. Pillemer F, Price RA, Paone S, Martich GD, Albert S, Haidari L, et al. Direct release of test results to patients increases patient engagement and utilization of care. *PLoS One* 2016;11:e0154743. [PubMed: 27337092]
44. Reynolds TL, Ali N, Zheng K. What do patients and caregivers want? A systematic review of user suggestions to improve patient portals. In: *AMIA annual symposium proceedings*; Virtual. Washington (DC): American Medical Informatics Association; 2020. p. 1070–1079.
45. Zhang Z, Citardi D, Xing A, Luo X, Lu Y, He Z. Patient challenges and needs in comprehending laboratory test results: mixed methods study. *J Med Internet Res* 2020;22:e18725. [PubMed: 33284117]
46. U.S. Department of Education. U.S. Skills Map: State and County Indicators of Adult Literacy and Numeracy. <https://nces.ed.gov/surveys/piaac/skillsmap/> (Accessed October 2022).
47. SteelFisher GK, Caporello HL, Lubell KM, Ben-Porath EN, Green AR, Luo F, et al. Getting critical information during the COVID-19 pandemic: experiences of Spanish and Chinese speakers with limited English proficiency. *Health Secur* 2022;20:273–85. [PubMed: 35771967]
48. Centers for Disease Control and Prevention. Numeracy. <https://www.cdc.gov/healthliteracy/researchevaluate/numeracy.html> (Accessed October 2022).
49. Hutmacher F, Reichardt R, Appel M. The role of motivated science reception and numeracy in the context of the COVID-19 pandemic. *Public Underst Sci* 2022;31:19–34. [PubMed: 34596464]
50. Lau NT, Wilkey ED, Soltanlou M, Lagacé Cusiak R, Peters L, Tremblay P, et al. Numeracy and COVID-19: examining interrelationships between numeracy, health numeracy and behaviour. *R Soc Open Sci* 2022;9:201303. [PubMed: 35308625]
51. Roozenbeek J, Schneider CR, Dryhurst S, Kerr J, Freeman ALJ, Recchia G, et al. Susceptibility to misinformation about COVID-19 around the world. *R Soc Open Sci* 2020;7:201199. [PubMed: 33204475]
52. O’Sullivan K, O’Meara N, Goos M, Conway P. How COVID-19 has reinforced the importance of a numerate society. *Ir Educ Stud* 2021;40:341–7.
53. López-Pérez B, Barnes A, Frosch DL, Hanoch Y. Predicting prostate cancer treatment choices: the role of numeracy, time discounting, and risk attitudes. *J Health Psychol* 2017;22:788–97. [PubMed: 26613709]
54. Smith SG, Kobayashi LC, Wolf MS, Raine R, Wardle J, Von Wagner C. The associations between objective numeracy and colorectal cancer screening knowledge, attitudes and defensive processing in a deprived community sample. *J Health Psychol* 2016;21:1665–75. [PubMed: 25512199]
55. Schapira MM, Fletcher KE, Ganschow PS, Jacobs EA, Walker CM, Smallwood AJ, et al. Improving communication in breast cancer treatment consultation: use of a computer test of health numeracy. *J Women’s Health* 2019;28:1407–17.
56. Prensky M Digital natives, digital immigrants part 1. *On the Horizon* 2001;9:1–6.
57. Evangelista L, Steinhubl SR, Topol EJ. Digital health care for older adults. *Lancet* 2019;393:1493. [PubMed: 30983579]
58. van Kessel R, Wong BLH, Clemens T, Brand H. Digital health literacy as a super determinant of health: more than simply the sum of its parts. *Internet Interv* 2022;27:100500. [PubMed: 35242586]
59. Bricchetto G, Pedullà L, Podda J, Tacchino A. Beyond center-based testing: understanding and improving functioning with wearable technology in MS. *Mult Scler J* 2019;25:1402–11.
60. Carroll NM, Blum-Barnett E, Madrid SD, Jonas C, Janes K, Alvarado M, et al. Demographic differences in the utilization of clinical and direct-to-consumer genetic testing. *J Genet Couns* 2020;29:634–43. [PubMed: 31749259]
61. Dadkhah M, Mehraeen M, Rahimnia F, Kimiafar K. Use of internet of things for chronic disease management: an overview. *J Med Signals Sens* 2021;11:138. [PubMed: 34268102]
62. Nasser AR, Hasan AM, Humaidi AJ, Alkhayyat A, Alzubaidi L, Fadhel MA, et al. Iot and cloud computing in health-care: a new wearable device and cloud-based deep learning algorithm for monitoring of diabetes. *Electron* 2021;10:2719.
63. Kutner M, Greenburg E, Jin Y, Paulsen C. The health literacy of America’s adults: Results from the 2003 national assessment of adult literacy. NCES 2006-483. Washington (DC): National Center for Education Statistics; 2006.

64. U.S. Department of Education. Adult Literacy in the United States. <https://nces.ed.gov/pubs2019/2019179/index.asp> (Accessed October 2022).
65. United Nations. 4 - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. <https://sdgs.un.org/goals/goal4> (Accessed October 2022).
66. United Nations. Progress Towards the Sustainable Development Goals - Report of the Secretary-General. United Nations. https://sustainabledevelopment.un.org/content/documents/29858SG_SDG_Progress_Report_2022.pdf (Accessed October 2022)
67. Abel T, McQueen D. Critical health literacy in pandemics: the special case of COVID-19. *Health Promot Int* 2021;36:1473–81. [PubMed: 33351138]
68. Samuels-Kalow ME, De Souza HG, Neuman MI, Alpern E, Marin JR, Hoffmann J, et al. Analysis of racial and ethnic diversity of population served and imaging used in US children's hospital emergency departments. *JAMA Netw Open* 2022;5:e2213951. [PubMed: 35653156]
69. Houston AJ, Hoover DS, Correa-Fernández V, Strong LL, Heppner WL, Vinci C, et al. Associations of acculturation with English- and Spanish-language health literacy among bilingual Latino adults. *Health Lit Res Pract* 2019;3:e81–9. [PubMed: 31294309]
70. Yeheskel A, Rawal S. Exploring the 'patient experience' of individuals with limited English proficiency: a scoping review. *J Immig Minor Health* 2019;21:853–78.
71. Agency for Healthcare Research and Quality. 2021 National Healthcare Quality and Disparities Report. <https://www.ahrq.gov/research/findings/nhqdr/nhqdr21/index.html> (Accessed October 2022).
72. Gal I, Grotluschen A, Tout D, Kaiser G. Numeracy, adult education, and vulnerable adults: a critical view of a neglected field. *ZDM* 2020;52:377–94. [PubMed: 32292526]
73. Giardina TD, Baldwin J, Nystrom DT, Sittig DF, Singh H. Patient perceptions of receiving test results via online portals: a mixed-methods study. *J Am Med Inform Assoc* 2018;25:440–6. [PubMed: 29240899]
74. Zikmund-Fisher BJ, Scherer AM, Witteman HO, Solomon JB, Exe NL, Fagerlin A. Effect of harm anchors in visual displays of test results on patient perceptions of urgency about near-normal values: experimental study. *J Med Internet Res* 2018;20:e98. [PubMed: 29581088]
75. Friedberg RC, Souers R, Wagar EA, Stankovic AK, Valenstein PN. The origin of reference intervals: a College of American Pathologists Q-Probes study of "normal ranges" used in 163 clinical laboratories. *Arch Pathol Lab Med* 2007;131:348–57. [PubMed: 17516737]
76. Ozarda Y, Higgins V, Adeli K. Verification of reference intervals in routine clinical laboratories: practical challenges and recommendations. *Clin Chem Lab Med* 2019;57:30–7.
77. Alnor AB, Vinholt PJ. Paediatric reference intervals are heterogeneous and differ considerably in the classification of healthy paediatric blood samples. *Eur J Pediatr* 2019;178:963–71. [PubMed: 30997593]
78. Fraccaro P, Vigo M, Balatsoukas P, Van Der Veer SN, Hassan L, Williams R, et al. Presentation of laboratory test results in patient portals: influence of interface design on risk interpretation and visual search behaviour. *BMC Med Inform Decis Mak* 2018;18:1–12. [PubMed: 29301576]
79. Barrow JM, Brannan GD, Khandhar PB. Research ethics. StatPearls [Internet]. Washington (DC): StatPearls Publishing; 2021.
80. Clark LT, Watkins L, Piña IL, Elmer M, Akinboboye O, Gorham M, et al. Increasing diversity in clinical trials: overcoming critical barriers. *Curr Probl Cardiol* 2019;44:148–72. [PubMed: 30545650]
81. Vilson FL, Schmidt B, White L, Soerensen SJC, Ganesan C, Pao AC, et al. Removing race from eGFR calculations: implications for urologic care. *Urology* 2021;162:42–8. [PubMed: 33798557]
82. American Association of Clinical Chemistry (AACC). AACC guidance document on chronic kidney disease diagnosis-improving equity in chronic kidney disease 2022. <https://www.aacc.org/science-and-research/-/media/FB681BDD9D51425BAD622172B08F7E9B.ashx> (Accessed March 2023).
83. Delgado C, Baweja M, Crews DC, Eneanya ND, Gadegbeku CA, Inker LA, et al. A unifying approach for GFR estimation: recommendations of the NKF-ASN task force on reassessing the inclusion of race in diagnosing kidney disease. *Am J Kidney Dis* 2022;79:268–88. [PubMed: 34563581]

84. Durán-Vega LA, Santana-Mancilla PC, Buenrostro-Mariscal R, Contreras-Castillo J, Anido-Rifón LE, García-Ruiz MA, et al. An IoT system for remote health monitoring in elderly adults through a wearable device and mobile application. *Geriatrics* 2019;4:34. [PubMed: 31067819]
85. Olczuk D, Priefer R. A history of continuous glucose monitors (CGMs) in self-monitoring of diabetes mellitus. *Diabetes Metab Syndr* 2018;12:181–7. [PubMed: 28967612]
86. Jackson MA, Ahmann A, Shah VN. Type 2 diabetes and the use of real-time continuous glucose monitoring. *Diabetes Technol Ther* 2021;23(Suppl 1):S27–34. [PubMed: 33534631]
87. Bode B, King A, Russell-Jones D, Billings LK. Leveraging advances in diabetes technologies in primary care: a narrative review. *Ann Med* 2021;53:805–16. [PubMed: 34184589]
88. Agency for healthcare research and quality. Health literacy universal precautions toolkit. <https://www.ahrq.gov/health-literacy/improve/precautions/index.htm> (Accessed October 2022).
89. Centers for Disease Control and Prevention. Health literacy. <https://www.cdc.gov/healthliteracy/index.htm> (Accessed October 2022).
90. Centers for Disease Control and Prevention. The CDC Clear Communication Index. <https://www.cdc.gov/ccindex/index.html> (Accessed October 2022).
91. Lab Tests Online. Global Sites. <https://labtestsonline.org.uk/global-sites> (Accessed January 2023).
92. Health Resources and Services Administration. Health literacy. <https://www.hrsa.gov/about/organization/bureaus/ohe/health-literacy> (Accessed October 2022).
93. Office of Disease Prevention and Health Promotion. Health literacy online: A guide for simplifying the user experience. <https://health.gov/healthliteracyonline/> (Accessed October 2022).
94. U.S. Department of Health and Human Services. National action plan to improve health literacy. <https://health.gov/our-work/national-health-initiatives/health-literacy/national-action-plan-improve-health-literacy> (Accessed October 2022).
95. PlainLanguage.gov. Federal plain language guidelines. <https://www.plainlanguage.gov/guidelines/> (Accessed October 2022).
96. Suckiel SA, Braganza GT, Aguiñiga KL, Odgis JA, Bonini KE, Kenny EE, et al. Perspectives of diverse Spanish-and English-speaking patients on the clinical use of polygenic risk scores. *Genet Med* 2022;24:1217–26. [PubMed: 35380538]
97. Venkatesan T, Naqvi D, Patel B. Deconstructing language barriers in healthcare: where are we going wrong? *Postgrad Med J* 2022;98:157–8. [PubMed: 37063072]
98. Tolan NV. Health literacy and the desire to manage one's own health. *Clin Lab Med* 2020;40:1–12. [PubMed: 32008634]
99. Carayon P, Wooldridge A, Hoonakker P, Hundt AS, Kelly MM. SEIPS 3.0: human-centered design of the patient journey for patient safety. *Appl Ergon* 2020;84:103033. [PubMed: 31987516]
100. Melles M, Albayrak A, Goossens R. Innovating health care: key characteristics of human-centered design. *Int J Qual Health Care* 2021;33(Suppl 1):37–44. [PubMed: 33068104]

IMPACT STATEMENT

This manuscript examines the impact of health literacy factors on patient access and understanding of laboratory test results and presents resources readily available to address literacy-related challenges. Health literacy is critical in patients' understanding of health communication and health-related decision-making, thus broadly affecting populations, particularly populations with low health literacy and specific social determinants of health (e.g., age, limited English proficiency, educational attainment, income). Although access to laboratory test results in patient portals is widely available, patients frequently experience disparities in accessing and understanding health communication efforts effectively, thus hampering actionable steps to improve their health outcomes.

Table 1.

Health literacy resources.

Site ^a	Features	Language	Potential use
AHRQ Health Literacy Universal Precautions Toolkit (88)	Guides, toolkit, resources	English	Train laboratory staff members on health literacy concepts and updated guidelines. Implementing patient communication designs based on plain writing and accounting for health literacy factors.
CDC's Health literacy website (89)	Health literacy activities by state, planning tools, guidelines, laws, standards, program evaluation tools, research	English	Train staff with health literacy concepts and current evidence. Use evaluation tools to assess reach and success of patient communication designs.
Clear Communication Index (90)	Writing guides, recommendations, resources	English	Implementing patient communication designs based on plain writing and accounting for health literacy factors.
Lab Test Online—Global websites (91)	Laboratory testing information, conditions, diseases, health screening	English, Spanish, Italian, French, Portuguese, Greek, Turkish, Czech, Hungarian, Polish	Provide information to patients to help with contextualization and understanding of results and next actions.
HRSA's Health literacy (92)	Definitions, reports, resources	English	Train laboratory staff members on health literacy concepts and updated guidelines.
Limited English Proficiency website (12)	Data, language maps, language access planning, laws, and regulations, I Speak Cards and resources	English, Armenian, Chinese (Traditional), Chinese (Simplified), French, Hmong Lao, Romanian, Tagalog, Arabic, Chuukese, Haitian Creole, Khmer/Cambodian, Portuguese, Russian, Urdu Farsi, Hindi, Korean, Punjabi, Spanish, Vietnamese	Train laboratory staff members on language access concepts and guidelines. Implementing language access plans and resources systemically in patient portals.
ODPHP's Health literacy online (93)	Writing guide for health information	English	Train laboratory staff members on health literacy concepts and writing guidelines.
U.S. Department of Health and Human Services (94)	National Action Plan to Improve Health Literacy	English	Train laboratory staff members on health literacy concepts, regulations, and guidelines.
U.S. Government's Plain Language website (95)	Guidelines, training, resources	English	Train laboratory staff members on plain writing. Implement system-wide use of plain writing principles to enhance readability of health communication documents, reports, and portals.

^aAHRQ, Agency for Healthcare Research and Quality; CDC, Centers for Disease Control and Prevention; HRSA, Health Resources and Services Administration; ODPHP, Office of Disease Prevention and Health Promotion.