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Review Article

Cognitive factors impacting patient understanding of laboratory test information

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ABSTRACT

Laboratory testing can provide information useful to promote patient health literacy and ultimately patient well-being. The human state of mind involves not only cognition but also emotion and motivation factors when receiving, processing, and acting upon information. The cognitive load for patients acquiring and processing new information is high. Modes of distribution can affect both attention to and receipt of information. Implicit unconscious biases can affect whom and what patients believe. Positive wording and framing of information with salience for patients can evoke positive emotions. Providing patients with the gist, or essential meaning, of information can positively influence decision-making. What laboratorians provide as information helps to combat mis- and disinformation. Laboratorians can actively participate in measures to improve the patient experience in health care by developing and contributing to high-quality information to enable timely, meaningful communication and interpretation of test results.

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Introduction

The information laboratorians provide with test results can enable patients through their health care providers to achieve health literacy and understand basic health information and services need to make appropriate decisions regarding their own health. How we present laboratory test result information to providers and patients, and what factors aid or impede acquiring quality information can affect promotion of good health.[1]

Biomedical informatics is the science of information, where information is defined as data with meaning, with the challenge to help providers and patients discover, accept, store, process, and retrieve meaningful information. There are implications for patients' safety and security as well as their perceived quality of care, respect for their beliefs, and subsequent actions taken to improve their health.[2]

Patients may seek to be partners in decision-making for their health care. Patient motivation for test requests may relate to high hopes for tests as a diagnostic tool, an assumption that the tests yield a great deal of information, belief that they provide proof of a good health status, and that they allow serious diseases to be detected at an early stage without mistakes.[3]

What influences acceptance of the information laboratorians provide, and how can we better enable others to use our information effectively?

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Health literacy

Personal health literacy has been defined as 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. Organizational health literacy is defined as the degree to which organizations equitably enable individuals to find, understand, and use information and services to inform health-related decisions and actions for themselves and others. Key recommendations include using plain language in the target audience's preferred language and communication channels using culturally and linguistically appropriate language.[4]

However, the National Assessment of Adult Literacy survey found that only 12% of U.S. adults had proficient health literacy, while 35% had basic or below basic health literacy. Factors contributing to lower socioeconomic status had a negative effect. Persons most likely to benefit from health care interventions were less likely to obtain them, especially in the context of increased marketing of direct-to-consumer testing (DTC).[5]

Health literacy and patient safety with reduction in diagnostic errors can be enhanced through interactions of patients and providers when laboratorians contribute to an understanding of test ordering, timely reporting, and appropriate interpretation. Health literacy for diabetic monitoring with test results has developed over time with guidance of health care professionals. Conversely, marketing of genetic testing to the public has been been shown to have ineffective result reporting, with risk assessment not well-understood or apparent to consumers.[5,6]

Patient satisfaction may be enhanced when the purpose of the test along with results interpretation and guidance is shared, along with explanation of both abnormal or normal results, and preferences for timeliness and means of communication are honored. One study showed that 98% of participants preferred to be notified by short message service when their laboratory test results were ready, and all preferred to receive their test results online, stating advantages of time savings and lowering the chance of missing the results.[7] Providing patients with electronic access to their medical information with adoption of patient portals can potentially improve quality of care, but with the expectation patients would be contacted concerning abnormal and sensitive results. Without an explanation of test results, patients can remain worried. Uncertainty about the meaning or accuracy of results may lead to additional unnecessary medical visits and diagnostic procedures. Patients may adopt either a proactive "consumerist" approach that pursuing test results is their own responsibility, or a more passive, reactive stance and feel it is the responsibility of the health care provider to communicate results. More consistent information delivered by provider staff with appropriate training may help address the potential imbalance between proactive and passive patients.[8]

Health care providers may be concerned about patient anxiety with confusion accessing abnormal test results online. In one study, very few patients experienced this emotion. Those who did experience anxiety received results they considered to be sensitive, or of high emotional impact, because they were related to suspicion of cancer.[9]

Cognitive load

Cognition involves all forms of knowing and awareness, such as perceiving, conceiving, remembering, reasoning, judging, imagining, and problem solving.[10] The amount of information our brains must process constitutes cognitive load, which can be both intrinsic to processing by the brain and extrinsic from obtaining the information. Intrinsic and extrinsic cognitive loads are additive, while germane load modifies both (Table A.1). If a patient were provided raw data from an online health record portal, sifting through the novel information without a working knowledge of meaning would be daunting.[1,11]

If we are trying to be receptive to information, both information-seeking and use are modified by cognitive processes and require mental manipulation of the data. Short-term acquisition of new information is limited to only 5–9 separate pieces; only 2– 4 of these pieces can be processed simultaneously, and only for a few seconds. Long-term memory developed over time supplies immediate access to multiple informational items simultaneously, and this is expertise which health care providers may possess, but patients do not.[12]

Modes of acquiring new information can be processed separately in the brain to reduce cognitive load. More than one mode can be used at a time. Instructional videos, for example, can provide patient education on the interpretation of common laboratory tests such as hemoglobin A1C and glucose values distributed as print. A video can provide a learning resource for a kinesthetic technique such as glucometer usage or insulin injection, followed by hands on coaching. For laboratory test result reporting, information transfer largely remains in print form with the reading mode of acquisition. Good practices for effective information retrieval with modes of learning are shown in Table A.2.[1,11,12]

Contextual biases and processing of information

Humans can be guided by trust in the science behind health care, but are not immune to a multitude of external, environmental influences affecting our thoughts and actions. Human cognition is influenced in many ways. Most of our mental processing takes place unconsciously, leaving less than 10% of decisions we make each day based upon conscious, rational thought. The rest are based upon automatic responses generated from a lifetime of experiences. We develop biases, good or bad, which guide immediate responses to most day-to-day situations requiring a decision, a very efficient way to deal with the demands of a multitude of everyday life events.[13] These biases are pervasive and can either be positive or negative as shown in Table A.3.[14,15,16,17,18,19]

Despite limitations of human cognition and influence of biases, access to laboratory reports can aid patients in reviewing their test results. Most patients will use a patient portal to view their test results, some will want to download the information, and some go on to transmit results to someone else. Most will use results to facilitate discussions with health care providers and to make treatment decisions.[20]

In our modern information age, there is considerable competition for attention to the information laboratorians provide. Misinformation has been defined as information initially presented as valid but subsequently retracted or corrected. Even reputable scientific journals have had to issue retractions and corrections. Disinformation has been defined as intentional propagation of false or misleading information. On the receiving end, an ignorant person is defined as having insight to realize the lack of appropriate information. A person who is misinformed may have confidence in acceptance of false information, but not realize it is false. Thus, the ability to perceive and receive quality information is hampered by an increasing amount of conflicting sources and by awareness or analysis of one's own thought processes with insight (metacognition).[15]

Medical mistrust may be rooted in social injustice as well as mistrust at a system-level, and with individual health care providers. Conspiracy beliefs play a role. Electronic sources of information, including social media platforms, constitute potential risk for both mis- and disinformation.[21,22] In laboratory medicine, we strive to apply sound scientific principles with good quality systematic approaches to supplying the best information possible so that those receiving the information have faith in us and trust they can believe in the information that laboratorians provide.

Human behavior can involve thoughts and actions aimed at preserving psychologic well-being. In this context, information-seeking could be perceived as having the potential to obtain benefits and avoid harm. People are more likely to seek information if expecting good news and not bad news. The choice to remain ignorant, as in avoidance of medical screening tests, could avoid a diminished sense of well-being. Ignorance could lead to a better outcome if mis- or disinformation might prompt actions leading to a worse outcome.[23]

Information, once obtained, can be difficult to disregard or forget, influencing future decisions or a sense of well-being. Denial is a psychologic defense mechanism to cope with painful, threatening, overwhelming, or awkward thoughts.[10] In the short-term, it provides a false sense of well-being, but it can lead to delay or avoidance in seeking diagnosis and

treatment of serious illness. Thus, patients may not be inclined to seek or use the information we provide in the manner we expect from our own expert perspective.[23]

Addressing the patient experience

What can laboratorians do to enhance the usage and value of tests results for patients? A survey of patients and physicians noted both groups agreed that providing more information on laboratory test reports had the potential to improve care. Patients wanted more in-depth explanation of the purpose for the tests, what the results meant, and how results informed next steps in their care. Lack of such information prompted patients to seek online resources. Physicians expressed concern that reports need to include cautionary information about potential false-positive or negative results and to prompt patients to contact them with further questions.[24]

Laboratorians can contribute to patient education with health literacy in multiple ways. First, by formatting one's own laboratory information system (LIS) reports, though customization may be limited by proprietary software. Second, collaborate in developing and contributing to high-quality health information web sites, as discussed elsewhere.[25] Third, and the focus of the following discussion, collaborate with stakeholders and focus groups in one's institutional setting to develop test reporting and interpretation schema in patient portals.

The design of a patient portal interface is important because the data may not have meaning for patients lacking prior knowledge built through experience. In addition to reduced health literacy, some patients struggle with numeracy (the ability to use and draw meaning from numbers, worse when more values are displayed at once) or graphical literacy, challenged to interpret basic laboratory test results as raw data or in tables and charts. Use of color-coding as in highway signs or signals (green, yellow, and red) may aid recognition of result value meaning.[26] Table A.4 details key aspects of patient portal development.[27]

What strategies do patients use in searching the internet for information? One study revealed that two-thirds used a symptom-based approach, such as searching on a term such as headache. If patients expected the potential diagnosis to be severe, they tended to use a hypothesis verification strategy to seek out data corresponding to their initial but likely incorrect initial self-diagnosis to confirm their own hypothesis and health beliefs. Self-diagnosing accuracy was related to younger age, the symptom scenario, and the use of high-quality websites. Almost two-thirds of patients shared their internet-derived information with a physician.[28] Laboratorians providing test results can assist patients to find quality sources of health information. A link to a reputable website may be provided in a report or portal.

Patients may employ exploratory gathering information from multiple sources, or exploit information from a single "high-yield" source. These divergent strategies represent opposing demands, balancing the desire to select what seems the richest option (exploitative), against the desire to seek a less familiar option that might turn out to be more advantageous (exploratory) but demands a higher cognitive load. Laboratorians developing and contributing to high-quality websites can positively influence patient education and health literacy.[12,25]

Gist representation of information, the essential meaning perceived by patients, may aid in making health care decisions. Health care providers may support patient decision-making by providing the gist of factual information and what it means for most people most of the time, giving patients both what they need and what they want.[29] In a study of both younger and older persons faced with decision-making, both used gist representations of information along with details of information, and both groups relied more on gist, a tendency increasing with age.[30]

The gist of information is retained more often when positively framed and when the magnitude of outcomes is more polarized, such as 90% success versus 10% failure with a drug lowering hemoglobin A1C, compared with overall 60% success versus 40% failure. Converting numeric data to natural language quantifiers, such as majority or minority, reduces perception of significance of differences in the data.[31] Gist representations are retained in memory longer than verbatim, individual factual representations. Health care interventions designed to facilitate gist-based reasoning favor improved decision-making for adoption of behaviors recommended to reduce health risks, with improved health outcomes. The ability of providers to process complex information into essential meaning supports patient health literacy with decision-making.[32]

Examples of a starting point for developing gist representations of takeaway information are shown in Table A.5. Collaborators working to compose succinct messages accompanying test results may go through multiple iterations of wordsmithing. Finding a point between oversimplified and overly complex messaging, within the comprehension level of the target audience, can be challenging. Ask yourself what you would want to know for your test result.

Conclusions

Laboratorians can actively participate in measures to improve the patient experience by enabling timely, meaningful communication and interpretation of test results. Providing more information to both patients and providers on laboratory reports has the potential to augment health literacy and improve care. Signal whether differences are meaningful or not; and when feasible, provide thresholds for concern and action. Lack of information prompts patients to seek online resources. Laboratorians developing and contributing to high-quality information sources with multiple modes of delivery have the potential to positively influence patient education. Consistently providing quality information that can be distilled to the gist of what it means and positively framed to promote decision-making leading to positive outcomes can combat mis- and disinformation and build trust in us and the information we provide.

Declaration of Competing Interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table A.1
Cognitive load.

Intrinsic load	The number of new information elements (pieces of data) to be processed simultaneously	Modified by element interactivity and conceptual difficulty: how many elements, how complex are the elements, and how closely are they are related to one another. Reduced by breaking down complex tasks into a series of simplified tasks.
Extrinsic load	The cognitive demand of information acquisition by the ways it is received.	High when there is no long-term working memory and when searching for information; high with multitasking.
Germane load	The extent that information resonates with the motivation to expend mental effort in comprehending information.	Modified by perceived level of importance. Reduced by implicit biases, lack of trust in information sources, mental fatigue, and distractions.

Table A.2
Modes of learning inform best practices to provide information.

Mode of learning	Attributes	Best practices
Reading (printed report or electronic device screen display)	An efficient way to distribute information. Requires literacy with language fluency for deciphering the meaning of informational content with the level of complexity presented.	Appropriate size fonts without dense text; break large data into smaller chunks and use lists to organize data elements; clearly identify abnormal values. Use positive wording. Avoid technical jargon; avoid irrelevant information.
Visual (graphical display of static images; or video recording)	Seeing illustrations or watching a video can lessen cognitive demands on working memory to comprehend new information. Less dependent upon language skills.	Judicious use of graphic illustrations in printed reports; format for visual clarity at appropriate magnification for the detail required; avoid overly complex imagery. Adapt for color blindness.
Auditory (hearing a narration)	Hearing while reading or watching a video aids information acquisition to lessen cognitive demand. Requires language fluency.	Provide vocal clarity with even pace, tone, and volume; avoid distracting noise or accent; avoid "talking head" with video.
Kinesthetic (performing a task)	Put into practice what was read, heard, or seen first. Can be combined with coaching.	Provide a private place without distractions; focus on the task, not the surroundings. Repeat as needed.

Table A.3
Cognitive biases influence information reception and processing.

Explicit bias	Attitudes and assumptions we consciously acknowledge as part of our own personal belief systems.
Implicit bias	Unconscious associations, beliefs, or attitudes toward others (prejudice) that can affect our judgment, decisions, and behaviors directed at others as an adaptive means to quickly react to novel or uncertain situations. They are formed through a combination of early experiences, emotions, and learned cultural practices.
Continued influence effect	Information initially presented as true, but later shown to be false, may continue influencing memory and reasoning, with reluctance to dismiss past information without a plausible alternative. If new information is presented to replace initial false information, repeating false information may serve to reinforce it, not replace it.
Illusory truth effect	The more a statement is repeated and becomes familiar, the more likely it is believed, whether true or not, as in mass marketing strategies.
Framing effect	How information is perceived may depend upon whether it is presented as a positive gain or a negative loss.
Salience bias	The perceived value, relevance, and attainability of an outcome of importance can be connected to information being presented, along with the mental effort to comprehend it, emotional resonance with it, and motivation to seek reward using the information.
Motivated reasoning	Searching for facts to support what we want to be true, confirming our beliefs, rather than letting facts guide us to a rationale conclusion. Even scientists are subject to bias supporting positive, conclusive results in experiments and clinical trials when there is reward for positive results, not negative results.

Table A.4
Design elements for patient portal information.

Provide a takeaway message for a test result	The patient wants to know if the test result is good or bad, if the variation up or down in serial results is meaningful, and if a result indicates some action may be needed.
Make reference ranges clear	Provide an explanation that reference ranges typically apply to healthy people, results within range may vary even when healthy, and small changes outside the range may not be serious, and that consultation with a medical professional may help resolve uncertainties.
Promote patient accessibility and usage	Laboratory information may be accessed on multiple devices, from desktop to laptop computers to mobile devices like a smartphone. Web Content Accessibility Guidelines may aid in developing enhanced access. Provide for download of results in standard file formats to retain formatting of graphics, reference ranges, and text.
Provide for conversion of results to other units of measure	Test results may originate from different sources reporting in different units or scales. Patients may get results from different health care providers or institutions. Patient may take results and try to apply them to online sources like risk calculators for result interpretation.
Collaborate with others in development	Employ focus groups of patient end users, both new to and experienced with electronic information access. Collaborate with experts in interface design for diverse audiences, content experts in interpretation of test data, and experienced clinicians who interface in person with patients.

Table A.5
Sample takeaway messages for test result reporting to patients.

Test performed	Your result	Reference range	Interpretation
Hemoglobin A1c (Hgb A1c)	6.6%	Less than 5.7% in healthy people	Your result increased from the last test, and above 6.4% can mean that diabetes mellitus is present. Treatment of diabetes can lower Hgb A1c.
Lead level in blood	53.7 μg/dL	3.5–19.9 μg/dL	Immediate medical attention is needed.
HER2 (ERBB2) for breast cancer	Positive (3+)	Negative or Positive	Positive result enables breast cancer treatment with HER2 specific therapy.
COVID-19 (SARS-CoV-2) by NAA	Positive	Negative	Positive result is a risk for serious illness and passing this virus to others. A positive result can occur if you are not ill, but medical attention is recommended.
Prostate-specific antigen (PSA), total	5.0 ng/mL	0.0–4.0 ng/mL	For your elevated result, an additional free PSA test may be helpful in distinguishing benign conditions like hyperplasia (BPH) from prostate cancer, along with medical evaluation.
Prothrombin time (PT) International Normalized Ratio (INR)	1.5 INR	2.0–3.0 INR	When taking warfarin (coumadin), for an INR below 2 or above 3, medical attention is recommended to determine if the dose needs adjusting.
Cholesterol, total	176 mg/dL	<200 mg/dL (<5.2 mmol/L in SI units)	Your result is good.

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