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Typology of solutions addressing diagnostic disparities: gaps and opportunities

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Abstract

Objectives: Diagnostic disparities are preventable differences in diagnostic errors or opportunities to achieve diagnostic excellence. There is a need to summarize solutions with explicit considerations for addressing diagnostic disparities. We aimed to describe potential solutions to diagnostic disparities, organize them into an action-oriented typology with illustrative examples, and characterize these solutions to identify gaps for their further development.
Methods: During four human-centered design workshops composed of diverse expertise, participants ideated and clarified potential solutions to diagnostic disparities and were supported by environmental literature scan inputs. Nineteen individual semi-structured interviews with workshop participants validated identified solution examples and solution type characterizations, refining the typology.
Results: Our typology organizes 21 various types of potential diagnostic disparities solutions into four primary expertise categories needed for implementation: healthcare systems' internal expertise, educator-, multidisciplinary patient safety researcher-, and health IT-expertise. We provide descriptions of potential solution types ideated as focused on disparities and compare those to existing examples. Six types were characterized as having diagnostic-disparity-focused examples, five as having diagnostic-focused examples, and 10 as only having general healthcare examples. Only three solution types had widespread implementation. Twelve had implementation on limited scope, and six were mostly hypothetical. We describe gaps that inform the progress needed for each of the suggested solution types to specifically address diagnostic disparities and be suitable for the implementation in routine practice.
Conclusions: Numerous opportunities exist to tailor existing solutions and promote their implementation. Likely enablers include new perspectives, more evidence, multidisciplinary collaborations, system redesign, meaningful patient engagement, and action-oriented coalitions.

Keywords: diagnostic disparities; diagnostic excellence; diagnostic error; implementation; collaborations; patient engagement

Introduction

Diagnostic disparities are preventable differences in deadly, dangerous, and costly diagnostic errors or in opportunities to achieve optimal diagnostic experiences and outcomes, or diagnostic excellence [1–3]. If diagnostic excellence is considered to occupy a multidimensional space, where the full space represents the sum of all health benefits that could accrue from achieving diagnostic excellence for every person in every situation, then diagnostic inequity or disparities represent the lack of a fair and just chance to have these benefits [4, 5]. Diagnostic disparities and historic vulnerabilities to diagnostic errors persist among those who are marginalized; socially, economically, demographically, or geographically disadvantaged; and other at-risk populations. They can result in patients from these groups experiencing disproportionate harms, even if overall diagnostic safety and quality is gradually improving [6]. For example, female patients and younger patients have higher odds of misdiagnosis of stroke [7, 8], and Black patients have higher odds of missed myocardial infarction diagnoses [9] and delayed cancer diagnoses [10–12]. Another example of facing diagnostic disparities is the patient's description of their urgent care visit with tooth pain where they were told "it is probably an STI because you're gay" [13].

Literature establishes several roots of diagnostic disparities. Among patient-related roots are lack of information about screening and symptoms among patients, anxiety regarding receiving a diagnosis, distrust toward healthcare systems, and experiences of discrimination or racism

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[14–16]. Among structural and interpersonal roots are failures in patient-provider relationships or communication, biased provider judgments or assumptions about patients, other cognitive biases, or failures in providing diagnostic tests, consultations, or referrals [17–20].

Solutions are being developed and implemented to address diagnostic errors and to improve patient safety in diagnosis [21–24]. However, these solutions have not always been designed with explicit considerations for diagnostic disparities, and the effect of some diagnostic safety and quality interventions on avoiding, exacerbating, or creating new diagnostic disparities is not established. Thus, there is a need for a comprehensive overview of possible diagnostic disparities solutions that focus on needs of the populations facing disparities and strive for diagnostic excellence for everyone.

To address this gap in understanding applicability of existing solutions to diagnostic disparities, we undertook this review. Specifically, we aimed to (1): map the realm of potential solutions to diagnostic disparities and organize them into a typology based on a selected category (2); illustrate these solutions with existing examples and characterize solutions by their focus on diagnostic disparities and estimated state of implementation; and (3) describe gaps that prevent these solutions from being diagnostic disparities-focused and widely implemented.

Methods

Our work on identifying and typologizing diagnostic disparities solutions was conducted within a series of four human-centered design workshops conducted during 2019–2021 and described in detail elsewhere [1]. In brief, 25 participants were recruited via professional networks to gather diverse and equal representation from three groups of stakeholders: patients or patient advocates with lived experience of diagnostic error [8], researchers [8], and clinicians or other healthcare professionals with expertise or interest in the field of diagnostic errors [9]. Following human-centered design principles, participants were first provided with an evidence base around diagnostic disparities and disproportionately affected historically marginalized patients [1, 25, 26]. This evidence base was intended to inform the generation of design challenges (for example, how might we make sure the provider understands the patient's medical concerns and experience?) and ideation of potential solutions. There were no restrictions placed on types of ideated solutions (i.e., inclusive of a wide range of sociotechnical interventions such as tools, technologies, and processes).

The initial set of 29 ideated solutions was produced by participants in response to specific design challenges at the first workshop [1]. Following the first workshop, the research team thematically grouped the ideated solutions into four preliminary categories (1): patient-physician interaction (2), the medical encounter environment (3), health systems workflow, and (4) health information and its accessibility. At subsequent workshops, the research team elicited additional input on each group, asking participants to clarify or add solutions [1]. The descriptions of 26 out of 29 initial solutions were further developed, and 11 new solutions were added. Finally, the research team members reviewed related literature and identified five additional solution ideas [24]. Thus, the broader set of ideated solutions extended beyond responding to the initial design challenges.

Subsequently, the solutions were sorted by types and assigned into a draft typology by research team members. This draft typology was an alternative to earlier thematic grouping and categorized solutions by primary expertise required for solution implementation to align with an action-orientation. The research team then conducted environmental scans to identify existing US healthcare examples of solutions that might illustrate and approximate solutions in the typology. We further reviewed available evidence on whether identified examples mitigate or exacerbate diagnostic disparities in the vulnerable groups and descriptively summarized our findings. Based on the availability of examples, the state of each solution type was characterized by its closest specificity to the focus on diagnostic disparities (as diagnostic disparity-focused, diagnostic-focused, or general, with no diagnostic focus) and the current state of implementation using a three-item scale. The scale levels were estimated based on available examples as (1): no implementation: solutions of mostly hypothetical nature (2); limited implementation: some solutions exist but of a limited scope; or (3) widespread implementation: wide use and uptake of a solution in routine practice (allowing for gradual uptake in rural settings and smaller practices). Our search for available examples followed a hierarchical approach. Such that for those solutions with no identified implementation examples that are diagnostic-disparity focused, diagnostic-focused examples were sought; for solutions with no examples that are diagnostic-focused, general healthcare examples were sought. The research team then reviewed the estimated characterizations of solution types against the descriptions of suggested solutions, as potentially focused on diagnostic disparities, and formulated gaps that prevent all suggested solutions from being diagnostic disparities-focused and widely implemented.

To validate this work, semi-structured individual interviews were conducted virtually with 19 workshop participants to elicit feedback on the typology and identified solution examples. For each solution type, three participants from the three different stakeholder groups but with matching interests and expertise were selected for the interviews. The interviewed participants were asked to provide feedback on the typology draft, identify alternative approaches to the typology organization, comment on the description of the solution type and each identified example for that solution type, and suggest additional or alternative solution examples. Furthermore, after the explanation of our methodology, the interviewed participants were asked to provide feedback on the characterization of the solution type, i.e., its estimated state of implementation and focus, and on the formulated gaps, inquiring for missing or supporting evidence. The interviews were recorded, transcribed, and analyzed by the research team. Additional environmental scans were conducted based on

suggestions in the interviews about missing examples and requested details. The research team made revisions incorporating each participant's input and finalized the typology of diagnostic disparity solutions as well as descriptions and estimations of characterizations of solution types. When any alternative suggestions were offered, the team opted for including all of those.

Results

Typology of diagnostic disparity solutions

We identified 21 types of potential diagnostic disparities solutions and mapped that variety into a typology that organizes the solution types by the primary expertise needed to create, adopt, and implement these solutions (Table 1). This classification by primary expertise does not limit the use of other expertise for implementation. We especially note the requirement of partnering with patients on any of the solutions.

The four conceptualized types of primary expertise for the typology were (1): healthcare systems' internal expertise (2); educators (3); multidisciplinary patient safety researchers; and (4) health information technology (IT) experts. Healthcare systems' internal expertise refers to the diverse implementers of solutions, ranging from internal quality improvement teams, administrative personnel, inward- and outward-facing communication teams, and medical staff leadership. These bodies often have decision-making capabilities that impact resource allocation, patient workflow strategy, culture of a healthcare institution and its public relations. Educators bring expertise as those responsible for creating the curriculum on medical education and standards for delivering patient care within the disciplines, including terminology for communicating these standards. Multidisciplinary patient safety researchers contribute their expertise by advancing a broad spectrum of topics within the realm of patient safety, such as human factors, clinical reasoning, patient experience, and quality measurement. Finally, health IT experts operate the technical aspects of patient health information management. Often, they are responsible for creating, implementing, and troubleshooting electronic health record (EHR) and other systems including algorithms and user-facing interface.

In the sections below, we provide descriptions of potential solution types ideated as specifically focused on diagnostic disparities.

Table 1: Typology of diagnostic disparity solutions.

Primary expertise in creating/ adopting solutions[a]	Solution
Healthcare systems' internal expertise	– Fostering trust – Ensuring diagnostic continuity – Organizational culture – Co-designing solutions – Organizational capacity
Educators	– Ongoing provider training – Medical education – Patient training – Customized information – Doctors' "presence" – Hands-on right language – Visit preparation – Equity communication strategies
Multidisciplinary patient safety researchers	– Checklists and collaborative tools – Enhanced differential diagnosis – Environment redesign – Diagnostic patient-reported measures
Health information technology (IT) experts	– Patient portal solutions – Debiasing existing IT – New anti-cognitive pitfall IT – IT workflow support

[a]In partnership with patients throughout all stages, from ideation to implementation and scaling.

Description of solution types primarily tapping into healthcare systems' internal expertise

This group of potential solutions comprises changes that might facilitate fostering trust, ensuring diagnostic continuity, organizational culture and capacity changes, and processes for co-designing solutions. For instance, internal expertise teams may facilitate trust in both health systems and providers operating within them, leading to patients' trust in the diagnostic process, by opening communication channels, improving consistency in practice, encouraging full disclosure and transparency, and employing a diverse composition of providers reflective of the patient population. Healthcare systems may facilitate diagnostic continuity (personal, informational, and logistical) by creating supports for reliable and individualized follow-ups with patients, taking into account, for example, patients' social determinants of health, vulnerabilities, and levels of

uncertainty of the diagnostic situation. In addition to enabling patients to be active partners in their diagnostic continuity, healthcare systems may empower staff and providers by setting an organizational culture that allows for adjusting workflows based on patient needs. For example, giving providers flexibility during the encounter for diagnostic time-outs, preparation time for diagnostic checklists and collaborative tools, and adjusting the encounter structure as needed. By using both internal and external resources, healthcare systems may expand their organizational capacity and adjust workflows for patient needs, such as increasing interaction opportunities between patients and their care partners with providers pre- and post-encounter, providing preemptively available technical support and interpreter services, as well as support by patient advocates. At the providers and staff side, such expanded organizational capacity may enhance patient triage and workflow management enabling those interaction opportunities. Finally, healthcare systems may also provide outlets that allow communities of healthcare experts and patients to co-design system- and context-specific diagnostic disparities solutions via, for example, workshops, fora for patient-experience sharing, and dedicated Patient & Family Advisory Council (PFAC) meetings. Thus, these workshops, fora, and meetings may become meta-solutions or solutions generating other solutions.

Description of solution types primarily concerning educators

This group of potential solutions comprises changes in ongoing provider training, medical education, patient training, and solutions tackling customized information, doctors' "presence," hands-on right language, visit preparation, and equity communication strategies. For instance, educators may be focusing ongoing training and communication campaigns for providers on biases, vulnerabilities, updating vocabulary, diagnostic uncertainty, and fostering empathetic and transparent communication. Additionally, educators may develop solutions for professional medical education and mentorship, such as formal educational modules on anti-paternalism, anti-racism, and anti-gender biases related to diagnostic disparities. In addition to training for providers, educators may also identify solutions for patient training on matters related to diagnostic uncertainty, developing relationships with healthcare providers, patient rights, and educating patients on their own vulnerabilities. To improve medical information-sharing, educators may create solutions that allow for customized information modality and information representation for patients, including meeting patients' preferences on paper vs. digital formats, adding more visual graphics, and accommodating patients' disabilities and impairments. Educators are primed to devise solutions that foster clinician presence and connection with patients in the context of diagnostic process, such as patients seeing a doctor's computer screen, eliminating hierarchy, and identifying communication barriers. To support routine care, educators may create hands-on tools for providers to facilitate and de-stigmatize conversations about patients' unique experiences as members of certain identity groups. Further, educators may lead the work on updating visit preparation guides, focusing on diagnostic disparities, empowering patients to advocate for themselves and systemize their thoughts prior to a clinical encounter. This empowerment might explore additional modalities for the guides, such as a video format for delivery and voice-recording capabilities for patients to reflect on the visit. Lastly, educators may work toward creating solutions for communicating organizational culture that is flexible, transparent, and patient-centered, such as creating signs that empower patients or physician scripts that offer reminders about biases in diagnosis.

Description of solution types relying on multidisciplinary patient safety research

This group of potential solutions might utilize the expertise of multidisciplinary patient safety researchers to advance checklists and collaborative tools, enhance differential diagnosis, conduct environmental redesign, and develop diagnostic patient-reported measures (PRMs). For instance, diagnostic disparity solutions may include constructing shared checklists and collaborative tools that facilitate diagnostic routine and follow-up encounters. They also may entail enhancing differential diagnosis with the appropriate use of the patient's socio-demographic information and known related pitfalls, specifically supporting transparency about cognitive biases, known diagnostic disparities, and quickly salient diagnostic vulnerabilities. Researchers might create solutions constituting patient-reported experience and outcome measures of their diagnostic process, for example, patient reporting on communication quality, duration of communication, and its sufficiency and clarity.

Other solutions, tapping into research, may focus on redesigning the clinical encounter rooms and telemedicine virtual rooms to facilitate collaboration with patients and combat cognitive pitfalls.

Description of solution types focusing on health IT

Health IT experts are well-positioned for a separate set of potential solutions, such as patient portal solutions, debiasing existing IT, developing new anti-cognitive pitfall IT and IT workflow support for other solutions. For instance, health IT experts may develop solutions to equalize and systematize patient portals in terms of access, needed training, sharing access with care partners, user's agency over portal's content, portal's real-time availability, support, and technology requirements. Health IT experts may also examine health IT systems, such as clinical decision support systems, for algorithm and dataset biasing diagnosis in vulnerable populations. Additionally, health IT experts may create systems for collecting and presenting doctors with known diagnostic pitfalls, such as flagging values or creating predictive analytics that expose pitfalls. Health IT may also develop solutions that support other solutions such as improved and individualized patient workflows, documentation of uncertainty, the use of diagnostic timeouts and checklists, differential diagnosis discussions, provision of additional support to patients with unique needs, consolidated referral system, allowing patient input into diagnostic records, and feedback on their accuracy.

Characterization of solution types

In Table 2 we illustrate one example of how we characterized each solution type from the typology. For each solution type, we present its abbreviated name, description of the solution type, examples of existing solutions of that type, and gaps identified by comparing the examples to the description accompanied by our experts' comments. Finally, each solution type description concludes with a summary that provides an estimated characterization of its current state of focus on diagnostic disparities and the state of solution implementation. Table 2 presents ongoing provider training as one solution type example, and the full descriptions of the rest of 20 solution types that includes detailing of the examples can be found in the Supplemental material.

Table 3 provides an overview of the estimated categorizations of types of diagnostic disparities solutions from the typology. We assessed six solution types as those having existing examples that focus on diagnostic disparities; one of them has widespread implementation (ongoing provider training), one limited implementation (co-designing solutions), and four with no implementation beyond conceptualization. Of those, de-biasing existing health IT and new anti-cognitive pitfall health IT do not have conceptualized examples that are either diagnostic-focused or diagnostic-disparity-focused. Two types have more examples of implementation that are focused on diagnosis than those focused on diagnostic disparities: checklists and collaborative tools (with wide implementation for diagnosis) and enhanced differential diagnosis (limited implementation for diagnosis). Along with those two types, five more, or seven total, were assessed as having existing examples that currently

Table 2: Example of solution type description: ongoing provider training.

Brief name according to the typology
Ongoing provider training
Description of solution
Solutions for ongoing provider training and communication campaign (on biases, on vulnerabilities, on updating vocabulary, uncertainty, empathetic and transparent communication)
Existing solution examples
See Supplemental Material for examples and their detailed descriptions
Identified gaps
– We found sufficient examples of training materials specifically addressing diagnostic disparities, often as a part of health equity in general.
– According to our experts, this training is routinely spreading across health systems; the spread is not equal between large health systems and rural clinical practices or between hospital versus emergency and outpatient settings.
– Our experts noted a need to expand training to nurses and other healthcare specialties.
– To address doubts raised by our experts, there is a need for more evidence whether health equity training in general sufficiently addresses diagnostic disparities occurring in medical subspecialties and is tailored toward their particular diagnostic workflows.
– It was suggested that training modules that are not didactic but provide performance feedback on the type of diagnostic disparities that exist in particular practices might be especially helpful.
– As remarked by our experts, while the availability of training resources is promising, resources enabling and encouraging or mandating their uptake among all clinicians, including leadership, might be a bottleneck.
Summary characterization
– Diagnostic-focused: Yes
– Diagnostic disparity-focused: Yes
– Implementation scale: Wide use and uptake in routine practice (with usual limitations of gradual uptake in rural settings and smaller practices)

Table 3: Diagnostic disparities solutions by their specificity to disparities and state of implementation.

Types of diagnostic disparities solutions	Diagnostic disparity-focused[a]	Diagnostic-focused[a]	General, no diagnostic focus
Ongoing provider training	3		
Co-designing solutions	2		
De-biasing existing health IT	1	the same	
New anti-cognitive pitfall health IT	1	the same	
Checklists and collaborative tools	1	3	
Enhanced differential diagnosis	1	2	
Customized information		2	
Diagnostic patient-reported measures		1	N/A
Visit preparation		1	3
Tailored medical education		1	2
Patient training		1	2
Patient portal solutions			2[b]
Fostering trust			2
Organizational capacity			2
IT workflow support			2
Ensuring diagnostic continuity			2
Doctors' "presence"			2
Environment redesign			2
Organizational culture			1
Hands-on right language			1
Equity communication strategies			1

[a]For those solutions with no implementation examples that are diagnostic-disparity focused, diagnostic-focused were sought, for solutions with no implementation examples that are diagnostic-focused, general healthcare examples were sought. [b]At the time was considered limited implementation, though wider implementation was predicted due to changes in US federal regulations. IT, information technology; N/A, not applicable. Solutions specificity to diagnostic disparities: Diagnostic disparity-focused. Diagnostic-focused. General, no diagnostic focus. Implementation state three-item scale, # inserted in a colored diamond: [#1] No implementation: solutions of mostly hypothetical nature to date. [#2] Limited: some solutions exist but of a limited scope. [#3] Widespread implementation: wide use and uptake in routine practice (with usual limitations of gradual uptake in rural settings and smaller practices).

focus on diagnosis. Of those, customized information has limited implementation for diagnosis, and diagnostic PRMs have no implementation beyond conceptualization when focusing on diagnosis and cannot be applicable to healthcare in general as diagnostic PRMs. Visit preparation, while having no examples of implementation for diagnosis, has wide implementation in healthcare in general. Tailored medical education and patient training solutions are both without implementation for diagnosis but have examples of limited implementation in healthcare in general.

We assessed 13 solution types as those whose existing examples are mostly general (three mentioned above) or only healthcare general [10] with no diagnostic focus and hence no diagnostic disparities focus. Among this last group, seven had limited implementation (solutions involving patient portal, fostering trust, organizational capacity, IT workflow support, ensuring diagnostic continuity, doctors' "presence," and environment redesign) and three had no implementation examples and are only conceptualized (solutions involving organizational culture, hands-on right language, and equity communication strategies).

Identified gaps in suggested solution types

We summarize identified gaps from the vantage point of necessary progress needed for each of the suggested solutions to be diagnostic disparities-focused and widely implemented. Those gap descriptions include remarks by our experts.

Gaps in solution types that have current diagnostic disparities-focused examples

For all solution types in this group, we have not found evidence whether they mitigate or exacerbate diagnostic disparities in the vulnerable groups.

Ongoing provider training. See Table 2.

Co-designing solutions. Meta-solutions allowing communities of healthcare experts and patients to co-design system- and context-specific solutions also enable designing solutions that address diagnostic disparities specifically. These meta-solutions have not become a routine practice but have strong potential and infrastructure of existing patient engagement activities in select places.

Debiasing existing health IT. Except for skin imaging incorporated into routine practice, identified solutions are only at the point of description or initial piloting. However, these solutions can directly address aspects of diagnostic disparities, for example, by tackling specific biases in data and algorithms. It was argued that solutions developed in dermatology for skin biases are not directly transferable to

other clinical disciplines or disparities based on other vulnerabilities.

New anti-cognitive pitfall health IT. Identified examples are within the research or piloting stage and in routine practice. As noted by our experts, current issues with diagnostic-decision supports are that they are labor- and time-intensive and require some physicians to change their decision-making approaches. However, it was suggested that these solutions can directly address aspects of diagnostic disparities.

Checklists and collaborative tools. We found evidence of routine use of shared checklists and collaborative tools that facilitate routine diagnostic encounters. However, these guides are not designed to specifically address diagnostic disparities. No checklists or tools were preparing patients to talk about their vulnerabilities and potential biases they might face, for instance, to initiate transparent discussions with clinicians about their social determinants of health, known diagnostic disparities, and quickly salient vulnerabilities that might lead to biases.

Enhanced differential diagnosis. Enhanced differential diagnosis solutions have limited use in mainstream clinical practice. Among those, solutions specifically designed to address aspects of diagnostic disparities are rare and do not comprehensively include directions for differential diagnosis that considers patients' social determinants of health, known diagnostic disparities, and quickly salient vulnerabilities that might lead to biases.

Gaps in solution types that currently have diagnostic-focused examples

Similarly, for all solution types in this group, we have not found evidence whether they mitigate or exacerbate diagnostic disparities in the vulnerable groups.

Customized information. Identified solutions do not specifically address diagnostic disparities, and we have not found evidence investigating the customization of information for vulnerable groups in the context of diagnostic errors. Existing publicly available solutions allow customizations for low literacy levels, multiple languages, and visual impairments. Identified solutions have limited spread in routine mainstream practice.

Diagnostic PRMs. Known diagnostic PRMs do not specifically address diagnostic disparities and do not penetrate most health systems or are not incorporated into routine mainstream practice. We have not found examples of how measures of patient-reported experiences of diagnostic process, such as communication quality, duration, sufficiency, or clarity, are tailored to address experiences of vulnerable groups.

Visit preparation. We found evidence of the use of visit preparation guides in select healthcare systems, with mixed results of their uptake by patients. These guides are not designed to specifically address diagnostic disparities. No guides are preparing patients to advocate for own health in the context of diagnosis or to talk about their vulnerabilities and potential biases they might face, nor are they tailored to facilitate and de-stigmatize conversations about unique patient identities. Our experts voiced concerns that visit preparation will have lower uptake among those most vulnerable to diagnostic disparities.

Tailored medical education. Several universities implement new paradigms of medical and nursing education that are patient-centered or social-justice-centered and potentially applicable to support reduction in diagnostic disparities; however, this trend has not yet become mainstream. Curricula that specifically focus on diagnostic errors are rarer and being piloted. We have not found examples of "hidden curriculum" activities around diagnostic disparities such as formal or informal mentorship or other fora during medical education.

Patient training. We have identified patient training materials focused on diagnosis experience that do not have mainstream prevalence. No materials focus on or educate patients about diagnostic disparities. Specifically, we have not found examples that would teach patients about their own vulnerabilities and how to communicate with providers about these vulnerabilities.

Gaps in solution types that currently do not have diagnostic-focused examples

Likewise, for all solution types in this group, we have not found evidence whether they mitigate or exacerbate diagnostic disparities in the vulnerable groups.

Patient portal solutions. Identified solutions do not specifically address diagnostic disparities. We have not found evidence investigating patient portal solutions tailored for vulnerable groups in the context of diagnosis. Identified non-specific solutions do not penetrate the majority of health systems or are not incorporated into routine mainstream practice. However, with the implementation of the Office of the National Coordinator for Health Information Technology (ONC) Final Rule on 21st Century Cures Act: Interoperability, Information Blocking, and the ONC Health IT Certification Program, note-sharing is expected to become mainstream rapidly.

Fostering trust. We found no solutions focused on fostering trust in diagnosis. Overall, facilitating trust in health systems and providers is envisioned as leading to trust in the diagnostic process. Empowering patients and

care partners through communication channels, full disclosure, and transparency does not specifically target vulnerable groups. Existing solutions do not penetrate many health systems or are not incorporated into routine practice.

Organizational capacity. Organizational capacity solutions are limited and not focused on incorporating diagnostic-specific workflows; solutions do not penetrate the mainstream healthcare practice. We have not found solutions on triage and workflow management as they relate to diagnostic processes. We have not found complex solutions on expanding organizational capacities to enable adjusting their workflows for patient needs. As remarked by our experts, expanding organizational capacities with external resources is promising and can be tailored to diagnostic disparities.

IT workflow support. Identified solutions are not designed specifically for diagnostic workflows, documenting uncertainty, or addressing diagnostic disparities. They have limited penetration into mainstream clinical practice. We have not found widespread examples of IT workflow supports that routinize documenting diagnostic uncertainty, the use of diagnostic timeouts and checklists, differential diagnosis discussions, or indications of biases.

Ensuring diagnostic continuity. Most solutions are not focused specifically on diagnostic continuity and follow-up. Targeted populations are often identified based on clinical or utilization factors but not vulnerabilities. Our experts noted a lack of common recognition of particular diagnostic vulnerabilities and understanding of factors that enhance or impede diagnostic continuity that might lead to diagnostic disparities. The existing solutions are not incorporated into routine mainstream practice and are not fully utilized. Solutions that rely on patients being active in follow-ups have shown to exacerbate rather than resolve disparities. However, as remarked by our experts, patient navigator network- and technology-enabled safety net program-like solutions have potential to be tailored to solving diagnostic disparities.

Doctors' "presence." Identified solutions do not specifically address diagnostic disparities. We have not found evidence investigating fostering clinician presence with the focus on patients of vulnerable groups specifically and in the context of diagnosis. Identified non-specific solutions do not penetrate the majority of health systems or are not incorporated into routine mainstream practice. As noted by our experts, there are indications of clinicians' time constraints, incentives, and stressors conflicting with fostering connections with patients. At the time, there were no studies establishing the effect of switching to telemedicine visits on diagnostic disparities.

Environment redesign. Current redesigning does not specifically address diagnostic disparities; for example, redesign does not aim to combat cognitive pitfalls. We have not found evidence investigating environmental redesigning tailored for vulnerable groups in the context of diagnosis. Identified non-specific solutions do not penetrate the majority of health systems or are not incorporated into routine mainstream practice, especially in acute care settings.

Organizational culture. Organizational culture solutions are not focused specifically on diagnosis or incorporating diagnostic-specific workflows; solutions are innovative or declarative and do not penetrate mainstream healthcare practice. As noted by our experts, the role of patients and care partners in shaping organizational cultures is usually not described, nor is the role of frontline providers, especially nurses.

Hands-on right language. We only found evidence of preliminary work by health systems to identify racial, ethnic, and linguistic minorities, people with disabilities, and sexual and gender minorities. We have not found solutions that allow providing clinicians with hands-on tools that would facilitate and de-stigmatize conversations about patient's unique experiences belonging to certain identity groups. Thus, we have not established that identification of patients leads to linking clinicians to resources they can immediately use during the clinic encounters to mitigate diagnostic disparities in the vulnerable groups.

Equity communication strategies. We found limited examples of healthcare systems communicating their flexible, transparent, or anti-biased culture. No examples were tailored to diagnostic disparities.

Discussion

We presented a typology organizing 21 types of potential diagnostic disparities solutions by the primary expertise – healthcare systems' internal expertise, educators, multidisciplinary patient safety researchers, and health IT experts – needed to create, adopt, and implement these solutions. For each solution type, we provided a description and existing examples (see Supplemental material) and characterized their state of implementation and current focus on addressing diagnostic disparities. Namely, we characterized less than one-third (6 of 21) as having diagnostic-disparity-focused examples, five as having diagnostic-focused examples, and almost half [10] as only having general healthcare examples. Only three solution types – ongoing provider training (diagnostic-disparity-focused), checklists and collaborative tools (diagnostic-focused), and visit

preparation (general healthcare) – were characterized as having widespread implementation. More than half [12] had been implemented on limited scope, and six were of mostly hypothetical nature. Finally, we described the gaps that inform the progress needed for each of the solution type to specifically address diagnostic disparities and be suitable for the implementation in routine practice.

We developed the typology through an action-oriented lens, given the original workshops' intention to develop solutions to reduce diagnostic disparities in the near term. Undoubtedly, different alternative criteria can be put into classification of the solutions to serve different purposes, and we are encouraged that our work might be utilized for such purposes. We illustrate an example of mapping solutions into a sociotechnical model typology that contextualizes the solutions further (see Figure 1) [27, 28]. Here, organizing solutions into components of a sociotechnical environment allows considerations of their mechanisms on the path to diagnostic excellence and mitigation and prevention of diagnostic disparities. Together with our taxonomy, this approach might be helpful when thinking about implementing diagnostic disparities solutions as an orchestrated activity under a system approach. However, in a fragmented health system where individual medical institutions do not share their sociotechnical environment, this approach might be arguably less feasible.

Our identified solutions to diagnostic disparities have many common themes with solutions identified in the National Quality Forum's report on improving diagnostic quality and safety [21]. However, the latter solutions did not explicitly focus on diagnostic disparities though they did engage with four use cases: missed subtle clinical findings, communication failures, information overload, and dismissed patients. In all four use cases, traditionally marginalized groups of patients might be especially vulnerable to diagnostic errors, and diagnostic disparities might persist even if diagnostic quality and safety improves on average. Some of our identified solutions – particularly organizational culture – also correspond to "A Resource List for Users of the AHRQ Diagnostic Safety Supplemental Items" [29, 30]. This resource is organized around domains from the Surveys on Patient Safety Culture (SOPS) composite measures, which is gathered from medical office personnel, making it more actionable. However, as an improvement resource that is not targeted to diagnostic disparities specifically, patient-reported measures, for example, are absent, but clinician-reported are featured. This raises an important question whether solutions oriented to overall improvements of diagnostic quality and safety will close diagnostic disparities gaps and should be prioritized over diagnostic-disparity-focused solutions. Or is the diagnostic equity future impact direction more about tailoring of and diverging from existing solutions to develop new solutions specific to disparities?

Our findings directly inform future research and practice. They highlight an opportunity and provide foundational

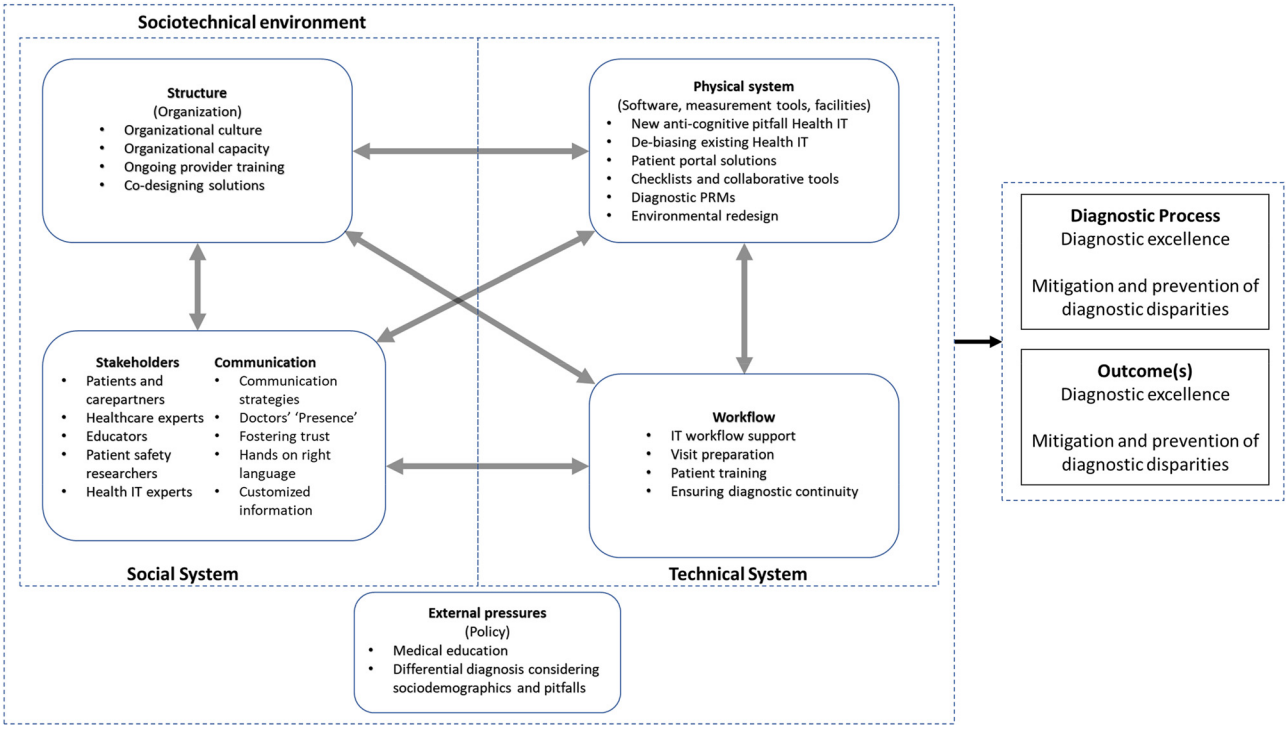

Figure 1: Example of organizing diagnostic disparities solutions along the sociotechnical model.

support, so that the solutions can be tailored to specifically address diagnostic disparities and implementation and scaling of these solutions can be expedited. We anticipate that identified gaps will motivate the variety of required expertise and emphasize opportunities for alliances and multidisciplinary collaborations, solidified by partnering with patients and frontline providers. This would be especially conducive, as the range of solutions points to the benefits of new perspectives. Future work will need to amass evidence, where it is lacking, on whether the identified potential solutions mitigate or exacerbate diagnostic disparities in vulnerable groups. This evidence will help with either focusing on a particular solution that can make a difference on its own or organizing an orchestrated system approach to implement many solutions simultaneously that will work in synergy.

Limitations

Our work has several limitations. The typology is missing distinct types of diagnostic disparities solutions that address the challenges some groups face engaging in healthcare at all. Identified solutions and especially examples are limited by our methods, for example, by environmental scans that might be biased by research team members' identities and interpretations; consultations with the workshops' members might be biased due to group composition or individual expertise and preferences. Additionally, due to the scope of considerations, we did not undertake a systematic review approach that would have ensured that all relevant solutions had been captured within the identified types. This work initially focused on disparities originating from age, sex, and race and gradually moved to disparities that are due to any quickly salient and visible factors. This initial focus on specific disparities might have excluded solutions relevant to other groups vulnerable to diagnostic disparities. The typology could be described as both overspecified and underspecified depending on vantage point. From some participants, we heard that this work presentation may require simplifications to support authentic patient engagement and leadership. At the same time, experts in particular disciplines of diagnostic safety and quality noted that some solution types might have been too simplified and unnecessarily grouped, advocating for more nuances and complexity. Finally, due to the exploratory nature of our work in the emerging field of diagnostic equity and the paucity of evidence on solutions, we had to rely on subjective expertise for validations and did not attempt to formally synthesize or characterize the quality of available evidence. Future studies should more systematically update the state of the solutions and map the evidence.

Conclusions

Under the imperative to counter devastating diagnostic disparities, our first-of-its-kind typology of potential diagnostic disparities solutions and identified gaps set a stage for the field of diagnostic equity to grow. Numerous opportunities to tailor existing solutions to make them disparity-focused and promote widespread implementation of the solutions exist and beckon new people and their perspectives. We highlight the need for evidence, collaborations across disciplines and types of expertise, meaningful patient engagement, and building coalitions for a system approach to achieve diagnostic equity. With those enablers, future efforts might focus on a particular promising solution or on orchestrated system approach supporting multiple synergetic solutions. Thus, the creation of a multistakeholder action-oriented alliance for implementing diagnostic disparities solutions is warranted.

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