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Patients, Policy and Practice Improvements

A health disparities research framework to guide a radiology response to achieve equitable care during crisis



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Health disparities place vulnerable populations at higher risk for disease and poor health outcomes.¹ Past crises have underscored that emergency situations amplify these disparities.² The current COVID-19 pandemic has exposed vulnerable populations to numerous obstacles, exacerbating the impact of social determinants of health (SDoH) that threaten access to equitable care.³ For example, low economic status may increase the likelihood of having a job in the service industry with fewer remote work options. During the crisis of the COVID-19 pandemic, this can increase the risk of virus exposure.⁴ Demographic data of COVID-19 cases reflect disproportionately high infection rates and worse outcomes among Black/African American, Hispanic, and other racial and ethnic minorities that experience structural barriers to health care.⁵ Structural barriers include work and living conditions that preclude social distancing and limit access to testing, such as living in multigenerational households in communities of high population density.^{6,7} As this pandemic continues to magnify health disparities and create new barriers to care, radiology departments are called to establish strategic multidisciplinary partnerships to address SDoH.

Radiology departments are central in the diagnosis and treatment of patients during the COVID-19 pandemic.⁸ In this capacity, radiologists have a unique opportunity to collaborate with other medical specialties and the community to assist vulnerable patient populations and address emerging disparities. Organized collaborations are necessary to foster effective interventions and advocate for communities experiencing increased hardship during the pandemic. Existing health disparities research frameworks (HDRFs) can be adapted to develop strategies to address emerging disparities, enhance workflow modifications in radiology departments, and guide the implementation of collaborative interventions.^{9,10} These frameworks can provide a standardized, data-driven approach to rapidly identify gaps in care, optimize operations and develop new programs to address existing and emerging health disparities.¹¹ In addition, HDRFs hold great potential for expediting the collaboration between radiology departments across institutions facing similar challenges, fostering synergy in strategies and bi-directional learning to enhance health equity efforts.

Kilbourne et al.'s *Detecting, Understanding, and Reducing* HDRF outlines collaborative health equity efforts.¹² We have adapted Kilbourne's

framework through the addition of evaluation elements from the implementation science RE-AIM (Reach, Effectiveness, Adoption, Implementation, Maintenance) framework (Fig. 1). Below we present how to adapt this HDRF to guide radiology department-based health equity efforts during a healthcare crisis, using the COVID-19 pandemic as an example.^{13,14} Additionally, we highlight the results of one of the interventions designed and implemented at our institution in response to the COVID-19 pandemic.¹⁵

1. Detecting health disparities

Identification of baseline health disparities and SDoH that may be exacerbated during a healthcare crisis is a critical first step to mitigating disparities. Understanding the SDoH, such as socioeconomic, cultural and environmental factors, that influence access to care during crisis is a foundational step in the development of interventions to address health disparities. Health disparities *detection* efforts should focus on identifying communities with decreased access to care and leverage trusted relationships between patients, healthcare institutions and community stakeholders to bridge gaps in care. As patients engage in radiology care during a crisis, radiology practices can play a central role in optimizing collaborations between community members and healthcare institutions.^{8,16}

Example: We identified a community health center in a location with the highest COVID-19 infection rate in the state.¹⁷ A high proportion of community members in this location identify as Hispanic, speak primarily Spanish, and have limited English proficiency (LEP). With most of the COVID-19-related actionable health information initially available only in English, appropriate resources from reliable sources were not readily accessible to members of this community. Thus, linguistic barriers resulting from LEP created barriers for disease prevention and treatment access due to increased challenges in health literacy and digital literacy. Consequently, we developed a strategy to increase access to multilingual health information, educational videos for disease prevention, and patient handouts about how to better prepare for their chest imaging studies in the pandemic for individuals with LEP.

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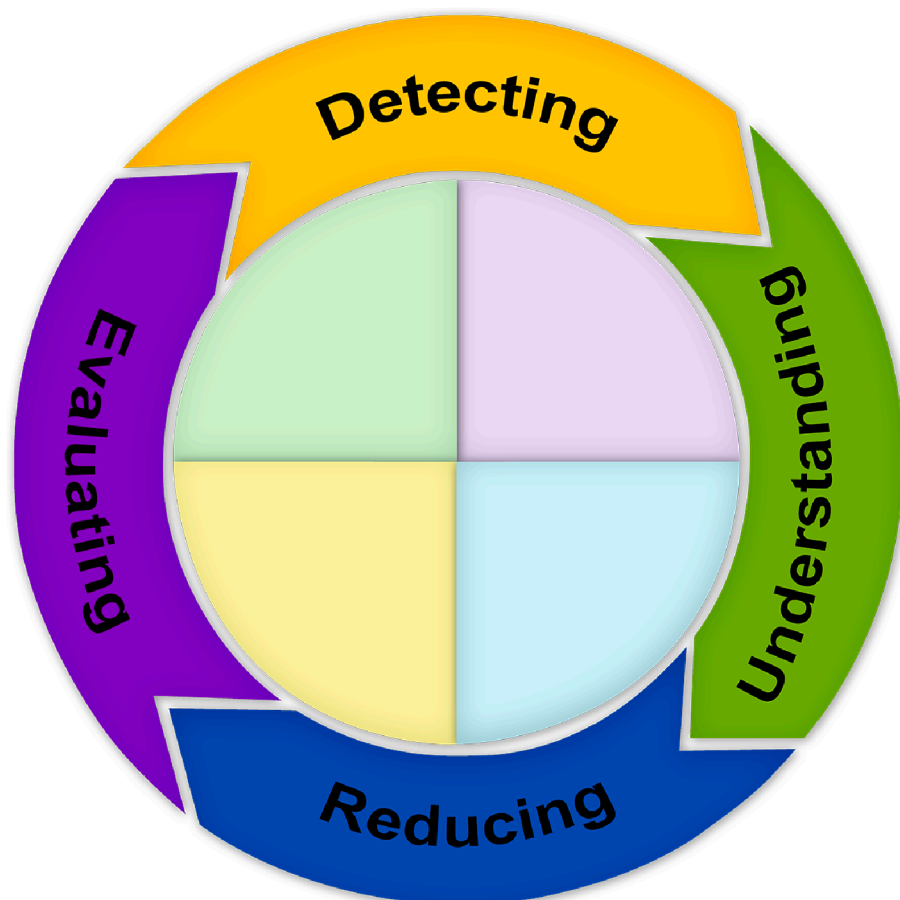


Fig. 1. Adapted framework to guide radiology response to emerging health disparities during crisis. Note the three strages of the framework, ‘Detecting’, ‘Understanding’, ‘Reducing’, and the added elements of implementations science, ‘Evaluating’ in the outermost section of the figure form a continuous cycle and to guide radiology departments. (Adapted from Kilbourne AM, et al. (2006) Advancing health disparities research within the health care system: A conceptual framework. *American Journal of Public Health* 96 (12): 2113–21).

2. Understanding the impact of health disparities

Kilbourne's framework suggests that once disparities are identified, it is imperative to understand their ensuing health implications at multiple levels. In increasing magnitude, these levels may include: individual, family, community, organization, and population health.¹⁸ This construct of the framework encourages users to gain an in-depth understanding of *how* and *why* SDoH translate into barriers of care and to engage and empower individuals and communities to take action. The *understanding* stage should prompt radiology departments and health organizations to reexamine their system-wide approach to health inequity mitigation. Radiology organizations should also leverage the critical expertise of the community and community health centers to explore grassroots efforts for the understanding and mitigation of disparities.¹⁹ Understanding disparities across a system and through the lens of the community can enhance collaborations and promote an evidence-based approach for action. Additionally, through community-engaged participatory research and user-centered design frameworks, radiology practices can incorporate the perspective of the community to better understand barriers to care and inform the development of patient-centered interventions to bridge these gaps. This is particularly important in addressing SDoH affecting intersectional groups whose inequities may be complex, including members of racial and ethnic minority groups requiring personal care assistance, or living with physical or mental disabilities.^{20,21}

Example: Through in-depth interactions with our largely Hispanic patient population with an increased need for chest radiography during the COVID-19 pandemic, we developed better *understanding* of the implications of LEP when navigating the health care system. We learned that immigration status and fear of punitive actions were additional factors that exacerbated health disparities, preventing care due to fear of

deportation. *Understanding* the link between these SDoH in radiology allowed us provide care that is culturally competent and sensitive to these issues. For example, institutional public service announcement videos were created by radiology staff in collaboration with the community health centers to reinforce the importance of receiving timely care during the pandemic, regardless of immigration status, insurance coverage or language.

3. Reducing health disparities and evaluating interventions

Reducing health disparities requires effective outreach initiatives and interventions. In the setting of a health crisis such as the current COVID-19 pandemic, flexibility and constant communication must lie at the core of any interventional design. Continuous assessment of the effectiveness of interventions designed to reduce health disparities, and proactively leveraging support from stakeholders, are vital to ensure generalizability and sustainability of these efforts. End user-driven evaluation and standardized review of interventions can increase the likelihood that initiatives remain relevant and useful across institutions. In order to analyze the effectiveness of such interventions and to ease the communication of results, institutions may benefit from the use of an implementation science evaluation frameworks, such as RE-AIM.¹⁴

The RE-AIM framework is used to assess interventions by *evaluating* critical factors. The first construct, *reach*, prompts an estimation of the number and representativeness of people in the target population reached by the intervention. *Effectiveness*, reflects the impact of an intervention on important outcomes. Effectiveness can be measured through a change in clinical outcome, such as the number of patients undergoing an imaging study. *Adoption*, reflects the number of providers or healthcare organizations willing to provide an intervention. This could be measured through surveys documenting the proportion of

healthcare workers aware of the materials and the frequency with which they offer them. *Implementation*, the fidelity with which an intervention is delivered as intended, can be captured through electronic medical record data, surveys, or interviews. Finally, *maintenance*, or long term sustainability of an intervention, can be assessed by identifying the number of clinical settings or institutions utilizing an intervention 6–12 months after implementation. Using this continuous evaluation framework can offer several advantages in terms of organizational clarity, early identification of detractors, and systematic assessment of effectiveness in addressing the targeted health disparities.

Example: By harnessing the lessons learned from direct patient care and guided by a community-based participatory approach, we designed, implemented, and *evaluated* an intervention to *reduce* the negative effect of LEP on health literacy and health outcomes. This collaboration resulted in the creation and dissemination of 1) a multilingual patient education materials addressing what patients should expect when coming to a radiology department for evaluation of possible COVID-19 infection and 2) an AI-powered, application that provides multilingual patient breathing and positioning instructions for chest radiographs (CXR) as part of the urgent clinic evaluation for patients with COVID-19.²² To promote adoption and sustainability, the multilingual education materials were disseminated, leveraging the established community distribution pathways of care-kits containing cleaning supplies and masks. The AI-powered application was implemented as an alternative to interpreter services and promptly adopted among all technologists performing CXR for patients with LEP presenting to the urgent clinic for evaluation of COVID-19. The utilization of this application to improve the care of patients with LEP has been expanded to other clinical settings and scenarios, including screening mammography.

4. Applying a modified HDRF: RadTranslate, enhancing care equity for patients with LEP through an AI-powered intervention

A noteworthy product of this HFRF is RadTranslate,¹⁵ an AI-powered text-to-speech web application designed to facilitate radiology care among individuals with LEP.²² As noted previously, LEP was *detected* as a leading SDoH in the application of this modified HDRF to the operations of our radiology department. This SDoH was further *understood* in the setting of our community-based centers, tending to communities with large Spanish-speaking communities with disproportionately higher rates of COVID-19 infections in these communities.¹⁵ *Understanding* the need further led to *contraposing* LEP to the known benefits of language concordant medical care. This intervention was born from this community-identified need to *reduce* the effects of LEP that negatively impact equitable care. This intervention is an example of how radiology practices can guide interventions using the RE-AIM framework as described in this study by Chonde et al. Details regarding the methodology for the development and assessment of this intervention can be found in the publication referenced below by Chone et al.¹⁵

5. Take home points

A primary challenge to the implementation of strategies to mitigate healthcare disparities arises from the limited time, personnel, and funding available. In the setting of the unprecedented burden of the COVID-19 pandemic on the health system, institutions are facing increased difficulties in allocating resources for new interventions.²³ This can be particularly challenging for institutions and radiology practices caring for populations in low-resource communities. Nevertheless, the COVID-19 pandemic has emphasized the importance of prioritizing action with intentionality. Small, but persistent initiatives towards equity can have sizable effects. Furthermore, this complex setting has highlighted the importance of facilitating inter and intra-institutional collaboration and partnerships. Radiology practices can leverage current resources and partner with other institutions to share lessons-learned and best-practices of their most effective interventions

while considering needs that are specific to each practice. The full spectrum of challenges and opportunities the COVID-19 pandemic will bring to our health system remains to be determined, but our preparedness for future crises can begin today. The utilization of established frameworks provides an opportunity for organizations to guide the development and evaluation of strategies to address health disparities. This reproducible structure can facilitate interinstitutional and cross-sector community collaborations to decrease the pandemic's negative impact on vulnerable populations. Effective strategies to reduce disparities in future health crisis scenarios of this magnitude should be a staple of our contingency procedures. Furthermore, long-term organizational efforts should be set in motion to ensure that *rapid response* also means a *response for our most vulnerable populations*.

Declaration of competing interest

Dr. James A. Brink reports personal fees from Accumen, Inc., outside the submitted work and is in an academic institution - non-partner/non-partnership track/employee.

References

- Institute of Medicine. *Unequal treatment: confronting racial and ethnic disparities in health care*. Washington, DC: The National Academies Press; 2003.
- Rudowitz R, Rowland D, Shartz A. Health care in New Orleans before and after hurricane Katrina: the storm of 2005 exposed problems that had existed for years and made solutions more complex and difficult to obtain. *Health Aff* 2006;25(5):393–406.
- Siroitch E, Hausmann JS. Removing barriers and disparities in health: lessons from the COVID-19 pandemic [Internet]. *Nat Rev Rheumatol* Oct 7 2020;1–2. <https://doi.org/10.1038/s41584-020-00524-8>. Available from: .
- Centers for Disease Control and Prevention. Available from: . In: Health Equity Considerations & Racial & Ethnic Minority Groups (Updated July 24, 2020). 2019; 2020. p. 18–21. <https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/race-ethnicity.html>.
- Office M of B. In: COVID-19 health inequity task force report; 2020. p. 1–9.
- Williams DR, Cooper LA. COVID-19 and health equity—a new kind of “herd immunity.”. Available from: *JAMA* Jun 23 2020;323(24):2478. <http://www.ncbi.nlm.nih.gov/pubmed/32391852>.
- Economic Policy Institute. Black workers face two of the most lethal preexisting conditions for coronavirus—racism and economic inequality. *Econ Policy Inst* [Internet]. Available from: <https://www.epi.org/publication/black-workers-covid-externalicon>.
- Madhuripan N, Cheung HMC, Alicia Cheong LH, Jawahar A, Willis MH, Larson DB. Variables influencing radiology volume recovery during the next phase of the coronavirus disease 2019 (COVID-19) pandemic. *J Am Coll Radiol* 2020;17(7):855–64. <https://doi.org/10.1016/j.jacr.2020.05.026> [Internet]. Available from: .
- Mossa-Basha M, Meltzer CC, Kim DC, Tuite MJ, Kolli KP, Tan BS. Radiology department preparedness for COVID-19: radiology scientific expert panel. Available from: *Radiology* Mar 16 2020;80(2):200988. <http://pubs.rsna.org/doi/10.1148/radiol.2020200988>.
- Nápoles AM, Stewart AL. Transcreation: an implementation science framework for community-engaged behavioral interventions to reduce health disparities. *BMC Health Serv Res* 2018;18(1):1–15.
- Thomas SB, Quinn SC, Butler J, Fryer CS, Garza MA. Toward a fourth generation of disparities research to achieve health equity. *Annu Rev Public Health* 2011;32:399–416.
- Kilbourne AM, Switzer G, Hyman K, Crowley-Matoka M, Fine MJ. Advancing health disparities research within the health care system: a conceptual framework. *Am J Public Health* 2006;96(12):2113–21.
- Chinman M, Woodward EN, Curran GM, LRM Hausmann. Harnessing implementation science to increase the impact of health equity research. Available from: *Med Care* Sep 2017;55(1). <http://journals.lww.com/00005650-201709001-00007>.
- Glasgow RE, Harden SM, Gaglio B, Rabin B, Smith ML, Porter GC. RE-AIM planning and evaluation framework: adapting to new science and practice with a 20-year review. Available from: *Front Public Heal* Mar 29 2019;7(64). <https://www.frontiersin.org/article/10.3389/fpubh.2019.00064/full>.
- Chonde DB, Pourvaziri A, Williams J, McGowan J, Moskos M, Alvarez C. Rad-Translate: an artificial intelligence-powered intervention for urgent imaging to enhance care equity for patients with limited English proficiency during the COVID-19 pandemic [Internet]. *J Am Coll Radiol* 2021. <https://doi.org/10.1016/j.jacr.2021.01.013>. Available from: .
- Betancourt JR, Tan-McGrory A, Flores E, López D. Racial and ethnic disparities in radiology: a call to action [Internet]. *J Am Coll Radiol* 2019;16(4):547–53. <https://doi.org/10.1016/j.jacr.2018.12.024>. Available from: .
- Coronavirus Disease 2019 (COVID-19) Cases in MA. *Massachusetts Dep Public Heal*; April 22, 2020.

- 18 Alvidrez J, Castille D, Laude-Sharp M, Rosario A, Tabor D. The National Institute on Minority Health and Health Disparities research framework. *Am J Public Health* 2019;109(S1):S16–20.
- 19 Cole MB, Wright B, Wilson IB, Galárraga O, Trivedi AN. Longitudinal analysis of Racial/Ethnic trends in quality outcomes in community health centers, 2009–2014. *J Gen Intern Med* 2018;33(6):906–13.
- 20 Burke JG, Hess S, Hoffmann K, Guizzetti L, Loy E, Gielen A, et al. Translating community-based participatory research (CBPR) principles into practice: building a research agenda to reduce intimate partner violence. *Prog Community Heal Partnersh*. 2014;7(2):115–22.
21. Lyles C, Schillinger D, Sarkar U. Connecting the dots: health information technology expansion and health disparities. *PLoS Med* 2015;12(7):3–7.
22. <https://www.radtranslate.com>. 2020; 2–3.
- 23 Brown AF, Ma GX, Miranda J, Eng E, Castille D, Brockie T, et al. Structural interventions to reduce and eliminate health disparities. *Am J Public Health* 2019;109(S1):S72–8.

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