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PRACTICE POINTER

Five strategies for clinicians to advance diagnostic excellence

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What you need to know

- The World Health Organization and the National Academy of Medicine (US) have identified measuring and reducing diagnostic error as a patient safety priority
- Diagnosis is a process that is influenced by systems, cognitive, teamwork, and social factors that may either enhance or reduce diagnostic accuracy
- Clinicians can integrate diagnostic performance feedback into their day-to-day work
- Clinicians can take steps to mitigate biases (regarding race, ethnicity, gender, and other identities) that run counter to their values and impair diagnostic performance
- Clinicians can integrate the expertise of other health professionals, patients, and families to reimagine the routines and culture around diagnosis

Diagnostic accuracy is an important component of clinical excellence. However, diagnostic errors—failures to establish an accurate and timely explanation of a patient's health problem or to communicate that explanation to the patient—harm patients worldwide.^{1,2} In a recent UK study, diagnostic errors occurred in 4.3% of primary care consultations.³ A meta-analysis estimated that nearly 250 000 harmful diagnostic errors occur annually among hospitalised adults in the United States.⁴ The National Academies of Science, Engineering, and Medicine's report *Improving Diagnosis in Health Care* highlighted that most people will experience at least one diagnostic error in their lifetime.¹ The World Health Organization now identifies measuring and reducing diagnostic error as a patient safety priority.⁵

Diagnostic excellence involves making a correct and timely diagnosis using the fewest resources while maximising patient experience and managing uncertainty.⁶ Compared with other patient safety problems such as medication errors, procedural complications, and hospital acquired infections, diagnostic errors have received less investigation.^{7–10} Diagnoses are rendered by clinicians but health system vulnerabilities frequently influence clinical reasoning and contribute to diagnostic error.^{11,12}

While system interventions are essential to achieving diagnostic excellence,¹³ this article focuses on the individual clinician. Based on current scientific

literature, expert opinion, and theoretical frameworks pertaining to diagnostic decision making and learning, we propose five strategies for clinicians to consider to achieve diagnostic excellence and reduce diagnostic error in their practice.

Why diagnostic errors occur

Diagnosis is a complex categorisation task driven by mental models (illness scripts and diagnostic schemas) that reside in long term memory. Through education and experience, clinicians form illness scripts that encapsulate their knowledge of specific conditions (such as osteoarthritis) and develop diagnostic schemas that structure their approach to a specific health problem (such as knee pain). This cognitive process intersects with systems, teamwork, and social factors that can enhance or reduce diagnostic accuracy.¹⁴ Diagnosis is often a dynamic longitudinal process in which patients' clinical features evolve, multiple interactions with the healthcare system occur, and additional information surfaces.¹⁵

Multiple factors can contribute to a delayed or inaccurate diagnosis. Clinicians may be unaware of a disease, or a disease may manifest in an atypical way. However, most diagnostic errors involve common conditions that clinicians are aware of.^{4,16–18} In these situations, diagnostic errors may result from inadequate data gathering, inadequate information processing, or inadequate application of knowledge.^{19–22} Clinicians may misestimate the likelihood of diseases they are familiar with (for example, overestimate the probability of cellulitis and underestimate the probability of venous stasis when evaluating a patient's oedematous erythematous leg).²³ Time and productivity pressures can adversely influence thinking. The electronic health record may hold diagnostic clues, but data may be disorganised, inaccurate, or fragmented across multiple care settings.^{24,25} Clinicians often do not have time to search medical records and reference materials because of taxing data-entry demands. Patients and other health professionals often hold critical diagnostic information and hypotheses, but this team expertise is regularly overlooked.²⁶ The way clinicians solicit, interpret, and pursue diagnostic information with patients can be influenced by stereotypes about various populations and communities.

Advancing Diagnostic Excellence

Five strategies for clinicians

Diagnostic excellence involves making a correct and timely diagnosis using the fewest resources while maximising patient experience and managing uncertainty. Based on current scientific literature, expert opinion, and theoretical frameworks pertaining to diagnostic decision making and learning, we propose five strategies for clinicians to consider to achieve diagnostic excellence and reduce diagnostic error in their practice.



Strategy	Why	How
 Seek feedback on diagnostic decisions	Fosters better understanding of your own diagnostic accuracy Ensures better calibration of future decisions	Create an electronic list of patients where diagnosis-related questions remain Solicit feedback from colleagues and patients on your performance
 "Byte" sized practice	Test-enhanced learning promotes knowledge acquisition and skill development	Integrate brief diagnostic challenges from apps, social media, and medical journals into your daily routine
 Consider biases	Encourages awareness of fallibility in clinical decision making Promotes humility Increases recognition of the impact of harmful societal forces (such as racism) on diagnosis	Find common ground, foster individuation, and build empathy Use practice level data to identify harmful patterns in diagnostic evaluation Consider if alternative diagnostic possibilities would be entertained if a patient had a different background or identity
 Make diagnosis a team sport	Diagnosis is not just the purview of doctors alone	Flatten hierarchy and elevate voices of all health professionals on the diagnostic team Seek opportunities for group decision making with colleagues and invite patient concerns and opinions about diagnoses Use technology to augment decision making
 Foster critical thinking	Optimises data acquisition and interpretation throughout the diagnostic process	Take a sceptical stance towards your initial provisional diagnosis by looking for data to both support and contradict it Commit to monitoring and collecting more data and setting prompts for further investigation if the patient doesn't improve

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Five strategies for diagnostic excellence

Seek diagnostic feedback

Feedback strategies, if effectively implemented, have been shown to lead to clinical practice improvement.²⁷ Clinicians learn most

from their day-to-day work, but it can be challenging to target knowledge and skill gaps that will reliably improve diagnostic performance.²⁸ Learning from feedback can help clinicians evaluate their diagnostic accuracy and calibrate their future decisions.^{6,29-31}

Two pathways can be useful for integrating feedback into day-to-day diagnostic work. First, we suggest tracking patients' clinical outcomes by creating an electronic list of patients where the diagnosis is still evolving or questions remain, setting reminders to check diagnostic outcomes, and creating a log of lessons learnt.³¹ Second, we recommend clinicians learn through feedback on their diagnostic outcomes from other health professionals, patients, and families.³² This feedback can be a brief communication about a patient's final diagnosis or outcome ("I have an update on that patient you saw") or a conversation that highlights opportunities to improve diagnostic performance and reinforces practices that lead to diagnostic excellence.³³ Routinely scheduled discussions of selected cases among peers interested in diagnostic excellence can enhance learning.³⁴ To be effective, performance feedback from colleagues should be established as a non-punitive, cultural norm that is sensitive to clinicians' potential discomfort around such discussions.^{33 35 36}

"Byte sized" learning

Digital learning activities can improve mental models and maximise diagnostic performance. Clinicians read the medical literature in order to acquire new information and maintain previous knowledge. Cognitive neuroscience has demonstrated that self testing (quizzing) by retrieving information from memory is a more effective way to enhance understanding and knowledge than re-reading the same content.³⁷ To actualise this strategy, we recommend developing a recurring, structured routine that is grounded in tackling brief diagnostic challenges on digital platforms, including smartphone applications (apps), social media, and medical journal websites (see box 1). These resources provide concise cases that clinicians can use to practise diagnostic thinking and effectively increase the number of patients they "see" each day.³⁸ The final diagnosis and brief teaching points in digital cases provide lessons that can be integrated to sharpen diagnostic schemas and illness scripts.

Box 1: Resources for short digital cases ("byte sized" learning)

- Human Diagnosis Project app (<https://www.humandx.org>)—Daily case challenge presented in multiple specialties
- #medtwitter on Twitter—Online community with instructive diagnostic challenges
- Clinical Problem Solvers (<https://clinicalproblemsolving.com>)—Podcasts and webinars featuring case discussions
- BMJ Case Reports (<https://casereports.bmj.com/pages/>)

Finding efficient training opportunities is not the main challenge; instead it is how clinicians can modify their routines such that 5-10 minutes of diagnostic training and practice is embedded in each day. This approach is typically more effective and practical than seeking large blocks of time for extended study.³⁹

Consider bias

Recognition of the pervasiveness of cognitive biases (such as anchoring and availability bias) has raised awareness of fallibility in clinical decision making and encouraged humility during the diagnostic process. However, it remains difficult to identify our cognitive biases in real time or in hindsight,⁴⁰ and debiasing interventions remain challenging to implement and require additional study.^{41 42} While current diagnostic decision making literature focuses on understanding and addressing cognitive biases, disparities in diagnosis indicate that implicit bias and stereotyping can also lead to diagnostic errors.^{43 44} There are numerous examples in the literature of diagnostic disparities linked with race and ethnicity, including disparities in hospitalisation for acute

myocardial infarction, diagnosis of schizophrenia, diagnosis of appendicitis in children, and timely diagnosis of dementia.⁴⁵⁻⁴⁸

Harmful societal forces such as racism, sexism, transphobia, ageism, and ableism that run counter to clinicians' values can affect diagnostic thinking despite the best intentions. Medical education lacks adequate representation of diverse individuals both as teachers and in training resources (such as textbooks). For example, teaching materials in the US typically illustrate and describe rashes as they appear on light skin, leading to failures to teach how to recognise key diagnostic clues in people with a full range of skin tones. This institutionalised racism results in knowledge gaps that can contribute directly to diagnostic error and harm.⁴⁹ Prior experiences with discrimination can damage trust between patients and clinicians before the visit begins and may constrain the diagnostic information that patients feel comfortable or empowered to share.⁵⁰⁻⁵²

While evidence on strategies to reduce the impact of implicit bias are still emerging, we suggest several pragmatic starting points. Taking time to see patients as individuals and finding common ground by learning about their lives and preferences can promote empathy and facilitate diagnostic evaluation based on individual, not stereotyped, attributes.^{53 54} We recommend taking a diagnostic pause to consider whether alternative diagnoses would be entertained if a patient had a different background or identity. Aggregated data from clinical practices can be used to detect inequitable diagnostic approaches.⁵⁵ For example, a practice may review its data to determine if urine toxicology screens are being ordered disproportionately for Black patients presenting with confusion. When data demonstrate biased diagnostic practices, individual clinicians and groups can develop systems-level solutions (such as requiring standardised criteria be met before ordering toxicology screens). Considering whether a practice reflects the background and identities of the patients it serves and making efforts to diversify clinicians and staff can foster a welcoming and equitable clinical environment. Strategies aimed at enhancing equity are most effectively implemented when clinicians commit to examining their own unconscious biases.⁵⁶

Make diagnosis a team sport

Leveraging the expertise of a diagnostic team can help reduce errors.^{57 58} For instance, a nurse may collect a nuanced time-course of illness; a physical therapist may detect an overlooked neurologic deficit; a dietician may discern a key nutrient deficiency. Patients and their families have important insights about their disease course and diagnostic hypotheses that warrant exploration.⁵⁹

A true diagnostic team requires reimagining the culture around making a diagnosis, which is often viewed as the purview of doctors alone.⁶⁰ Interprofessional huddles, where the hierarchy between physicians and other health professionals is flattened, can be effective forums to synthesise all diagnostic information and hypotheses. We suggest asking patients "What do you think you have?" or "What are you concerned this could be?" Such inquiry invites the patient into a conversation and can introduce new diagnostic possibilities.

Clinicians can leverage the power of group decision making to discuss diagnostic challenges with colleagues in other specialties, including laboratory medicine, pathology, and radiology, who can also help with test selection and interpretation.⁶¹ Increased experience with videoconferencing during the covid-19 pandemic has enhanced our ability to have real-time verbal discussions among colleagues,⁶² which is more likely to lead to satisfactory diagnostic decisions than asynchronous electronic communication through

the electronic health record, email, or texting. Increasingly the diagnostic “team” will also include decision support systems and other technologies that augment diagnostic reasoning.⁶³

Foster critical thinking

Critical thinking skills can help clinicians optimise their acquisition and interpretation of data throughout the diagnostic process.⁶⁴ Critical thinking involves reflective scepticism, a propensity to consider diagnoses as provisional and subject to revision, and a willingness to seek and examine contradictory evidence. In one study of diagnostic errors in primary care, no differential diagnosis was documented in 81% of cases,¹⁶ suggesting that clinicians may not always consider alternative possibilities in their diagnostic thinking.

We suggest using intentional strategies that foster critical thinking in daily practice. When evaluating a 45 year old patient with new onset headaches, deliberately seeking both supportive and conflicting evidence on history and examination for a provisional diagnosis of migraine exemplifies critical thinking.⁶⁵ Reflective scepticism is a cognitively demanding path that involves contemplating competing and mimicking conditions (such as intracranial hypotension or cluster headache), evaluating the case from different points of view (for example, if the patient’s partner expressed concern about the diagnosis because they never had headaches like this before), commitment to monitoring and collecting more data (such as reassessing for changes in cognitive function),⁶⁶ and setting prompts for further investigation (such as head imaging if no improvement after two months of treatment). This metacognitive stance takes practice but may lead to enhanced diagnostic judgment.

How this article was made

The article was synthesised from multiple sources including (1) a review of peer reviewed literature, including narrative reviews and systematic reviews on diagnostic error, and interventions to reduce them; (2) research studies on feedback, calibration, clinical reasoning, teamwork, and disparities in diagnosis; (3) opinion based on commentaries and perspectives from the literature on potential strategies to reduce error with special focus on individual clinical reasoning, developing expertise, learning from feedback, and critical thinking; (4) reports from several international bodies including National Academies of Science, Engineering and Medicine, National Quality Forum, and the World Health Organization; (5) conceptual frameworks that outline approaches to components of the diagnostic process, including generating and providing feedback; and (6) input from patient reviewers.

Education into practice

- How might you develop a system to track your diagnostic decisions and outcomes?
- Do you examine and reflect on your biases and their potential impact on the diagnostic process?
- Which one of the strategies in this article could you encourage as a career-long habit for a trainee you work with?

How patients were involved in the creation of this article

We invited two patient advocacy and diagnostic error experts (Helen Haskell, president of Mothers Against Medical Error, and Desiree Collins Bradley, network lead of Patient Partner Innovation Community) to provide comments on an earlier version of this paper. They advised us to clarify the intent of the “byte sized” learning strategy, be more explicit about the problem of bias, and strengthen recommendations related to patients and teamwork. They also advised us to highlight the role of the electronic

health record. This input was used to make changes to the paper prior to submission.

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- 1 Balogh EP, Miller BT, Ball JR, eds. *Improving diagnosis in health care*. National Academies Press, 2015;doi: 10.17226/21794.
- 2 Singh H, Schiff GD, Graber ML, Onakpoya I, Thompson MJ. The global burden of diagnostic errors in primary care. *BMJ Qual Saf* 2017;26:484-94. doi: 10.1136/bmjqs-2016-005401 pmid: 27530239
- 3 Cheraghi-Sohi S, Holland F, Singh H, et al. Incidence, origins and avoidable harm of missed opportunities in diagnosis: longitudinal patient record review in 21 English general practices. *BMJ Qual Saf* 2021;30:977-85. doi: 10.1136/bmjqs-2020-012594 pmid: 34127547
- 4 Gunderson CG, Bilan VP, Holleck JL, et al. Prevalence of harmful diagnostic errors in hospitalised adults: a systematic review and meta-analysis. *BMJ Qual Saf* 2020;29:1008-18. doi: 10.1136/bmjqs-2019-010822 pmid: 32269070
- 5 World Health Organization. Global Patient Safety Action Plan 2021-2030: Towards eliminating avoidable harm in health care. 2021. <https://www.who.int/teams/integrated-health-services/patient-safety/policy/global-patient-safety-action-plan>.
- 6 Meyer AND, Singh H. The path to diagnostic excellence includes feedback to calibrate how clinicians think. *JAMA* 2019;321:737-8. doi: 10.1001/jama.2019.0113 pmid: 30735239
- 7 Singh H, Graber ML. Improving diagnosis in health care—the next imperative for patient safety. *N Engl J Med* 2015;373:2493-5. doi: 10.1056/NEJMp1512241 pmid: 26559457
- 8 Graber ML, Kissam S, Payne VL, et al. Cognitive interventions to reduce diagnostic error: a narrative review. *BMJ Qual Saf* 2012;21:535-57. doi: 10.1136/bmjqs-2011-000149 pmid: 22543420
- 9 Lyratzopoulos G, Vedsted P, Singh H. Understanding missed opportunities for more timely diagnosis of cancer in symptomatic patients after presentation. *Br J Cancer* 2015;112(Suppl 1):S84-91. doi: 10.1038/bjc.2015.47 pmid: 25734393
- 10 Zwaan L, El-Kareh R, Meyer AND, Hooftman J, Singh H. Advancing diagnostic safety research: results of a systematic research priority setting exercise. *J Gen Intern Med* 2021;36:2943-51. doi: 10.1007/s11606-020-06428-3 pmid: 33564945
- 11 Singh H, Graber ML, Kissam SM, et al. System-related interventions to reduce diagnostic errors: a narrative review. *BMJ Qual Saf* 2012;21:160-70. doi: 10.1136/bmjqs-2011-000150. pmid: 22129930
- 12 Singh H, Sittig DF. Advancing the science of measurement of diagnostic errors in healthcare: the Safer Dx framework. *BMJ Qual Saf* 2015;24:103-10. doi: 10.1136/bmjqs-2014-003675 pmid: 25589094
- 13 Dave N, Bui S, Morgan C, Hickey S, Paul CL. Interventions targeted at reducing diagnostic error: systematic review. *BMJ Qual Saf* 2021;bmjqs-2020-012704. doi: 10.1136/bmjqs-2020-012704. pmid: 34408064
- 14 Holmboe ES, Durning SJ. Understanding the social in diagnosis and error: a family of theories known as situativity to better inform diagnosis and error. *Diagnosis (Berl)* 2020;7:161-4. doi: 10.1515/dx-2020-0080. pmid: 32653873
- 15 Zwaan L, Singh H. The challenges in defining and measuring diagnostic error. *Diagnosis (Berl)* 2015;2:97-103. doi: 10.1515/dx-2014-0069 pmid: 26955512
- 16 Singh H, Giardina TD, Meyer AN, Forjuoh SN, Reis MD, Thomas EJ. Types and origins of diagnostic errors in primary care settings. *JAMA Intern Med* 2013;173:418-25. doi: 10.1001/jamainternmed.2013.2777 pmid: 23440149
- 17 Schiff GD, Hasan O, Kim S, et al. Diagnostic error in medicine: analysis of 583 physician-reported errors. *Arch Intern Med* 2009;169:1881-7. doi: 10.1001/archinternmed.2009.333 pmid: 19901140
- 18 Singh H, Thomas EJ, Wilson L, et al. Errors of diagnosis in pediatric practice: a multisite survey. *Pediatrics* 2010;126:70-9. doi: 10.1542/peds.2009-3218 pmid: 20566604
- 19 Graber ML, Franklin N, Gordon R. Diagnostic error in internal medicine. *Arch Intern Med* 2005;165:1493-9. doi: 10.1001/archinte.165.13.1493 pmid: 16009864
- 20 Bergl PA, Nanchal RS, Singh H. Diagnostic error in the critically ill: defining the problem and exploring next steps to advance intensive care unit safety. *Ann Am Thorac Soc* 2018;15:903-7. doi: 10.1513/AnnalsATS.201801-068PS. pmid: 29742359
- 21 Medford-Davis L, Park E, Shlamovitz G, Suliburk J, Meyer AN, Singh H. Diagnostic errors related to acute abdominal pain in the emergency department. *Emerg Med J* 2016;33:253-9. doi: 10.1136/emered-2015-204754 pmid: 26531859
- 22 Schiff G, Volodarskaya M, Ruan E, et al. Characteristics of disease-specific and generic diagnostic pitfalls: a qualitative study. *JAMA Netw Open* 2022;5:e2144531. doi: 10.1001/jamanetworkopen.2021.44531 pmid: 35061037
- 23 Morgan DJ, Pineles L, Owczarzak J, et al. Accuracy of practitioner estimates of probability of diagnosis before and after testing. *JAMA Intern Med* 2021;181:747-55. doi: 10.1001/jamainternmed.2021.0269 pmid: 33818595

- 24 Schiff GD, Bates DW. Can electronic clinical documentation help prevent diagnostic errors? *N Engl J Med* 2010;362:1066-9. doi: 10.1056/NEJMp0911734 PMID: 20335582
- 25 Graber ML, Byrne C, Johnston D. The impact of electronic health records on diagnosis. *Diagnosis (Berl)* 2017;4:211-23. doi: 10.1515/dx-2017-0012 PMID: 29536944
- 26 Thomas DB, Newman-Toker DE. Diagnosis is a team sport - partnering with allied health professionals to reduce diagnostic errors: A case study on the role of a vestibular therapist in diagnosing dizziness. *Diagnosis (Berl)* 2016;3:49-59. doi: 10.1515/dx-2016-0009 PMID: 28758055
- 27 Brown B, Gude WT, Blakeman T, et al. Clinical Performance Feedback Intervention Theory (CP-FIT): a new theory for designing, implementing, and evaluating feedback in health care based on a systematic review and meta-synthesis of qualitative research. *Implement Sci* 2019;14:40. doi: 10.1186/s13012-019-0883-5 PMID: 31027495
- 28 van de Wiel MWJ, Van den Bossche P, Janssen S, Jossberger H. Exploring deliberate practice in medicine: how do physicians learn in the workplace? *Adv Health Sci Educ Theory Pract* 2011;16:81-95. doi: 10.1007/s10459-010-9246-3. PMID: 20848187
- 29 Croskerry P. The feedback sanction. *Acad Emerg Med* 2000;7:1232-8. doi: 10.1111/j.1553-2712.2000.tb00468.x PMID: 11073471
- 30 Schiff GD. Minimizing diagnostic error: the importance of follow-up and feedback. *Am J Med* 2008;121(Suppl):S38-42. doi: 10.1016/j.amjmed.2008.02.004 PMID: 18440354
- 31 Dhalwal G. Inpatient Notes: Diagnostic excellence starts with an incessant watch. *Ann Intern Med* 2017; doi: 10.7326/M17-2447.
- 32 Cifra CL, Sittig DF, Singh H. Bridging the feedback gap: a sociotechnical approach to informing clinicians of patients' subsequent clinical course and outcomes. *BMJ Qual Saf* 2021;30:591-7. doi: 10.1136/bmjqs-2020-012464 PMID: 33958442
- 33 Meyer AND, Upadhyay DK, Collins CA, et al. A program to provide clinicians with feedback on their diagnostic performance in a learning health system. *Jt Comm J Qual Patient Saf* 2021;47:120-6. doi: 10.1016/j.jcjq.2020.08.014 PMID: 32980255
- 34 Sommers LS, Morgan L, Johnson L, Yatabe K. Practice inquiry: clinical uncertainty as a focus for small-group learning and practice improvement. *J Gen Intern Med* 2007;22:246-52. doi: 10.1007/s11606-006-0059-2 PMID: 17356994
- 35 Bowen JL, Ilgen JS, Regehr G, Cate OT, Irby DM, O'Brien BC. Reflections from the rearview mirror: internal medicine physicians' reactions to clinical feedback after transitions of responsibility. *Acad Med* 2019;94:1953-60. doi: 10.1097/ACM.0000000000002831 PMID: 31192795
- 36 Grubenhoff JA, Zinief SI, Cifra CL, Singhal G, McCleed RE, JrSingh H. Pediatric clinician comfort discussing diagnostic errors for improving patient safety: a survey. *Pediatr Qual Saf* 2020;5:e259. doi: 10.1097/pq9.0000000000000259 PMID: 32426626
- 37 Green ML, Moeller JJ, Spak JM. Test-enhanced learning in health professions education: A systematic review: BEME Guide No. 48. *Med Teach* 2018;40:337-50. doi: 10.1080/0142159X.2018.1430354. PMID: 29390949
- 38 Manesh R, Dhalwal G. Digital tools to enhance clinical reasoning. *Med Clin North Am* 2018;102:559-65. doi: 10.1016/j.mcna.2017.12.015 PMID: 29650076
- 39 Pereira R. The Difference Between Naïve, Purposeful, and Deliberate Practice. Gemba Academy LLC. 2021. <https://blog.gembaacademy.com/2020/02/28/the-difference-between-naive-purposeful-and-deliberate-practice/>.
- 40 Zwaan L, Monteiro S, Sherbino J, Ilgen J, Howey B, Norman G. Is bias in the eye of the beholder? A vignette study to assess recognition of cognitive biases in clinical case workshops. *BMJ Qual Saf* 2017;26:104-10. doi: 10.1136/bmjqs-2015-005014 PMID: 26825476
- 41 Ludolph R, Schulz PJ. Debiasing health-related judgments and decision making: a systematic review. *Med Decis Making* 2018;38:3-13. doi: 10.1177/0272989X17716672 PMID: 28649904
- 42 Scott IA. Errors in clinical reasoning: causes and remedial strategies. *BMJ* 2009;338:b1860. doi: 10.1136/bmj.b1860. PMID: 19505957
- 43 Udoetuk S, Dongarwar D, Salihu HM. Racial and gender disparities in diagnosis of malingering in clinical settings. *J Racial Ethn Health Disparities* 2020;7:1117-23. doi: 10.1007/s40615-020-00734-6 PMID: 32152834
- 44 Piccardi C, Detollenaere J, Vanden Bussche P, Willems S. Social disparities in patient safety in primary care: a systematic review. *Int J Equity Health* 2018;17:114. doi: 10.1186/s12939-018-0828-7 PMID: 30086754
- 45 Pope JH, Aufderheide TP, Ruthazer R, et al. Missed diagnoses of acute cardiac ischemia in the emergency department. *N Engl J Med* 2000;342:1163-70. doi: 10.1056/NEJM200004203421603 PMID: 10770981
- 46 Olbert CM, Nagendra A, Buck B. Meta-analysis of Black vs. White racial disparity in schizophrenia diagnosis in the United States: Do structured assessments attenuate racial disparities? *J Abnorm Psychol* 2018;127:104-15. doi: 10.1037/abn0000309 PMID: 29094963
- 47 Goyal MK, Chamberlain JM, Webb M, et al. Pediatric Emergency Care Applied Research Network (PECARN). Racial and ethnic disparities in the delayed diagnosis of appendicitis among children. *Acad Emerg Med* 2021;28:949-56. doi: 10.1111/acem.14142 PMID: 32991770
- 48 Tsou E, Kiehlhofer RE, Guterman EL, et al. Assessment of racial/ethnic disparities in timeliness and comprehensiveness of dementia diagnosis in California. *JAMA Neurol* 2021;78:657-65. doi: 10.1001/jamaneurol.2021.0399 PMID: 33779684
- 49 Nolen L. How medical education is missing the bull's-eye. *N Engl J Med* 2020;382:2489-91. doi: 10.1056/NEJMp1915891 PMID: 32579809
- 50 Sacks TK. *Invisible visits: black middle-class women in the American healthcare system*. Oxford University Press, 2018.
- 51 Aronson J, Burgess D, Phelan SM, Juarez L. Unhealthy interactions: the role of stereotype threat in health disparities. *Am J Public Health* 2013;103:50-6. doi: 10.2105/AJPH.2012.300828. PMID: 23153125
- 52 Gonzalez CM, Deno ML, Kintzer E, Marantz PR, Lypson ML, McKee MD. Patient perspectives on racial and ethnic implicit bias in clinical encounters: Implications for curriculum development. *Patient Educ Couns* 2018;101:1669-75. doi: 10.1016/j.pec.2018.05.016. PMID: 29843933
- 53 Burgess D, van Ryn M, Dovidio J, Saha S. Reducing racial bias among health care providers: lessons from social-cognitive psychology. *J Gen Intern Med* 2007;22:882-7. doi: 10.1007/s11606-007-0160-1. PMID: 17503111
- 54 Weisz E, Zaki J. Motivated empathy: a social neuroscience perspective. *Curr Opin Psychol* 2018;24:67-71. doi: 10.1016/j.copsyc.2018.05.005. PMID: 29966924
- 55 Powell JA, Tropp LR, Goff PA, Godsil RD. The Science of Equality Volume 1: Addressing implicit bias, racial anxiety, and stereotype threat in education and health care. Perception Institute. <https://escholarship.org/content/qt2t95b844/qt2t95b844.pdf?t=qc4z6v>
- 56 Project Implicit. 2021. <https://implicit.harvard.edu/implicit/takeatest.html>
- 57 Gleason KT, Davidson PM, Tanner EK, et al. Defining the critical role of nurses in diagnostic error prevention: a conceptual framework and a call to action. *Diagnosis (Berl)* 2017;4:201-10. doi: 10.1515/dx-2017-0015. PMID: 29536939
- 58 Hautz WE, Kämmer JE, Schaubert SK, Spies CD, Gaissmaier W. Diagnostic performance by medical students working individually or in teams. *JAMA* 2015;313:303-4. doi: 10.1001/jama.2014.15770. PMID: 25603003
- 59 Giardina TD, Haskell H, Menon S, et al. Learning from patients' experiences related to diagnostic errors is essential for progress in patient safety. *Health Aff (Millwood)* 2018;37:1821-7. doi: 10.1377/hlthaff.2018.0698. PMID: 30395513
- 60 Graber ML, Rusz D, Jones ML, et al. The new diagnostic team. *Diagnosis (Berl)* 2017;4:225-38. doi: 10.1515/dx-2017-0022. PMID: 29536943
- 61 Lubin IM, Astles JR, Shahangian S, et al. Bringing the clinical laboratory into the strategy to advance diagnostic excellence. *Diagnosis (Berl)* 2021;8:281-94. doi: 10.1515/dx-2020-0119. PMID: 33554526
- 62 Lee TH. Zoom family meeting. *N Engl J Med* 2021;384:1586-7. doi: 10.1056/NEJMp2035869 PMID: 33914438
- 63 Sutton RT, Pincok D, Baumgart DC, Sadowski DC, Fedorak RN, Kroeker KI. An overview of clinical decision support systems: benefits, risks, and strategies for success. *npj Digit Med* 2020;3:1-10. doi: 10.1038/s41746-020-0221-y.
- 64 Sharples JM, Oxman AD, Mahtani KR, et al. Critical thinking in healthcare and education. *BMJ* 2017;357:j2234. doi: 10.1136/bmj.j2234. PMID: 28512135
- 65 Hayes MM, Chatterjee S, Schwartzstein RM. Critical thinking in critical care: five strategies to improve teaching and learning in the intensive care unit. *Ann Am Thorac Soc* 2017;14:569-75. doi: 10.1513/AnnalsATS.201612-1009AS PMID: 28157389
- 66 Walter FM, Penfold C, Joannides A, et al. Missed opportunities for diagnosing brain tumours in primary care: a qualitative study of patient experiences. *Br J Gen Pract* 2019;69:e224-35. doi: 10.3399/bjgp19X701861 PMID: 30858332