



Racial/Ethnic Inequities in Healthcare-associated Infections Under the Shadow of Structural Racism: Narrative Review and Call to Action

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Abstract

Purpose of Review The purpose of this study is to review racial and ethnic inequities in the incidence and prevention of healthcare-associated infections (HAIs) in the USA, identify gaps in the literature, and recommend future directions to mitigate these inequities.

Recent Findings While some existing literature has identified the presence of racial/ethnic inequities in HAI incidence and outcomes, few studies to date have evaluated whether HAI prevention efforts have mitigated these inequities. Factors contributing to inequities in HAI prevention may include unconscious bias of healthcare professionals towards minoritized patients; socioeconomic and structural inequities disparately affecting minoritized communities; the racial segregation of quality healthcare through hospital price discrimination; divergent reimbursement rates between public and private insurers; policies or performance metrics which underfund and financially penalize safety-net hospitals; and insufficient research evaluating and addressing HAI inequities.

Summary Expansion of the literature is needed to further interrogate root causes and evaluate the impact of interventions on racial/ethnic inequities in HAI incidence. Measures to mitigate inequities might include teaching healthcare workers how to recognize and mitigate unconscious biases, expanding community resources which address the social and structural determinants of health, increasing access to preventive health services, reforming federal and institutional policies to better support safety-net hospitals and disincentivize price discrimination, and improving diversity and inclusion within the health workforce.

Keywords Healthcare-associated infections (HAIs) · Racial/ethnic disparities · Structural racism · Health policy · Social determinants of health

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Introduction

Race and ethnicity are categories defined by social interpretations of phenotypic characteristics (e.g., skin color) and national origin or cultural background. In the USA, minoritized racial/ethnic groups are projected to comprise the majority of the national population by 2045 [1], yet racial and ethnic identities remain among the strongest individual predictors of an individual's health and wealth. The tight correlation between race and health is largely because of historic and present racism [2, 3]. Though racism is pervasive and operates on multiple levels [2] to harm minoritized communities, *structural racism* is perhaps the most impactful form, defined as “structures, policies, practices, and norms resulting in differential access to goods, services, and opportunities of society by ‘race’” [4].

Structural racism has left tangible footprints across nearly all facets of society, ranging from financial security to the criminal justice system, and racial/ethnic inequities in healthcare access and health outcomes are inextricably linked to these footprints. For example, residential racial segregation has been pervasive in urban areas across the USA since the early twentieth century due to neighborhood redlining and discriminatory mortgage lending practices. Racial segregation continues to be strongly associated with present-day rates of cancer, preterm birth, chronic health conditions, and HIV outcomes as well as adverse social determinants of health including air pollution, less green space, increased food insecurity, and more [3•, 5–8]. The quality of healthcare delivery is also segregated along racial and ethnic lines; in the 2018 National Healthcare Quality and Disparities Report, Black, Hispanic, American Indian/Alaska Native, and Native Hawaiian/Pacific Islander patients were reported to receive worse care than White patients for 35–40% of quality measures evaluated [5]. The downstream consequences of structural racism have manifested throughout the COVID-19 pandemic, with Black, Native Americans, and Hispanic populations experiencing disproportionately higher rates of infection and death compared to White Americans [9].

Racial/Ethnic Inequities in Healthcare-associated Infections

Healthcare-associated infections (HAIs) are infections acquired during hospital stay that typically present after 48 h of hospital admission [10•]. The most common types of HAIs include central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), surgical site infections (SSI), and ventilator-associated pneumonia (VAP) [11]. Adverse outcomes of HAIs include higher medical costs, increased antimicrobial resistance, prolonged hospital stays, and higher mortality [12]. We conducted an English language literature search using Google Scholar and PubMed with a combination of search terms including racial/ethnic disparities, healthcare infection prevention, nosocomial infections, structural racism, underserved population, racial/ethnic minorities, and different types of common hospital-acquired infections (e.g., central line-associated infection).

Although the current literature on racial/ethnic inequities in HAI incidence is mixed, most studies suggest that minoritized patients experience higher rates of HAIs compared to their White counterparts. A chart review of 79,019 all-payer hospital adult patients by Bakullari et al. concluded that Asian and Hispanic patients experienced significantly higher rates of CAUTI than non-Hispanic White patients (5.0% and 4.6% vs. 3.2%, respectively) [13]. Gualandi et al. found that

Black patients had higher incidence rates of hospital-onset MRSA infection than White patients (6.21 per 100,000 vs. 2.94 per 100,000) [14•]. Argamany et al. analyzed 1.7 million discharges following *Clostridium difficile* infection and reported that Black patients had significantly higher mortality rates (7.4% vs. 7.2%) and increased incidence of severe *Clostridium difficile* infection (24% vs. 19%) compared to White patients, despite overall *C. difficile* incidence being significantly higher among White patients (7.7 per 1,000 vs. 4.9 per 1,000 discharges) [15]. Jeon et al. noted that non-Hispanic Black patients had greater risk of hospital-acquired bloodstream infections than non-Hispanic White patients after adjusting for sociodemographic factors including age, sex, distance to the hospital, and month and year of discharge (hazard ratio 1.31, 95% CI 1.02–1.69). However, these differences were no longer significant after controlling for other covariates including comorbidities, primary payer, and admission through the emergency department [16].

Inequities in the incidence and outcomes of HAIs among minoritized populations potentially stem from disparities in HAI prevention efforts. In this article, we review literature on racial/ethnic inequities in HAIs, consider how racism operates on multiple levels to influence these inequities, and offer recommendations to close these gaps and institutionalize practices which promote equity.

Potential Drivers of Racial/Ethnic Inequities in HAI

Our literature search did not yield any publications highlighting HAI prevention efforts targeted at specifically addressing racial/ethnic inequities. Drawing from existing literature on health inequities and HAI prevention, we propose that contributors to HAI inequities may include manifestations of racism across multiple socioecological levels, displayed in the conceptual framework in Fig. 1.

Interpersonal Level

Unconscious Bias of Healthcare Professionals Towards Minoritized Groups

Unconscious bias refers to “attitudes or stereotypes that unconsciously alter our perceptions or understanding of our experiences, thereby affecting behavior, interactions, and decision-making” [17•]. Unconscious bias among healthcare professionals towards racial/ethnic minority patients may result in lower quality of care delivered to these patients compared to White patients [5]. For example, in a landmark study of medical students and residents, Hoffman et al. identified a high prevalence of beliefs that Black patients have fundamental biological differences from White patients,

Potential Drivers of Racial/Ethnic Inequities in Healthcare-associated Infections, and Proposed Actions to Mitigate Them

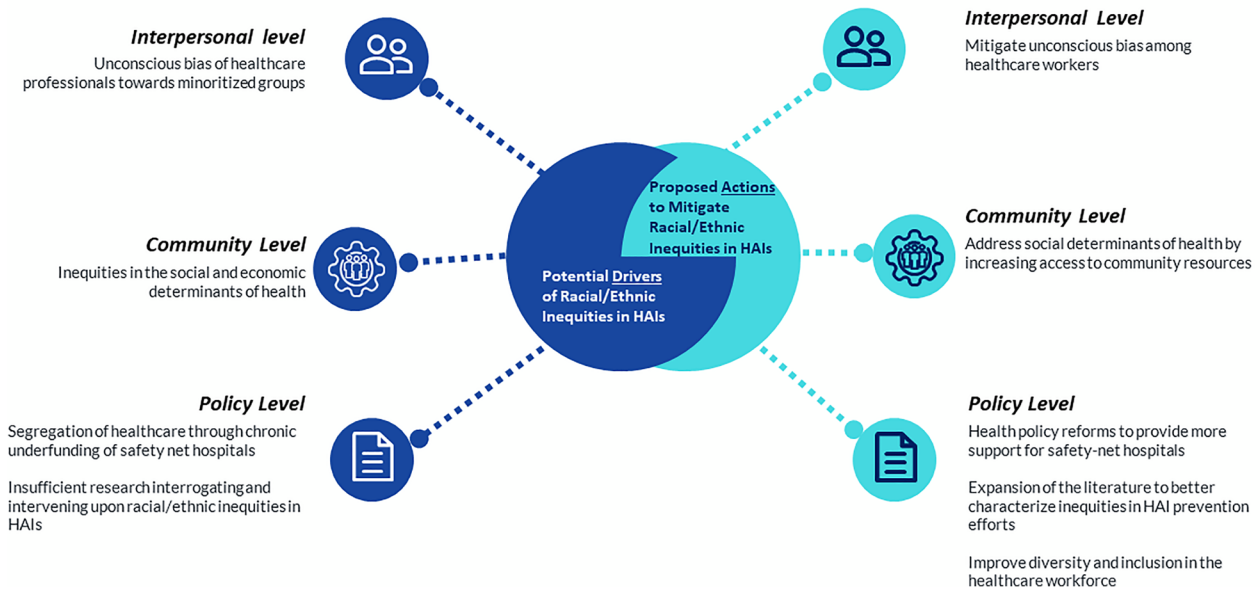


Fig. 1 Conceptual framework

including innate differences in pain perception [18]. Biased attitudes and behaviors among healthcare professionals contributes to racial/ethnic minorities’ feelings of distrust [19] and perception of racial discrimination in the healthcare system [20, 21]. Furthermore, these beliefs contribute to longstanding patterns of unequal treatment [22], including minoritized patients receiving less attention from nurses [19], fewer tests for the same chief complaints [19], and inadequate pain management [19, 22, 23]. Inadequate post-operative pain control is associated with increased risk for developing postoperative pneumonia [24]. Thus, clinician biases and inequitable treatment may directly contribute to racial/ethnic minorities’ higher risk of developing postoperative pneumonia [25].

Community Level

Inequities in the Social and Economic Determinants of Health

The effects of social and economic factors on health outcomes are well-documented. Racial/ethnic inequities in income and educational attainment may contribute to inequities in HAIs [16, 26, 27, 28•]. For instance, poverty rate, income inequality, and percent of the population self-identified as Black were significantly correlated with hospital-onset MRSA bacteremia [28•]. See et al. reported higher annual incidence of invasive community-acquired MRSA infections in Black Americans than White Americans, but racial differences were

non-significant after controlling for structural vulnerabilities including poverty and housing status [29]. Wiemken et al. reported that hospital-area deprivation was associated with the hospitals’ HAI performance, with facilities located in higher deprivation areas (e.g., greater poverty rates) associated with higher rates of SSI after colectomy [30•]. Jeon et al. reported that Hispanic people were more likely to develop hospital-acquired UTI than White people. However, the relative hazard of race/ethnicity for UTI decreased with the progression of hospital stay, suggesting that factors prior to hospital admissions may have driven these disparate outcomes [16].

Policy Level

Segregation of Healthcare Through Chronic Underfunding of Safety Net Hospitals

Safety-net hospitals have fewer financial resources than non-safety-net hospitals [31] and care for a higher proportion of racial/ethnic minorities [32•]. Safety-net hospitals also have greater prevalence of HAIs compared to non-safety-net hospitals [32•, 33•]. Thus, the under-resourcing of safety-net hospitals may directly contribute to racial/ethnic inequities in HAIs.

The 2010 Patient Protection and Affordable Care Act created the Hospital-Acquired Condition Reduction Program (HACRP) and the Hospital Value-Based Purchasing

(HVBP) Program, which both aimed to reduce HAIs in hospitals across the USA through monetary incentives and penalties. HVBP rewards or penalizes the highest- and lowest-performing hospitals by up to 2% of their total inpatient payment, whereas the HACRP reduces the total payments by up to 1% for the lowest-performing hospitals [33•]. However, the implementation of these programs did not significantly improve targeted HAI rates or reduce HAI inequities between safety-net and non-safety-net hospitals in 2018 compared to 2013 across 618 acute care hospitals; infection rates for CLABSI, SSI after colon surgeries, and CAUTI remained significantly higher in safety-net hospitals [33•]. Moreover, the HVBP and HACRP disproportionately penalized safety-net hospitals carrying the greatest proportions of socioeconomically disadvantaged patients (e.g., hospitals serving a larger proportion of individuals insured by Medicaid), thereby further worsening the financial hardship of these hospitals [33•].

Insufficient Research Interrogating and Intervening Upon Racial/Ethnic Inequities in HAI

The Society for Healthcare Epidemiology of America (SHEA) recently highlighted a lack of understanding in current literature on how social determinants of health affect antimicrobial prescription among different racial/ethnic populations [34]. Similarly, the dearth of literature evaluating the impact of HAI prevention efforts on racial/ethnic inequities suggests insufficient identification of root causes for HAI inequities and failure to develop race-conscious preventive measures that narrow these gaps, despite ample evidence that racial/ethnic inequities in HAI do indeed exist [26, 27].

Next Steps to Address Racial/Ethnic Inequities in HAI

Structural racism in healthcare impacts minoritized groups in many ways, including inequities in the incidence of HAIs. Greater efforts to mitigate HAI inequities among racial/ethnic minorities are needed. Within our socioecological framework, we suggest the following approaches as initial steps forward (Fig. 1).

Interpersonal Level

Mitigate Unconscious Bias Among Healthcare Workers

Healthcare professionals must first be aware of their unconscious biases towards racial/ethnic minority patients in order to mitigate the negative impacts of bias on patient care [17•] and its potential contributions to HAI inequities. For example, first year medical students from the Albert Einstein College of Medicine participated in nine 1.5 h sessions to learn about the unconscious

bias in the healthcare environment. These sessions consisted of interactive discussions, self-reflection, and role-plays. After the conclusion of the unconscious bias curriculum, the learners felt more confident about their ability to recognize unconscious bias in the healthcare settings [35•]. The evaluation of future bias interventions must move beyond assessing knowledge, skills, and attitudes, as feelings of confidence may be a poor proxy for actual behavior and impacts on patient outcomes.

Structured curricula on the impacts of unconscious bias should be an important component of training for all health professionals, but these curricula are insufficient on their own. Favorable contact with members of the Black community (e.g., Black doctors) is associated with reduced implicit racial bias among medical students [36]. Thus, a comprehensive strategy to address unconscious bias must include building a diverse workforce that supports health professionals from minoritized backgrounds. This can be accomplished by implementing training programs that incorporate evidence-based bias reduction strategies, intentionally mentoring and sponsoring individuals from groups historically marginalized and excluded in medicine for training and leadership, and ensuring that institutional leaders embrace principles of cultural humility in professional development [17•].

Community Level

Address Social Determinants of Health by Increasing Access to Community Resources

Racial/ethnic minorities experience more adverse social determinants of health [37] which likely contribute to HAI inequities [16, 26, 27, 28•]. In 2020, more Black and Hispanic renters had difficulties paying rent than White renters, and racial/ethnic inequities in accessing affordable housing has widened during the COVID-19 pandemic [38]. As housing status was a mediator of racial/ethnic differences in community-acquired MRSA rates [29], addressing housing insecurity may reduce MRSA incidence. Routine healthcare visits in primary care settings should involve care coordination for socially complex patients as this can assist with screening for and addressing unmet social needs. For example, the completion of a list of questionnaires by patients during routine visits at primary care clinics were very effective to screen for unmet social needs and for physicians to refer patients for social assistance [39].

Community-based resources can be effective in helping minoritized populations address their socioeconomic needs and improve their health outcomes. For example, the distribution of weekly meals to a group of individuals enrolled in both Medicaid and Medicare tailoring specifically to each individual's medical needs (e.g., renal diet) was associated with fewer ED visits, fewer inpatient admissions, and lower monthly medical spending [40]. Fewer ED visits and inpatient admissions would likely reduce exposure to healthcare-associated pathogens.

Policy Level

Reform National and Institutional Policies to Better Support Safety-net Hospitals

The HACRP and HVBP programs under the Affordable Care Act disparately penalized safety-net hospitals, which disproportionately care for minoritized patients [33•]. In addition, disparities in the rates of HAIs between safety-net and non-safety-net hospitals have persisted, despite decreasing overall rates of HAIs since the Affordable Care Act's enactment [33•]. Thus, it is important for policy makers to systematize equity through policy reforms. Shashikumar et al. highlighted that HACRP could reduce the penalization of safety-net hospitals by over \$32 million by stratifying hospitals based on the proportion of patients dually enrolled in Medicaid and Medicare, with penalties are assigned to the lowest performing quartile within each group rather than universally across the entire sample [41•]. Payers and clinicians alike should support the implementation of equity-based quality metrics [42], which can incentivize accurate and comprehensive sociodemographic data collection. Health systems should leverage existing procedures for patient safety and quality to systematically track and redress inequities in key outcomes like HAI incidence [43].

In addition, uptake of innovative technologies may assist in mitigating HAI inequities. For example, the implementation of an electronic hand hygiene voice reminder system in a rural health system showed a significant improvement of hand hygiene within 6 months and concomitant significant reduction in HAIs [44]. A safety-net hospital reduced its CAUTI rates and enhanced staff maintenance bundle practices by implementing a CAUTI prevention campaign that included multidisciplinary education based on evidence-based guidelines and the enforcement of a tight indwelling catheter monitoring system [45]. Other potential strategies to reduce HAIs in safety-net hospitals include increasing patient participation in HAI prevention efforts, developing of antibiotic stewardship programs, and implementing standardized HAI surveillance programs [46•].

Finally, policymakers can begin dismantling root causes of healthcare segregation by addressing hospital price discrimination [47•] and incorporating equity measures into the healthcare payment model [48]. Price discrimination refers to hospitals choosing to attract privately insured patients based on dramatically increased reimbursement rates relative to public payers like Medicaid. This practice is not solely limited to private hospitals, as high-revenue academic medical centers have increasingly consolidated into larger health systems to bargain for higher profit margins with private insurers while remaining “out-of-network” for public insurance and even ACA marketplace plans [49]. In short, price discrimination shifts resources

away from hospitals caring for low-income, minoritized populations and incentivizes health systems not to care for their most vulnerable community members [47•]. Policy reforms are needed to equitably distribute costs of uncompensated care across hospitals, reduce health system consolidation, and eliminate financial incentives to prioritize privately insured patients—all of which can help prevent the deepening of racial/ethnic health inequities.

Expand the Research Literature to Better Characterize Inequities in HAI Prevention

Current literature on racial/ethnic inequities in HAI prevention and efforts to mitigate these inequities is limited. The Society for Healthcare Epidemiology of America (SHEA) has highlighted the need for more research to understand potential socioeconomic factors that led to racial/ethnic inequities in antimicrobial stewardship [34]; similarly, funding should be prioritized for HAI prevention efforts that intentionally seek to evaluate and mitigate disparate outcomes.

It should be noted that studies describing racial/ethnic disparities citing conclusions of race as a risk factor or marker of disease reify biological race and obfuscate the impacts of racism as the underlying factor fueling inequities [50]. What is often lacking is a robust interrogation of the complex negative effects of social stressors on the health of the patients in their study populations. For example, neighborhood socioeconomic disadvantage can be assessed using area-based tools like the Area Deprivation Index [7, 30•, 51•], which includes factors such as education, employment, income, and housing quality. Such in-depth assessment may be more useful in not only characterizing patterns of the inequities but also identifying potential solutions to mitigate them. Future research and policy interventions should consider structural racism and downstream inequalities as fundamental causes of HAI inequities [50, 53].

The lack of representation of racial/ethnic minorities in the research workforce and their relative low success rate to secure research funding despite racial/ethnic minority scholars should also be addressed. Minoritized researchers are more likely to be aware of racial/ethnic health inequities and bring valuable lived experiences to addressing these inequities [52]. Thus, it is important to not only increase research funding to combat HAI inequities, but to also ensure that minoritized scholars are granted access to this research funding [52].

Improve Diversity and Inclusion in the Healthcare Workforce

Despite decades of diversity and inclusion efforts, racial/ethnic minorities remain underrepresented across multiple health professions [54, 55]. Furthermore, minoritized

individuals are vastly underrepresented in health organizational leadership; in 2019, 89% of hospital CEOs was non-Hispanic and White despite minoritized individuals representing 40% of the total US population [56]. A health workforce which is representative of the diversity of our patients will be better equipped to support and advocate for health policies that specifically address barriers faced by minoritized groups. For example, patient-clinician racial concordance has been associated with better preventive care utilization [57•], increased patient participation in shared decision-making [58•], and multiple improved health outcomes [59•]. Thus, enhancing diversity and inclusion in the healthcare workforce is not only a moral imperative; it may also help mitigate inequities.

Conclusion

Structural racism in the US healthcare system drives racial/ethnic inequities in health outcomes. While the data is sparse, these inequities likely extend to HAI incidence and highlight a need for equity-centric evaluations of existing HAI prevention efforts. Ameliorating racial/ethnic HAI inequities may require interventions which consider structural racism as a fundamental cause and take targeted action across multiple socioecological levels.

Compliance with Ethical Standards

Conflict of Interest Jiabi Chen, Rohan Khazanchi, Gonzalo Bearman, and Jasmine Marcelin declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies involving human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:

• Of importance

1. Frey WH. The US will become 'minority white' in 2045, Census projects. In: Brookings. 2018. <http://www.brookings.edu/blog/the-avenue/2018/03/14/the-us-will-become-minority-white-in-2045-census-projects/>. Accessed 23 Feb 2021.
2. Jones CP. Level of racism: a theoretic framework and a gardener's tale. *Am J Public Health*. 2000;90:1212–5. <https://doi.org/10.2105/ajph.90.8.1212>.
3. Bailey ZD, Feldman JM, Bassett MT. How structural racism works – racist policies as a root cause of U.S. racial health inequities. *N Engl J Med*. 2021;384:768–773. <https://doi.org/10.2105/ajph.90.8.1212>. **Overview of the history of structural**

racism in the United States, and the relationship of racist policies to present-day racial health inequities.

4. Jones CP. Confronting institutionalized racism. *Phylon* (1960-). 2002;50:7–22. <https://www.jstor.org/stable/4149999>.
5. 2018 national healthcare quality and disparities report. Rockville, MD: Agency for Healthcare Research and Quality. 2019. <https://www.ahrq.gov/sites/default/files/wysiwyg/research/findings/nhqrdr/2018qdr.pdf>. Accessed 25 Mar 2021.
6. Williams DR, Collins C. Racial residential segregation: a fundamental cause of racial disparities in health. *Public Health Rep*. 2001;116:404–16. <https://doi.org/10.1093/phr/116.5.404>.
7. Khazanchi R, Sayles H, Bares SH, Swindells S, Marcelin JR. Neighborhood deprivation and racial/ethnic disparities in HIV viral suppression: a single-center cross-sectional study in the U.S. Midwest. *Clin Infect Dis*. 2020. <https://doi.org/10.1093/cid/ciaa1254>.
8. Krieger N, Feldman JM, Waterman PD, Chen JT, Coull BA, Hemenway D. Local residential segregation matters: stronger association of census tract compared to conventional city-level measures with fatal and non-fatal assaults (total and firearm related), using the index of concentration at the extremes (ICE) for racial, economic, and racialized economic segregation, Massachusetts (US), 1995–2010. *J Urban Health*. 2017;94:244–58. <https://doi.org/10.1007/s11524-016-0116-z>.
9. Khazanchi R, Evans CT, Marcelin JR. Racism, not race, drives inequity across the COVID-19 continuum. *JAMA Netw Open*. 2020;3:e2019933. <https://doi.org/10.1001/jamanetworkopen.2020.19933>.
10. Monegro AF, Muppidi V, Regunath H. Hospital acquired infections. In: StatPearls. 2020. <https://www.ncbi.nlm.nih.gov/books/NBK441857/>. Accessed 5 Feb 2021. **Defined hospital acquired infections and their epidemiology.**
11. Mehboob HA. Nosocomial infections: epidemiology, prevention, control and surveillance. *Asian Pac J Tropical Biomed*. 2017;7:478–82.
12. WHO. Report on the burden of endemic health care-associated infection worldwide. 2011. https://apps.who.int/iris/bitstream/handle/10665/80135/9789241501507_eng.pdf;jsessionid=2D9AE4C21917A07FAE710E3E3C8AFED5?sequence=1. Accessed 5 Feb 2021.
13. Bakullari A, Metersky M, Wang Y, Eldridge N, Eckenrode S, Pandolfi M, et al. Racial and ethnic disparities in healthcare-associated infections in the United States, 2009–2011. *Infect Control Hosp Epidemiol*. 2016;35:S10–6.
14. Gualandi N, Mu Y, Bamberg WM, Dumyati G, Harrison LH, Leshner L, et al. Racial disparities in invasive methicillin-resistant staphylococcus aureus infections, 2005–2014. *Clin Infect Dis*. 2018;67:1175–81. <https://doi.org/10.1093/cid/ciy277>. **Examined racial disparities in hospital-acquired MRSA infection.**
15. Argamany JR, Delgado A, Reveles KR. Clostridium difficile infection health disparities by race among hospitalized adults in the United States, 2001 to 2010. *BMC Infect Dis*. 2016;16:454. <https://doi.org/10.1186/s12879-016-1788-4>.
16. Jeon CY, Muennig P, Furuya EY, Cohen B, Nash D, Larson EL. Burden of present-on-admission infections and health care-associated infections, by race and ethnicity. *Am J Infect Control*. 2014;42:1296–302. <https://doi.org/10.1016/j.ajic.2014.08.019>.
17. Marcelin JR, Siraj DS, Victor R, Kotadia S, Maldonado YA. The impact of unconscious bias in healthcare: how to recognize and mitigate it. *J Infect Dis*. 2019;220:S62–73. doi:<https://doi.org/10.1093/infdis/jiz214>. **Described negative impacts of unconscious bias in healthcare settings and proposed specific ways to mitigate it, particularly within the infectious disease field.**
18. Hoffman KM, Trawalter S, Axt JR, Oliver MN. Racial bias in pain assessment and treatment recommendations, and false beliefs about biological differences between blacks and whites. *PNAS*. 2016;113:4296–301. <https://doi.org/10.1073/pnas.1516047113>.

19. Feagin J, Bennefield Z. Systemic racism and U.S. health care. *Soc Sci Med*. 2014;103: 7–14. doi:<https://doi.org/10.1016/j.socscimed.2013.09.006>.
20. Stepanikova I, Oates GR. Perceived discrimination and privilege in health care: the role of socioeconomic status and race. *Am J Prev Med*. 2017;52:S86–94. <https://doi.org/10.1016/j.amepre.2016.09.024>.
21. Ghoshal M, Shapiro H, Todd K, Schatman ME. Chronic noncancer pain management and systemic racism: time to move toward equal care standards. *J Pain Res*. 2020;13:2825–36. <https://doi.org/10.2147/JPR.S287314>.
22. Institute of Medicine. Unequal treatment: confronting racial and ethnic disparities in health care. Washington, DC: The National Academic Press. 2003. <https://www.nap.edu/catalog/12875/unequal-treatment-confronting-racial-and-ethnic-disparities-in-health-care>. Accessed 26 Mar 2021.
23. Johnson JD, Asiodu IV, McKenzie CP, Tucker C, Tully KP, Bryant K, et al. Racial and ethnic inequities in postpartum pain evaluation and management. *Obst Gynecol*. 2019;134:1155–62. <https://doi.org/10.1097/AOG.0000000000003505>.
24. Amour J, Cholley B, Ouattara A, Longrois D, Leprince P, Fellahi JL, et al. The effect of local anesthetic continuous wound infusion for the prevention of postoperative pneumonia after on-pump cardiac surgery with sternotomy: the STERNOCAT randomized clinical trial. *Intensiv Care Med*. 2019;45:33–43. <https://doi.org/10.1007/s00134-018-5497-x>.
25. Keeling WB, Binongo J, Halkos ME, Leshnowar BG, Nguyen DQ, Halkos ME, et al. The racial paradox in multiarterial conduit utilization for coronary artery bypass grafting. *Ann Thorac Surg*. 2017;103:1214–21. <https://doi.org/10.1016/j.athoracsur.2016.07.042>.
26. Studnicki J, Ekezie BF, Tsulukidze M, Honoré P, Moonesinghe R, Fisher J. Disparity in race-specific comorbidities associated with central venous catheter-related bloodstream infection (AHRQ-PSI7). *Am J Med Qual*. 2013;28:525–32. <https://doi.org/10.1177/1062860613480826>.
27. Studnicki J, Ekezie BF, Tsulukidze M, Honoré P, Moonesinghe R, Fisher J. Classification tree analysis of race-specific subgroups at risk for a central venous catheter-related bloodstream infection. *Jt Comm J Qual Patient Saf*. 2014;40:134–43. [https://doi.org/10.1016/s1553-7250\(14\)40017-5](https://doi.org/10.1016/s1553-7250(14)40017-5).
28. Freeman JT, Blakiston MR, Anderson DJ. Hospital-onset MRSA bacteremia rates are significantly correlated with sociodemographic factors: a step toward risk adjustment. *Infect Control Hosp Epidemiol*. 2018;39:479–81. <https://doi.org/10.1017/ice.2018.12>. **Examined the relationship between racial disparities in hospital-onset MRSA bacteremia and sociodemographic factors, highlighting the need for risk adjustment when using hospital-onset MRSA as a quality metric.**
29. See I, Wesson P, Gualandi N, Dumyati G, Harrison LH, Leshner L, et al. Socioeconomic factors explain racial disparities in invasive community-associated methicillin-resistant staphylococcus aureus disease rates. *Clin Infect Dis*. 2017;64:597–604.
30. Wiemken TL, Marc-Oliver W, Johnston KJ. Association of hospital-area deprivation with hospital performance on health care associated infection rates in 2018. *Am J Infect Control*. 2020;48:1478–84. **Described the relationship between hospital area deprivation index and standardized infection ratio.**
31. Wakeam E, Hevelone ND, Maine R, Swain J, Lipsitz SA, Finlayson SRG, et al. Failure to rescue in safety-net hospitals: availability of hospital resources and differences in performance. *JAMA Surg*. 2014;149:229–36. <https://doi.org/10.1001/jamasurg.2013.3566>.
32. Paredes AZ, Hyer JM, Diaz A, Tsilimigras DI, Pawlik TM. Examining healthcare inequities relative to United States safety net hospitals. *Am J Surg*. 2020;220:525–31. **Examined the association between hospital safety-net burden and complications from selected surgeries.**
33. Hsu HE, Wang R, Broadwell C, Horan K, Jin R, Rhee C, et al. Association between federal value-based incentive programs and health care-associated infection rates in safety-net and non-safety-net hospitals. *JAMA Netw Open*. 2020;3: e209700. <https://doi.org/10.1001/jamanetworkopen.2020.9700>. **First study to examine the differential impact of HACRP and HVBP programs on the rates of healthcare-associated infections between safety-net and non-safety-net hospitals.**
34. Fortin-Leung K, Wiley Z. What about race and ethnicity in antimicrobial stewardship? *Infect Control & Hosp Epidemiol*. 2021. <https://doi.org/10.1017/ice.2020.1426>.
35. Gonzalez CM, Walker SA, Rodriguez N, Karp E, Marantz PR. It can be done! A skills-based elective in implicit bias recognition and management for preclinical medical students. *Acad Med*. 2020;95:S150–155. <https://doi.org/10.1097/ACM.0000000000003697>. **Described the effectiveness of a longitudinal implicit bias curriculum on teaching medical students to recognize and combat the impacts of bias in clinical settings.**
36. Van Ryn M, Hardeman R, Phelan SM, Burgess DJ, Dovidio JF, Herrin J, et al. Medical school experiences associated with change in implicit racial bias among 3547 students: a medical student CHANGES study report. *J Gen Intern Med*. 2015;30:1748–56. <https://doi.org/10.1007/s11606-015-3447-7>.
37. Noël RA. Race, economics, and social status. U.S. Bureau of Labor Statistics. 2018. <http://www.bls.gov/spotlight/2018/race-economics-and-social-status/pdf/race-economics-and-social-status.pdf>. Accessed 9 Feb 2021.
38. Greene S, McCargo A. New data suggest COVID-19 is widening housing disparities by race and income. Urban Institute. 2020. <https://www.urban.org/urban-wire/new-data-suggest-covid-19-widening-housing-disparities-race-and-income>. Accessed 20 Mar 2021.
39. Berkowitz SA, Hulberg AC, Hong C, Stowell BJ, Tirozzi KJ, Traore CY, et al. Addressing basic resource needs to improve primary care quality: a community collaboration programme. *BMJ Qual & Saf*. 2016;25:164–72. <https://doi.org/10.1136/bmjqs-2015-004521>.
40. Berkowitz SA, Terranova J, Hill C, Ajayi T, Linsky T, Tishler LW, et al. Meal delivery programs reduce the use of costly health care in dually eligible medicare and medicaid beneficiaries. *Health Aff*. 2018;37:535–42.
41. Shashikumar SA, Waken RJ, Luke AA, Nerenz DR, Maddox KEJ. Association of stratification by proportion of patients dually enrolled in medicare and medicaid with financial penalties in the hospital-acquired condition reduction program. *JAMA Intern Med*. 2021;181:330–8. <https://doi.org/10.1001/jamainternmed.2020.7386>. **This study examined the effectiveness of a theoretical stratification system for the HACRP program, and highlighted potential benefits for decreasing financial penalties among safety-net hospitals.**
42. Sandhu S, Saunders RS, McClellan MB, Wong CA. Health equity should be a key value in value-based payment and delivery reform. *Health Affairs Blog*. 2020. <https://doi.org/10.1377/hblog20201119.836369>.
43. Sivashanker K, Gandhi TK. Advancing safety and equity together. *N Engl J Med*. 2020;382:301–3. <https://doi.org/10.1056/NEJMp1911700>.
44. Huddleston L, Bennett S, Hermann C. A decade in trying to increase hand hygiene—finally success. *Infect Control Hosp Epidemiol*. 2020;41:s93–4. <https://doi.org/10.1017/ice.2020.592>.
45. Gray D, Nussle R, Cruz A, Kane G, Toomey M, Bay C, et al. Effects of a catheter-associated urinary tract infection prevention campaign on infection rate, catheter utilization, and health care workers' perspective at a community safety net hospital. *Am J Infect Control*. 2016;44:115–6. <https://doi.org/10.1016/j.ajic.2015.08.011>.

46. • Saleem Z, Godman B, Hassali MA, Hashmi FK, Azhar F, Rehman IU. Point prevalence surveys of health-care-associated infections: a systematic review. *Pathog Glob Health*. 2019;113:191–205. <https://doi.org/10.1080/20477724.2019.1632070>. **Systematic review with extensive suggestions on potential interventions to mitigate healthcare associated infections.**
47. • Kaplan A, O'Neill D. Hospital price discrimination is deepening racial health inequity. *NEJM Catalyst*. 2020. <https://doi.org/10.1056/CAT.20.0593>. **Described negative impacts hospital price discrimination have on health inequities.**
48. NQF issues quality roadmap for reducing healthcare disparities. National Qual Forum. 2017. http://www.qualityforum.org/News_And_Resources/Press_Releases/2017/NQF_Issues_Quality_Roadmap_for_Reducing_Healthcare_Disparities.aspx. Accessed 20 Mar 2021.
49. Johnson SF, Ojo A, Warraich HJ. Academic health centers' anti-racism strategies must extend to their business practices. *Ann Intern Med*. 2021. <https://doi.org/10.7326/M20-6203>.
50. Boyd RW, Lindo EG, Weeks LD, McLemore MR. On racism: a new standard for publishing on racial health inequities. *Health Affairs Blog*. 2020. <https://www.healthaffairs.org/doi/https://doi.org/10.1377/hblog20200630.939347/full/>. Accessed 11 Mar 2021.
51. • Kind AJH, Buckingham W. Making neighborhood disadvantage metrics accessible: the neighborhood atlas. *N Engl J Med*. 2018;378:2456–8. <https://doi.org/10.1056/NEJMp1802313>. **Highlights an impactful tool to measure and study neighborhood socioeconomic disadvantage using a publicly-available, area-level metric.**
52. Sopher CJ, Adamson BJS, Andrasik MP, Flood DM, Wakefield SF, Stoff DM, et al. Enhancing diversity in the public health research workforce: the research and mentorship program for future HIV vaccine scientists. *Am J Public Health*. 2015;105:823–30. <https://doi.org/10.2105/AJPH.2014.302076>.
53. Phelan JC, Link BG. Is racism a fundamental cause of inequities in health. *Ann Rev Sociol*. 2015;41:311–30. <https://doi.org/10.1146/annurev-soc-073014-112305>.
54. Holmes AM, Nir M. Retention of minority faculty: does a leaky pipeline threaten achieving diversity in academic health administration? *J Health Adm Educ*. 2017;34:229–42.
55. Lett LA, Murdock HM, Orji WU, Aysola J, Sebros R. Trends in racial/ethnic representation among US medical students. *JAMA Netw Open*. 2019;2: e1910490. <https://doi.org/10.1001/jamanetworkopen.2019.10490>.
56. American College of Healthcare Executives. Increasing and sustaining racial diversity in healthcare leadership. 2020. <http://www.ache.org/about-ache/our-story/our-commitments/policy-statements/increasing-and-sustaining-racial-diversity-in-healthcare-management>. Accessed 9 Feb 2021.
57. • Ma A, Sanchez A, Ma M. The impact of patient-provider race/ethnicity concordance on provider visits: updated evidence from the medical expenditure panel survey. *J Racial Ethn Health Disparities*. 2019;6:1011–20. <https://doi.org/10.1007/s40615-019-00602-y>. **Reviewed benefits of racial concordance between physicians and patients on minority patients' use of preventive care.**
58. • Shen MJ, Peterson EB, Costas-Muñiz R, Hernandez MH, Jewell ST, Matsoukas K, Bylund CL, Bylund CL. The effects of race and racial concordance on patient-physician communication: a systematic review of the literature. *J Racial Ethn Health Disparities*. 2018;5:117–40. <https://doi.org/10.1007/s40615-017-0350-4>. **Systematic literature review of the effects of patient-physician racial concordance on communication.**
59. • Alsan M, Garrick O, Graziani G. Does diversity matter for health? Experimental evidence from Oakland. *Am Economic Rev*. 2019;109:4071–111. <https://doi.org/10.1257/aer.20181446>. **Randomized controlled trial demonstrating the benefits of patient-physician racial concordance on preventive care utilization and health outcomes among Black men.**

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