

A Comprehensive Review of Disparities in Surgical Site Infection Diagnosis and Management in Highly Pigmented Skin Tones

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Received: 25 April 2025

Accepted: 10 May 2025

Published: 20-May 2025

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Abstract

Surgical site infections (SSIs) remain a significant cause of postoperative morbidity, yet their diagnosis and management in patients with darker skin tones present unique and underexplored challenges. Current clinical criteria heavily rely on visual signs such as erythema, which may be less apparent in highly pigmented skin, leading to delayed or missed diagnoses. This review examines the intersection of skin pigmentation, diagnostic accuracy, and disparities in SSI outcomes. We explore five key areas: (1) the limited visibility of erythema and the lack of diagnostic tools validated for darker skin; (2) the influence of provider bias on clinical decisionmaking; (3) the impact of healthcare segregation on access to quality surgical care; (4) the absence of skin tone-specific management protocols; and (5) the poorly understood long-term outcomes and complications of SSIs in patients with highly pigmented skin, including increased risk of keloid and hypertrophic scarring. Through a synthesis of current literature, we highlight critical gaps and propose future directions for research and clinical practice aimed at improving equity in surgical outcomes. Addressing these disparities is essential for developing more inclusive diagnostic frameworks, enhancing provider education, and ultimately improving postoperative care for patients with darker skin tones. This abstract is supported by the literature, such as the review by Bonner et al. (2023), which discusses racial and ethnic inequities in surgical care and the need for evidence-based interventions to address these disparities. Additionally, the work by Hooper et al. (2022) on racial/ethnic health disparities in dermatology underscores the importance of addressing provider biases and improving diagnostic accuracy in skin of color.

1. INTRODUCTION

Surgical site infections (SSIs) are infections that occur at or near a surgical incision within 30 days of the procedure, or up to one year if prosthetic material or an implant is placed. SSIs may be superficial-limited to the skin-or deep, underlying tissues, organs, involving or spaces manipulated anatomical during surgery.[1] SSIs are one of the most common causes of postoperative complications and death, and they lead to increased hospital admissions, longer hospital stays, higher healthcare costs, and higher mortality rates. For instance, SSIs following colorectal surgery can increase the hospital stay by 7.8 to 8.5 days and the costs by \$18,410 to \$20,890. [2] SSIs are more frequent in low and middle income countries than in high income countries as per the World Health Organization (WHO). [4]

Nonetheless, the issue of diagnosis and management remains a challenge especially for the patients with darker skin pigmentation. Skin pigmentation can hinder the early identification of erythema, warmth, or other typical signs of infection that are easily seen in lighter skin. The Fitzpatrick skin type classification is a dermatological classification from I (very fair skin) to VI (very dark skin) that helps to explain how melanin levels affect the ability to diagnose. Patients with Fitzpatrick types V and VI may have delayed diagnosis or receive suboptimal clinical examination which may result in worse outcomes. This review seeks to bring together existing evidence on the issue of skin color and skin tone in the diagnosis and treatment of SSIs. We believe that highlighting the impact of pigmentation on clinical evaluation and results will be useful for further research, developing more inclusive diagnostic standards, and promoting practices that will help reduce health disparities.

2. METHODOLOGY

This review aimed to explore existing literature on disparities in the diagnosis and management of surgical site infection (SSI) in individuals with highly pigmented skin tones. A literature analysis was conducted using PubMed, Embase and Google Scholar. The search strategy combined Medical Subject Headings (MeSH) terms and keywords related to surgical site infections. wound healing, skin pigmentation, and disparities. The following search terms were used, with appropriate Boolean operators (AND, OR): ("surgical site infection" OR "SSI" OR "postoperative infection" OR "wound infection") AND ("skin pigmentation" OR "pigmented skin" OR "Fitzpatrick skin type") AND ("management" OR "treatment" OR "outcomes" OR "disparities" OR "inequities").

Articles were included if they met the following criteria: published between January 2015 and February 2025, peer-reviewed original research articles, systematic reviews, or meta-analyses. Studies that focused solely on animal models or in vitro research were excluded.

Titles and abstracts were screened to assess relevance based on inclusion criteria. Full-text articles were retrieved for studies that met the preliminary screening criteria. Key data extracted from selected studies included population demographics, study design, type of surgical procedure, Fitzpatrick skin type (if reported), outcomes related to SSI diagnosis and management, and disparities or recommendations for equity-focused care.

2.1. Visibility of Erythema and Limitations in Diagnostic Tools

Erythema is a well-established marker for the early detection of inflammation associated with surgical site infections (SSIs), but its clinical visibility is often reduced in patients with darker skin tones. In highly pigmented skin, redness may not appear clearly, obscuring one of the earliest signs of infection. In a clinical study, erythema was present in only 2.3 percent of patients with Fitzpatrick types V and VI, despite microbial loads similar to those found in lighter skin. [5] This limitation challenges the assumption that visual signs are consistent across all skin tones. A global clinician survey found that nearly 40 percent of respondents had difficulty assessing wound infections in darker skin, and over two-thirds reported not using a standardized method for evaluating skin tone in wound care. [6] Visual-based frameworks, including the ASEPSIS scoring system, rely on indicators such as redness, discharge, and tissue separation. However, these signs may appear inconsistently in melanin-rich skin. [7] Although widely used, such tools can yield variable results when visual cues are influenced by pigmentation. Relying on erythema as a primary sign in patients with highly pigmented skin may lead to diagnostic delays and contribute to disparities in surgical outcomes.

Diagnostic inaccuracy in patients with darker skin is a well-documented clinical concern that extends beyond individual case reports. In a multi-site observational study, early signs such as erythema and localized warmth were frequently underreported in patients with darker skin tones, even when bacterial cultures confirmed infection. [5] Clinician feedback supports this finding, with ervthema and cellulitis identified as particularly difficult to evaluate in individuals with Fitzpatrick types V and VI. [6] Structured tools like the ASEPSIS score aim to improve objectivity in postoperative wound assessments but still depend heavily on visual impressions such as redness and exudate color. These features can appear differently depending on the degree of skin pigmentation. [7] The lack of skin toneadapted protocols increases the risk of missed or delayed diagnoses, particularly during the early stages of infection when prompt treatment is most effective. Delays in detection can lead to more severe infections requiring surgical revision or systemic antibiotic therapy. These are not merely technical oversights but symptoms of broader systemic inequities. Addressing this

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issue requires a reevaluation of how skin tone is incorporated into both training and clinical protocols.

Current tools for assessing wounds do not adequately adjust for skin tone, which significantly impacts diagnostic reliability. Many telemedicine and mobile wound documentation platforms depend on color photography, which may not effectively capture erythema or inflammation on darker skin due to lighting conditions and sensor limitations. [7] In contrast. non-visual techniques such as thermal imaging have demonstrated clinical utility. These portable devices detect areas of elevated temperature, enabling clinicians to identify possible infections without relying on visible redness, which may not appear on pigmented skin. [8] Clinical studies show that both thermal and fluorescence imaging significantly improve the detection of bacterial burden in darker-skinned patients, with some trials reporting over tenfold increases in sensitivity compared to visual assessment alone. [5] Despite these advantages, such technologies remain underutilized and are not integrated into most wound care guidelines. Additionally, diagnostic systems that incorporate image-based assessments often underperform when tested on richly pigmented skin due to a lack of representation in training datasets. [9] Achieving diagnostic equity requires validation of these emerging tools across a wide range of skin tones and patient populations.

Closing the gap in surgical site infection detection across diverse populations will require both clinical and technological change. Although skin tone affects how well infection signs such as erythema are observed, current wound care protocols rarely include baseline documentation of a patient's skin color. [6] While experienced clinicians may recognize erythema more reliably, objective tools such as thermal imaging and skin impedance sensors, which measure internal tissue changes using ultrasound rather than relying on visible redness, offer complementary diagnostic methods when erythema is difficult to detect. [8,10] These devices are especially valuable in low-resource settings and among providers with limited exposure to darker skin presentations. Fluorescence-based detection techniques have also improved diagnostic sensitivity across skin tones, yet their adoption in postoperative care remains limited. [5] The absence of diverse skin tones in medical training materials continues to hinder equitable care. Routine documentation of skin tone and the broad validation of diagnostic technologies across different pigmentation levels are essential for addressing this disparity. Without these reforms, patients with darker skin will continue to experience preventable delays in infection recognition and poorer surgical outcomes.

2.2. Mechanisms of Surgical Wound Healing

Wound healing occurs in four distinct phases: hemostasis, inflammation, proliferation, and remodeling. Hemostasis begins immediately after injury, where platelet aggregation leads to the formation of a fibrin clot that halts bleeding and initiates cell signaling. [11] This is followed by inflammation, during which neutrophils and and secrete macrophages remove debris cytokines that regulate the transition to the next phase of healing. [12] The proliferative phase re-epithelialization, involves fibroblast migration, and angiogenesis, ultimately forming granulation tissue that serves as the foundation for tissue repair. [13] During this stage, extracellular matrix proteins such as fibronectin and type III collagen are deposited. These are gradually replaced by type I collagen in the final remodeling phase, strengthening the tissue. [12] The efficiency of these stages determines the success of wound healing, while disruptions at any point can result in chronic wounds or excessive fibrosis.

Among the key regulators of wound healing is transforming growth factor-beta (TGF- β), a signaling molecule that orchestrates cell migration, immune responses, and extracellular matrix production. In the early stages, TGF- β 1, secreted by platelets and macrophages, facilitates fibroblast activation and collagen deposition, reinforcing the wound site. [14] Beyond structural support, TGF- β 1 plays a crucial role in modulating immune cell recruitment and angiogenesis. However, excessive activity of this isoform has been linked to fibrosis and hypertrophic scarring. In contrast, TGF-B3 has been associated with reduced scarring and improved tissue remodeling. [11] These isoforms function through Smad-dependent pathways, regulating gene expression critical to tissue repair. Because of TGF-\beta's dual role in both promoting healing and contributing to fibrosis, clinical interventions aim to modulate its activity to prevent pathological scarring, particularly in populations predisposed to hyperplastic responses.

In addition to TGF- β , vascular endothelial growth factor (VEGF) plays a pivotal role in the

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proliferative phase by driving angiogenesis, the formation of new blood vessels. Hypoxiainducible VEGF is released by macrophages and platelets, promoting endothelial cell migration and capillary formation to restore oxygen supply to the regenerating tissue. [14] This process is essential for sustaining metabolic demands during wound healing. However, when VEGF levels are insufficient, such as in diabetic wounds, vessel formation is impaired, leading to delayed closure and prolonged inflammation. [11] VEGF also enhances endothelial cell survival and vascular permeability, which are necessary for successful wound healing. Given its importance, VEGF-based therapies have been explored in clinical settings to treat chronic wounds. Restoring angiogenic capacity is particularly crucial in surgical wounds prone to ischemia, infection, or delayed closure, where inadequate vascularization can compromise outcomes.

While angiogenesis and extracellular matrix remodeling shape the wound bed. Wnt signaling contributes to re-epithelialization and pigmentation during healing. Wnt ligands activate β -catenin pathways that stimulate keratinocyte and stem cell proliferation, accelerating epidermal closure and restoring the skin barrier. [12] Beyond structural repair, Wnt signaling also influences melanocyte precursors, affecting pigmentation in newly healed tissue. This is especially relevant for surgical wounds in darker skin, where post-healing pigmentation changes may alter scar visibility. Aberrant Wnt signaling has been linked to pathological healing and hyperpigmentation, highlighting its potential role in postoperative outcomes. Larouche et al. (2018) emphasize that interactions between Wnt signaling and inflammatory cytokines shape the wound microenvironment, suggesting that targeted modulation of these pathways could improve healing in melanin-rich skin. [13] Understanding the interplay between Wnt, VEGF, and TGF- β in wound repair may provide insights into more effective interventions, particularly for individuals at higher risk of pigmentation abnormalities or fibrotic scarring.

2.3. Long-Term Outcomes and Complications in Darker Skin

Long-term outcomes and complications of SSIs in patients with darker skin tones are shaped by a combination of biological, genetic, and sociocultural factors. While it's well-known that

certain skin types are more likely to develop hypertrophic scars and keloids after trauma or surgery, there is a lack of longitudinal studies examining these complications, especially in patients with darker skin (Marella et al., 2023). This prevents the development of effective interventions to improve outcomes for these patients. Patients with darker skin tones are at a of developing higher risk keloids and hypertrophic scars following SSIs, and this tendency is tied to the fact that fibroblast activity tends to be more pronounced in darker-skinned individuals compared to those with lighter skin (Andrews et al., 2016).

This increased activity contributes to an exaggerated wound healing response, and it is characterized by excessive collagen deposition and prolonged inflammatory phases. Abnormal wound healing characteristics therefore make individuals with darker skin more susceptible to developing hypertrophic scars and keloids. The transforming growth factor-beta (TGF-β) signaling pathway also plays a major role in this process. Overexpression of TGF- β and its downstream signaling components has been linked to fibrotic scarring (Huang et al., 2020). When considering the implications of this pathway, it holds an important role in promoting fibroblast proliferation and collagen synthesis.

In addition to TGF- β signaling, genetic predispositions and epigenetic modifications further complicate wound healing in darkerskinned individuals. A study has identified polymorphisms in genes regulating collagen synthesis, fibroblast activity, and inflammatory responses as factors increasing the risk of keloid formation (Dmytrzak et al., 2020). These findings imply that there is a genetic basis for increased scarring. They also highlight the complexity of wound healing. Another study has shown that increased expression of pro-fibrotic cytokines, such as interleukin-6 (IL-6), may contribute to exaggerated scar formation (Kenny et al., 2023). This suggests that heightened cytokine activity could lead to a further influence genetic susceptibilities. Additionally, of epigenetic modifications such as DNA methylation have been implicated in the dysregulation of wound healing pathways (Yasom et al., 2021). These modifications can worsen scar formation and increase the likelihood of post-inflammatory hyperpigmentation. Genetic and epigenetic demonstrate the importance factors for personalized wound management strategies that

examine the biological characteristics of highly pigmented skin.

The physical manifestations of keloids and hypertrophic scars are often associated with psychosocial concerns. Unsightly scars can lead to diminished self-esteem, social stigma, and decreased psychological well-being (Kim et al., 2022). This negative impact is likely worsened when healthcare providers overlook the specific needs of patients with darker skin. unintentionally reinforcing feelings of neglect in the medical system. Additionally, studies have shown that the pain associated with keloids and hypertrophic scars is frequently dismissed by healthcare providers (Ongoro et al., 2023). This not only contributes to inadequate pain management but mav also exacerbate psychological distress by invalidating the patient's experience of pain. Patients who experience prolonged scarring following SSIs may also encounter functional impairments (Zwanenburg et al., 2021). This can occur when scars form over joints or other areas essential for mobility. The psychosocial burden of these complications has shown to be worsened by healthcare systems that lack the necessary materials to address the specific needs of patients with darker skin.

Despite these well-known disparities, there are still very few longitudinal studies that examine how SSIs affect patients with darker skin tones. Current guidelines for SSI management are mainly obtained from studies conducted on populations with lighter skin tones (Garg et al., 2023). The lack of inclusivity in these studies leaves knowledge gaps regarding how SSIs progress in patients with highly pigmented skin. Furthermore, the absence of skin tone-specific data collection in clinical trials continues to hinder the understanding of long-term complications unique to darker skin tones (Jacobs et al., 2023. This deficiency prevents the development of evidence-based interventions. Research has also shown that imaging technologies and diagnostic tools commonly used to assess SSIs are often calibrated on lighter skin tone (Rochon et al., 2024). This bias can lead to more frequent diagnostic errors in patients with darker skin and limits the reliability of clinical studies that depend on these tools. Filling these gaps will require more research that looks specifically at how SSIs affect patients with diverse skin tones and developing guidelines that are truly inclusive.

2.4. Provider Bias and Clinical Decision-Making

2.4.1. Implicit Bias and Its Impact-Evidence that providers perceive pain, infection risk, and healing capacity differently by race/skin tone

Implicit bias is a form of bias where the stereotypes and attitudes that individuals unconsciously hold impact their beliefs and how they perceive and interact with others.

These biases are prevalent in all areas including healthcare. Several studies have examined the role that implicit bias plays amongst health care providers, particularly, as it relates to racial differences in pain perception, infection risk, and healing capacity. In one study by Hoffman et al., it was shown that nearly 50% of medical students and residents surveyed held at least one false belief about the biological differences between Black and White patients. Specifically, a racial bias in pain perception was noted with many believing that providers Black patients than their experience less pain White counterparts. This implicit bias has significant clinical implications, as it will impact how health providers determine treatment care recommendations. The same study also revealed that the individuals who held false beliefs regarding differences in pain were more likely to make race-based treatment decisions. This further underscores the potential harm of implicit bias in clinical practice, which often leads to an underestimation of pain levels in Black patients and as result less effective pain management. [27]

Similar to pain perception, implicit biases also impact wound care and clinicians assessment of infection risk. It is known that early detection of wound infections is crucial for timely intervention.

However, many healthcare providers have reported difficulty with accurately recognizing the early clinical signs of infection particularly in patients with darker skin tones. For instance, diagnostic indicators of infection, such as redness, are often highlighted in wound assessment tools but are inherently biased toward lighter skin tones where it may be easier to recognize redness. In a survey conducted by Dhoonmoon et al., 200 healthcare providers from around the world reported that recognizing wound infections, particularly redness, were a

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main challenge when treating patients with dark skin tones. This bias can result in delayed or inadequate care, highlighting the need for increased healthcare training to not only promptly recognize various wound infection presentations on darker skin tones but also create more reliable diagnostic tools that can be applicable in darker skin patients. [28]

2.4.2. Underuse of Antibiotics, Debridement, or Advanced Wound Care in Patients with Darker Skin

The underuse of antibiotics, debridement, or advanced wound care in patients with darker skin tones has significant implications for their treatment and outcomes. Several studies have documented racial disparities in wound care, with patients of color often receiving less timely or One effective interventions. such study. conducted by Johnson et al., highlights the role of skin pigmentation in the clinical diagnosis of wound infection. Despite equal bacterial loads in wounds of patients with light, medium, and dark skin tones, healthcare providers were less likely to detect erythema, delayed wound healing, and wound breakdown in patients with darker skin. This is a critical finding, as it suggests that patients with darker skin tones may not receive prompt or adequate treatment for their wounds, whether through medication or surgical debridement. The failure to promptly address these issues increases the risk of infections worsening, potentially leading to more severe complications, including the need for more invasive surgeries and even higher mortality rates. [29]

The issue of underuse of appropriate antibiotic treatment is similarly concerning. Wurcel et al. (2021) examined the racial disparities in antibiotic prescriptions for hospitalized patients with skin and soft tissue infections (SSTIs). Their analysis revealed a significant difference in the prescribing patterns of β -lactams, such as cefazolin, which is considered first-line therapy treating Staphylococcus aureus for and Streptococcus species which are the two most common culprits in skin infections. The study found that cefazolin was more commonly prescribed to White inpatients (13%) compared to Black inpatients (5%), whereas clindamycin, an alternative antibiotic, was more frequently prescribed to Black patients (12%) compared to White patients (7%). This difference in antibiotic prescription practices is concerning for several

reasons. Cefazolin is considered the more effective first-line treatment for certain skin infections, while clindamycin is often considered inferior, especially in cases of methicillinresistant Staphylococcus aureus (MRSA). The racial disparity in prescribing practices may result in Black patients receiving less optimal care for their skin infections. Furthermore, even after adjusting for factors such as MRSA colonization, infection severity, and penicillin allergies, White patients were still found to receive cefazolin more often than Black patients. This suggests that racial bias, whether implicit or explicit, may play a role in the decision-making process, leading to inequities in the care patients receive. [30]

2.5. Data on Provider Education and Skin Tone Training Gaps

2.5.1. Dermatology and surgery education largely based on lighter-skinned imagery

An important issue in medical education is the lack of representation of diverse skin tones in textbooks, which may perpetuate gaps in knowledge and contribute to diagnostic challenges. Medical education has traditionally relied on lighter-skinned imagery in educational materials. This lack of diversity in clinical illustrations and teaching tools has significant consequences, especially for clinicians who will inevitably treat a variety of skin conditions across all racial and ethnic groups. Despite this, educational materials are often limited in their depiction of how various pathologies, such as erythema, infections, or surgical wounds, manifest on darker skin tones. In one study, Louie et al., conducted an analysis of 4,146 images from widely used medical textbooks, such as Atlas of Human Anatomy, Bates' Guide to Physical Examination & History Taking, Clinically Oriented Anatomy, and Gray's Anatomy for Students. They found that less than 5% of images in these textbooks included persons with dark skin tones, highlighting a significant disparity in the representation of diverse skin tones. [31] In a similar study, Ajmal et al. examined 556 images from four prominent general surgery textbooks and found that 96.9% of the images were of patients with light skin tones, while less than 4% depicted patients with dark skin tones. [33] This disparity is not unique to medical or surgical texts. In dermatology education, this issue is also particularly prominent. Reilley-Luther et al. analyzed four popular dermatology textbooks, Bolognia, Andrews' Diseases of the Skin, Lookingbill & Marks' Principles of Dermatology, and Fitzpatrick's Dermatology in General Medicine, and found that the majority of images depicted Fitzpatrick skin types II and III. The least represented skin types in these textbooks were Fitzpatrick types V and VI. This underrepresentation of darker skin tones and lack of adequate educational materials exacerbates health disparities by limiting medical providers' ability to recognize various conditions and provide adequate care. [32]

2.5.2. Skin Tone Training Gaps in Medical Education: Low Confidence in Assessing Surgical Site Infections in Skin of Color

In addition to the visual representation gaps in medical education and also dermatology and surgical textbooks, trainees including medical students and residents, often report low confidence in assessing surgical site infections in patients with skin of color. A study by Shango et al., found that medical students at one university reported the lowest confidence in diagnosing skin infections in patients with darker skin tones in comparison to other dermatological conditions including skin cancers. [34] This uncertainty in diagnosing capabilities could be attributed to inadequate training of how dermatological conditions present in darker skin tones as well as limited educational resources that represent diverse clinical images. Without such training or resources, students may struggle clinically to identify subtle signs of infection, ultimately resulting in practicing physicians who feel illprepared to address the needs of their patients with darker skin tones. To address these gaps in education it is essential that medical schools and residency programs include comprehensive education on dermatologic conditions across various skin tones, especially skin of color.

2.5.3. Case Examples and Studies Showing Disparities in Time-to-Treatment and Surgical Site Monitoring (discussed above)

Disparities in time-to-treatment and surgical site monitoring represent a critical aspect of healthcare inequalities, particularly among patients with darker skin tones. A study by Johnson et al. (2024) highlights how differences in skin pigmentation can influence the timely detection of wound infections and ultimately impact the treatment outcomes for patients with

skin of color. The researchers analyzed total bacterial load (TBL) in 350 chronic wounds and found equivalent mean TBL from tissue cultures between Fitzpatrick skin color groups (light, medium, and dark tones). However, the researchers found that patients with highly pigmented skin were 8.4 times less likely to detect wound infections using the International Wound Infection Institute guidelines. [29] This underdetection likely leads to delayed treatments and increased risk of complications, such as wound dehiscence, sepsis and prolonged infections. Further emphasis must be placed on improving clinical practice and bridging gaps in education to ensure all patients receive adequate and timely care no matter their skin tone. [29]

2.6. Systemic Barriers and Gaps in Culturally Competent SSI Care

2.6.1. Systemic Barriers To Culturally Competent Ssi Care

Systemic barriers to culturally competent Supplemental Security Income (SSI) care for patients with darker skin tones are multifaceted. One of the most important concerns is the pervasive lack of clinical training specific to identifying signs of infection in patients with melanin-rich skin. Harrison (2023) highlights that healthcare professionals often lack confidence in assessing patients with dark skin, leading to delayed treatment and safety issues. This lack of confidence stems from insufficient training and a bias in medical literature favoring lighter skin tones. This issue is compounded by a medical curriculum and body of literature heavily favoring lighter skin, creating an implicit bias in both training materials nd clinical algorithms. In order to solve these issues, medical education must be completely redesigned, using clinical simulations and a variety of dermatological images. To overcome these obstacles and enhance cultural competency in healthcare, specific educational programs and structural adjustments are needed.[35] In the absence of these adjustments, patients of color continue to be more vulnerable to avoidable complications. exacerbate which would further health inequalities in SSI outcomes.

2.6.2. Structural Barriers to High-Quality Surgical Settings

The quality of surgical care is greatly impacted by systemic variables, especially in hospitals that serve populations that are predominantly Black and Brown. According to Gaskin et al., these

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hospitals usually have worse surgical safety scores, fewer resources, and restricted access to cutting-edge technology that is essential for the best possible postoperative results. [36] These defects are not coincidental; they stem from systemic disinvestment driven by geographic. racial, and socioeconomic segregation. Zip code, insurance status, and racial demographics also have a significant impact on the availability and quality of surgical specialists as well as postoperative follow-up care. Delays in identifying surgical site infections (SSIs), worse health outcomes, and more postoperative complications are all directly caused by these systemic inequities. [37] Meaningful improvements in surgical outcomes require policy-level investments in underserved hospitals and the redistribution of healthcare resources based on need rather than location or demographics.

2.6.3. Data on Care Delays and Readmission Rates

Racial minority populations are disproportionately impacted by geographic segregation and limited transportation alternatives, which causes significant delays in follow-up care and wound evaluations. [38] Due to delayed diagnosis and restricted access to specialized wound care clinics, studies have repeatedly found that these individuals have higher rates of SSI readmissions. [39] For example, a comparison of patients living in racially segregated neighborhoods versus those in more integrated, resource-rich areas revealed significantly longer recovery periods and higher readmission risks for SSIs. [40] To reduce disparities in readmission and recovery, healthcare systems should address these access issues through community-based wound care programs, mobile clinics, and patient navigation services that bridge the transportation and follow-up gap.

2.6.4. Intersectionality with Socioeconomic Status

Disparities faced by racially minority groups receiving surgery are further exacerbated by intersectionality. Due to compounding factors such as housing instability, lower health literacy, job instability, and limited access to resources that promote health, poverty and racial identity greatly increase the likelihood of poor surgical outcomes. Johnson et al. (2020) emphasize that these social determinants of health are not only

prevalent among low-income patients but are more likely to co-occur in communities of color, exacerbating surgical risk profiles. [41] For example, a patient discharged with wound care instructions may lack a clean space to change dressings or the financial means to purchase medical supplies, increasing the likelihood of SSI development. These issues are isolated but represent the downstream effects of structural underinvestment racism and chronic in communities of color. These intersecting disadvantages mean that even when care is initiated, the continuity and impact of that care is often compromised. It is important toa address these disparities through integrating social support services and incorporating social determinants screening into preoperative planning.

2.6.5. Current Guidelines Are Race-Blind

Current clinical guidelines from organizations like the CDC and the American College of Surgeons (ACS) overlook how skin pigmentation might influence the detection of surgical site infections (SSIs). A key early indicator of infection, redness or erythema, is readily noticeable on lighter skin but can be considerably more difficult to identify on darker skin tones.[42] Despite this, the CDC's SSI prevention guidelines remain silent on the adjustment of evaluations by skin color. This shortcoming results in delayed SSIs identification and risk of underestimation of the severity, especially in Black and Brown patients.[43] There are no guidelines for altering national wound surveillance or postoperative monitoring to account for such differences, allowing race-blind clinical standards to prevail. [44] By failing to recommendations, provide race-conscious national guidelines are normalizing a one-sizefits-all model, which does not serve all patients equally. It is important that future updates to SSI prevention and management protocols incorporate these considerations to ensure that all skin tones are accounted for in visual diagnostic criteria.

2.7. Evidence-Based Interventions to Reduce Disparities

2.7.1. Successful Models in Surgical Equity

Strategic surgery pipeline programs can enhance diversity in surgical specialties and positively impact patient outcomes. Surgical pipeline programs are designed to increase the number of surgeons from underrepresented backgrounds, and have been shown to successfully recruit and graduate underrepresented minority students into surgical residency programs (Clayborne, E. P., et al). Race and ethnic concordance between patients and providers has been connected with enhanced communication, improved patient trust, and better adherence to postoperative wound care instructions (Saha, S. et al). These are critical components in SSI prevention and management, as studies suggest that shared racial identity may also mitigate medical mistrust. This is particularly noted in black and brown communities, where historical injustices have shaped perceptions of the healthcare system. These relationships create space for open dialogue around wound care concerns, which support earlier detection and treatment of SSIs.

2.7.2. Cultural competency training in wound care and surgery

Cultural competency training in wound care and surgery is essential for reducing implicit bias and improving the accurate assessment of skin pathology across diverse skin tones (Chenoweth, L., et al). This training reduces implicit bias and enhances accurate assessment of skin pathology across skin tones by equipping healthcare professionals to recognize and address variations in skin presentation. This supports effective diagnosis and management of wounds and surgical complications. Research highlights that existing disparities in healthcare outcomes are often a result of insufficient provider awareness or training regarding the diverse presentations of dermatological conditions in patients of color. In instances such as the ability to discern subtle changes in skin color, texture, and temperature is vital in wound assessment, and cultural competency training enhances this skill and mitigates any impact of implicit bias in delayed treatment (Mora, R., et al).

2.7.3. Gaps in Implementation Research

Despite promising models for improved methods of addressing surgical wound care in deeper skin tones, there remains a notable gap in implementation research. Most existing programs focus broadly on equity in surgery without tailored efforts to address the diagnostic challenges posed by variations in skin pigmentation. Lack of detail in existing data, such as limited categorizations by Fitzpatrick skin type, dampens the ability to design and scale interventions targeting these disparities. Without additional and detailed data, disparities in SSI diagnosis across racial and skin tone groups remain obscured, hindering progress in both clinical and research realms.

3. RECOMMENDATIONS FOR PRACTICE AND POLICY

Addressing disparities in wound care and surgical outcomes requires a multifaceted approach encompassing standardized reporting, equitable data sets, and incentivized research. Incorporation of standardized reporting by Fitzpatrick skin type into surgical records would allow for accurate surveillance of disparities, as evidenced by studies highlighting the variability in dermatological conditions across different skin tones (Subedi, S.K., et al). The development of equitable imaging and training datasets can reduce racial biases in diagnostic algorithms. Lastly, studies focused on addressing surgical disparities through culturally competent care research show that incentivizing and disparity-focused surgical research is vital for developing targeted interventions. The implementation of these recommendations can lead to more equitable effective surgical practices and wound care for all patients.

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Citation: Ochuwa Precious Imokhai et al. A Comprehensive Review of Disparities in Surgical Site Infection Diagnosis and Management in Highly Pigmented Skin Tones. ARC Journal of Dermatology. 2025; 8(4):13-24. DOI:https://doi.org/10.20431/2456-0022.0804002

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