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AHA SCIENTIFIC STATEMENT

Disparities in Current Pulmonary Embolism Management and Outcomes: A Scientific Statement From the American Heart Association

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ABSTRACT: Pulmonary embolism is a common cause of cardiovascular-associated morbidity and mortality. Although pulmonary embolism affects individuals from all demographics, the incidence of pulmonary embolism is higher among people from certain racial groups, reproductive-age women compared with age-matched men, and transgender people taking estrogen hormones. Furthermore, disparities may exist in the diagnosis or management strategies of pulmonary embolism associated with race, ethnicity, sex, or socioeconomic status, which may correlate with poorer downstream outcomes, including recurrent pulmonary embolism, chronic thromboembolic pulmonary hypertension, or short- or long-term mortality. This scientific statement summarizes disparities in diagnosis, treatment strategies, and outcomes related to pulmonary embolism, and reviews approaches to create equitable pulmonary embolism care and address the knowledge gaps in the literature.

Key Words: AHA Scientific Statements ■ delivery of health care ■ pulmonary embolism ■ risk

Pulmonary embolism (PE) is a potentially life-threatening disease responsible for ≈100 000 deaths each year in the United States.[1] Recent data indicate that the PE mortality rate increased between 2008 and 2018.[2] Furthermore, disparities have been identified across different demographic groups, which may affect PE treatment strategies and outcomes.[2,3] Recognizing these disparities, and understanding their complex association with PE incidence, presentation, and treatment, may help identify individual- or policy-level interventions to improve outcomes for those most affected by inequitable PE care.

This scientific statement identifies different populations of patients at risk for disparate PE management based on a review of the scientific literature. Differences in clinical presentation, diagnosis, and treatment, and the potential effects on mortality, recurrent PE, and chronic thromboembolic pulmonary hypertension (CTEPH), are reviewed in the context of race, sex, gender, and socioeconomic status (Figure 1). Methods to address disparities in current and future research investigations for PE, including clinical trials, are discussed.

METHODS

A diverse group of experts involved in research and clinical care of patients with PE was convened. For reporting the incidence, epidemiology, or prognostication, where available, studies with detailed clinical information (such as representative large prospective cohort studies) were prioritized. If not available, regional or single-center studies using high-quality patient-level data collection were considered, recognizing that external validity may be limited. Large-scale studies using administrative claims data (ie, International Classification of Diseases codes) were considered, particularly if they used a validated reliable method for identification of patients or the outcome variable.[4,5] For comparative effectiveness or safety questions, randomized controlled trials (RCTs) and rigorously conducted pooled analyses of trials were prioritized. If RCTs were not available, prospective controlled

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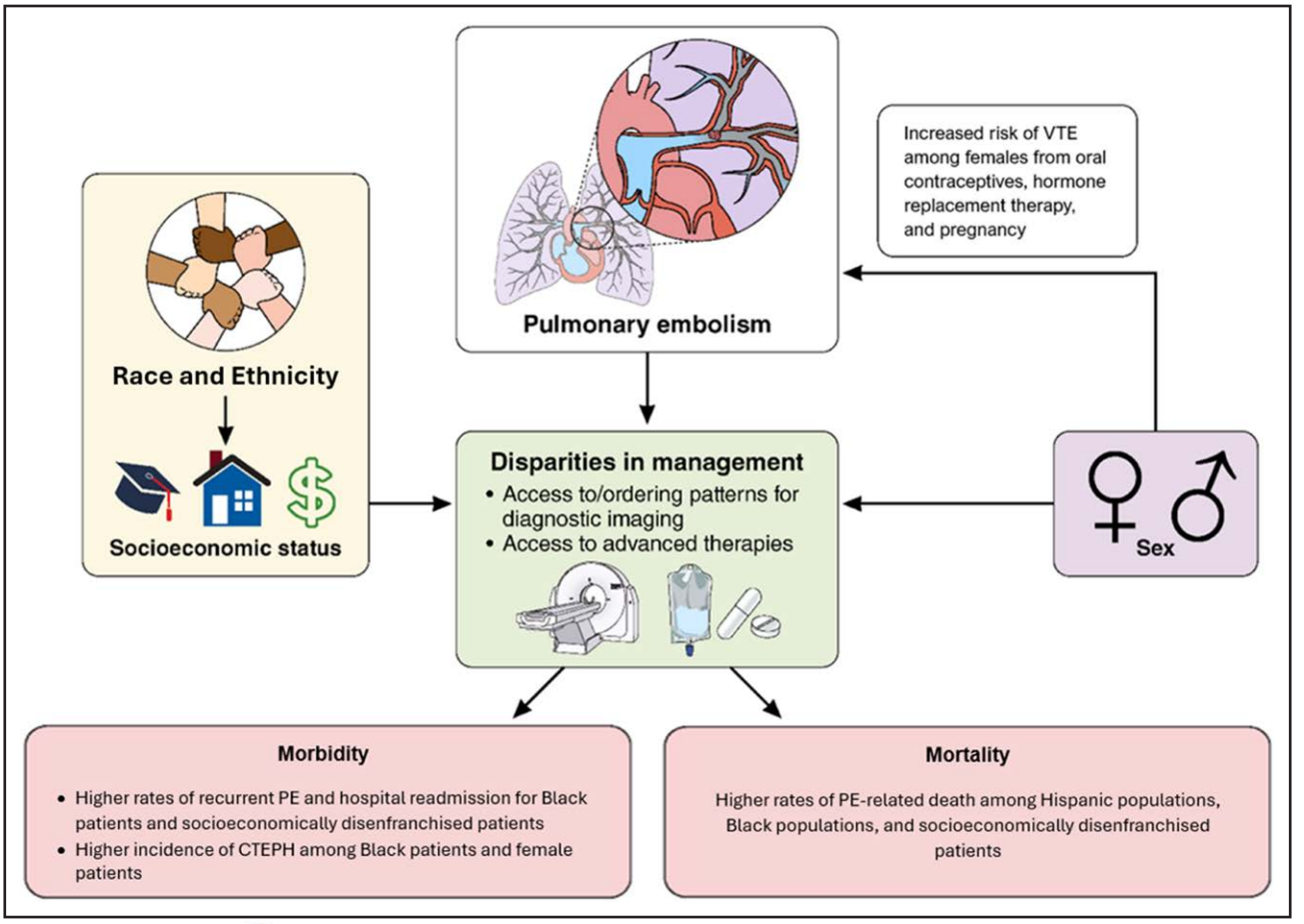

Figure 1. Factors influencing disparities in pulmonary embolism management.
CTEPH indicates chronic thromboembolic pulmonary hypertension; PE, pulmonary embolism; and VTE, venous thromboembolism.

observational studies were considered, recognizing that causal inference would be limited with such studies or other designs.

Racial and Ethnic Considerations

Race refers to the classification of people by physical or biologic traits, such as skin color (eg, Black, White, Asian, American Indian or Alaska Native, Native Hawaiian or Pacific Islander), whereas ethnicity characterizes people on the basis of cultural identification, such as common history and language (eg, Hispanic). Racial and ethnic differences in the incidence and outcomes of PE in the United States are well-documented. Black patients experience higher incidence, clinical severity, and age-adjusted mortality rates from PE compared with other racial and ethnic groups.[6–13] A study by Martin and colleagues[14] analyzing the Illinois Health and Hospital Association's Comparative Health Care and Hospital Data Reporting Services found that Black patients were 1.9 times more likely to be hospitalized for PE than White patients after adjusting for age and sex. A study of 545 343 fee-for-service Medicare beneficiaries age 65 years or older from 1999 to 2010 showed a higher rate of hospitalization and mortality for Black individuals compared with people from other racial groups.[15] These mortality differences may be associated with factors such as insurance status, as well as immediate and longitudinal access to medical care, including access to centers of excellence.[7]

Hispanic patients have a lower incidence of venous thromboembolism (VTE) compared with non-Hispanic White patients, but a higher incidence than Asian patients and Pacific Islander patients.[13] However, 1 single-center study found that despite presenting with lower PE severity and lower rates of PE-specific intervention, Hispanic patients had similar in-hospital all-cause and PE-related mortality rates compared with non-Hispanic patients.[16] Studies of Asian individuals are more limited and have smaller sample sizes. Available data suggest that Asian individuals have low VTE risk, although an explanation for this lower incidence rate remains unclear.[17,18] The limited studies of Native American or Alaskan native populations have also found a lower incidence of PE compared with Black populations or White populations.[19]

Sex and Gender Considerations

Biologic sex (female or male) and sociocultural factors related to gender (woman, man, or nonbinary) may correlate with the incidence of PE, how PE symptoms are perceived and reported, and how pharmacologic and nonpharmacologic therapies are being delivered.[20] Females of reproductive age have a higher risk of PE compared with males.[20,21] Recent epidemiologic data, contrary to previous estimates,[21] suggest that even among older adults (≥65 years), identified cases of PE are more frequently found in females than in males.[5,22] Regarding presentation, dyspnea is the most common initial PE symptom in both sexes, but chest pain and hemoptysis are slightly less common in females.[5,20] In some studies, females were more likely to have severe symptoms, such as hypotension, hypoxemia, and right heart strain at presentation.[23]

Whereas several PE risk factors, such as major surgery or trauma, may occur similarly for females and males, others, such as a hyperestrogenic state because of oral contraceptive use, pregnancy, or hormone replacement therapy, are almost exclusive to females. Other risk factors for VTE are more common in females, such as varicose veins or May-Thurner physiology.[24,25] Enduring risk factors, such as malignancy, particularly lung cancer, and cardiovascular disease, are more commonly found in males, whereas rheumatologic diseases and depression are more frequent in females.[5]

Sex-related differences may also exist because of the influence of biologic sex on choice of therapies by clinicians or patients, differences in access to optimal care, or implicit or explicit biases within the health care system. For example, heavy menstrual bleeding may affect patients' adherence to or informed choices for the duration of anticoagulation.[26]

Establishing PE risk assessments among transgender and gender-diverse individuals is challenging due to widely variable hormonal therapies and the paucity of high-quality studies investigating the presentation, therapies, or outcomes of these individuals.[27] Gender-affirming hormone therapy is a key part of a transgender or gender-diverse individual's treatment path. For transfeminine individuals (people who identify as women but were assigned male at birth), the specific hormone regimen is particularly important.[28] Estrogens are associated with increased levels of fibrinogen, factors II, VII, VIII, and X, decreased protein S and antithrombin, and activated protein C resistance.[29–31] The risk of PE and other thromboembolic events is higher in transfeminine individuals who have been taking estrogens,[32,33] particularly oral ethinyl estradiol.[34] The risk is especially high during the first year of taking the supraphysiologic-level regimens of feminizing hormones.[35] Transfeminine individuals taking hormones increase their risk further when they have other risk factors. such as smoking, obesity, or a history of thrombosis.[27,29,32,36] More research is crucial to better understand the effects of hormone therapy on VTE risk among the transgender population and to determine incidence rates, optimal management strategies, and outcomes.

Pediatric PE

There are limited data on disparities in PE management among children because VTE is uncommon in this cohort. However, over the past several decades, the incidence of PE in children has increased.[37] Reasons for the higher incidence rate include increased survival in patients with chronic medical conditions, more frequent use of catheters and interventional procedures, and better diagnostic techniques.[38,39] Pediatric PE is also likely underdiagnosed. For example, in a single-institution retrospective study that reviewed 38 cases of pediatric PE at autopsy, PE was only considered in the initial differential diagnosis in 15% of children.[40,41] In addition, children with PE often experience delays in diagnosis. Rajpurkar et al[42] reported the average time to accurate diagnosis of PE was 7 days after the onset of symptoms due to the patients' presentation being mistaken for a more common condition, such as pneumonia. Furthermore, only 29% of patients in that study were diagnosed correctly with PE at the time of presentation. As a result of underdiagnosis, PE-related morbidity and mortality are also likely underestimated in the pediatric population.

Sex differences among children with PE have not been well-described, but there is evidence that adolescent females share similar risks with females of childbearing age. Studies have demonstrated that oral contraceptive use in teenagers increases the relative risk of DVT and PE by 2- to 5-fold.[43] One single-center retrospective study that reviewed children undergoing diagnostic testing for suspected PE found that 30.6% of patients with PE were taking oral contraceptives, compared with 14.7% of patients who did not have PE.[44]

Data on racial differences in PE incidence and management among children are also limited. One study demonstrated the rate of PE among Black children to be about 2.4 times higher than that of White children.[19] Another study showed that the PE recurrence rate for Black children and Hispanic children (12% and 10.7%, respectively) was higher than that of White children (8%), which was statistically significant.[37] More studies on PE incidence and outcomes among people from other races and ethnicities are needed to appraise the state of PE management in the pediatric population. Moreover, it is important to determine whether PE disparities seen in adulthood can be traced to childhood factors.

Disparities in Diagnosis

Imaging tests are key components to the workup of PE. Pulmonary computed tomography (CT) angiography and, less commonly, ventilation/perfusion scans are used

to confirm the diagnosis. Echocardiography is used to evaluate for right heart dysfunction, and lower-extremity venous ultrasound is often ordered to identify coexisting DVT.

There is a paucity of data regarding the trends in tests ordered across various racial and ethnic populations specific for VTE. A major challenge in teasing out racial disparities in imaging is the confounding effects of socioeconomic factors. Black patients, compared with White patients, undergoing evaluation for PE have lower mean household income ($35 383 versus $63 396, respectively [$P<0.01$]) and higher rates of Medicaid or Medicare insurance (78.8% versus 61.8%, respectively [$P<0.01$]).[45] Jose et al[46] compared imaging trends among patients from disadvantaged and advantaged zip codes determined by Area Deprivation Index scores, which uses 17 US Census-based metrics to derive socioeconomic disadvantage percentiles for US zip codes. The study found that patients from disadvantaged zip codes had 11% less access to CT, 13% less access to magnetic resonance imaging, 7% less access to nuclear medicine, and 15% less access to ultrasound. In this context, Black patients may disproportionately receive care at lower-quality hospitals that lack high-technology imaging modalities.[47] Studies have also shown that people from underrepresented racial and ethnic groups are generally less likely to receive diagnostic imaging during emergency department visits in both pediatric and adult populations.[48,49]

Several sex-dependent disparities related to PE imaging have been identified. Women tend to undergo a greater number of low-yield CT angiograms for PE, resulting in greater radiation and iodinated contrast exposure.[50] In addition, pregnant patients are susceptible to unique imaging issues. Pulmonary CT angiography has lower diagnostic yield among pregnant than nonpregnant patients due to changes in circulation, including greater venous return from the inferior vena cava as well as increased cardiac output leading to the dilution of iodinated contrast.[51] This increases the likelihood of missed PE or need for additional imaging that may expose the patient to further radiation. Despite the multisociety recommendations prioritizing ventilation/perfusion scan over CT, CT remains the first modality for PE imaging in pregnancy.[52,53] A 2018 study[54] evaluated trends in early transthoracic echocardiography use among 15 375 patients from RIETE (Computerized Registry of Patients With Venous Thromboembolism), the largest prospective registry of patients with VTE, including >35 000 patients with acute PE. The authors found that men with acute PE were significantly less likely to undergo early transthoracic echocardiography compared with women (odds ratio [OR], 0.93 [CI, 0.88–0.98]; $P<0.01$). Whether such disparities translate into differences in treatment or correlate with outcomes remains to be determined.

Disparities in Treatment

Racial disparities in PE treatment have been identified by many authors. A summary of disparities in PE management are provided in the Table.[3,46,50,55–61] A recent study that reviewed the National Inpatient Sample data from 2016 through 2019 identified nearly 130 000 patients with the diagnosis of acute PE.[3] The authors found that compared with White men, female patients and individuals from other racial and ethnic groups were less likely to undergo catheter-directed therapies (CDTs). For example, the OR of White women versus White men receiving CDT was 0.89 (CI, 0.83–0.95; $P<0.01$). Hispanic women and Black women had even lower odds (OR, 0.78 [CI, 0.65–0.94]; $P<0.01$ and OR, 0.74 [CI, 0.66–0.82]; $P<0.01$, respectively). Black men were also significantly less likely to undergo surgical embolectomy (OR, 0.69 [CI, 0.52–0.92]; $P<0.05$). Furthermore, in an evaluation of nearly 82 000 regional state-level hospitalizations for VTE, Black patients were less likely to undergo inferior vena cava (IVC) filter placement (OR, 0.83 [CI, 0.75–0.92]) compared with White patients.[62] Whether these observations were attributable to differences in clinical severity of illness, patients' decisions, or biases in the health system remain unknown.

The disparities in treatment related to race are closely intertwined with socioeconomic inequities. There are data showing that the use of direct oral anticoagulation for treatment and prevention of VTE in a fully insured population remains lower among Black patients and those with lower household income.[55] In another study, use of advanced therapies (eg, systemic thrombolysis, CDT, surgical embolectomy, extracorporeal membrane oxygenation) was lower in Medicare and Medicaid-insured patients (OR, 0.68 [CI, 0.63–0.74]) compared with those with private insurance (OR, 0.73 [CI, 0.69–0.77]).[56] This outcome was observed although patients with Medicare and Medicaid

Table. Summary of Disparities in Pulmonary Embolism Management and Outcomes

Factors	Disparities in management	Disparities in outcomes
Race and ethnicity[3,55,58,61]	Black patients may be offered direct oral anticoagulation less frequently than White patients; underrepresented racial and ethnic patients are less likely to undergo advanced therapies for PE	Black patients have higher rates of CTEPH; Black and Hispanic patients have higher mortality and hospital readmission rates than White patients
Sex[3,50,59,60]	Females undergo more low-yield CT scans to rule out PE and fewer advanced PE therapies, such as thrombectomy	Females have more bleeding complications from anticoagulation as well as higher CTEPH rates than men
Socioeconomic status[3,46,56,57]	Patients with lower SES have reduced access to high-quality imaging centers and undergo fewer advanced interventions	Patients with lower SES have higher PE-related readmission rates and mortality risk compared with affluent patients

CT indicates computed tomography; CTEPH, chronic thromboembolic pulmonary hypertension; PE, pulmonary embolism; SES, socioeconomic status; and VTE, venous thromboembolism.

insurance had a greater length of stay than their privately insured counterparts. Additional studies have evaluated other markers for socioeconomic status, such as income or neighborhood socioeconomic status, on the impact of PE treatment, and have reported lower use of advanced therapies and greater length of hospitalization among people from socioeconomically disadvantaged populations.[56,57,63]

The literature on sex-related disparities is inconsistent and more data are needed to fully elucidate the impact of sex on treatment trends. A few single-center retrospective studies[64,65] have found no sex-related differences in PE treatment. Another retrospective study that reviewed the National Readmissions Database from 2016 through 2018, with >125 000 hospitalizations, found that women underwent a greater number of systemic thrombolysis treatments and CDTs than did men.[66] On the other hand, analyses of the National Inpatient Sample[3,67] have shown significantly fewer catheter-based and surgical interventions among women as well as delayed advanced PE therapies compared with men.[68] Most recently, the SERIOUS-PE study (Sex Differences in Presentation, Risk Factors, Drug and Interventional Therapies, and Outcomes of Elderly Patients With Pulmonary Embolism) identified no sex differences in use or duration of anticoagulation or use of advanced therapies in RIETE, with 33 462 patients (57.7% female) from 2001 through 2021, or among 102 391 US Medicare beneficiaries (55% female) from 2019. The exception was use of fibrinolytic therapy for intermediate-risk PE (systemic or catheter-based), which occurred less frequently for female versus male patients.[69] The use of extracorporeal membrane oxygenation also tends to be lower among female patients.[66,71]

Disparities in Outcomes From Acute PE

Morbidity

Clinical and population-level data have established that Black patients, Hispanic patients, and patients from socioeconomically disadvantaged populations face substantially increased morbidity after acute PE.[3,6,12,45,72,73] Available longitudinal CTEPH Registry data suggest that Black patients develop CTEPH at earlier ages, have more comorbidities, and have a higher rate of recurrent PE than White patients with CTEPH.[58] Black patients and patients from socioeconomically disadvantaged populations may also experience higher rates of hospital readmission after PE.[45,57,74]

Women, particularly Hispanic women, may have higher odds of major bleeding events from PE therapy compared with White men (OR, 1.89 [CI, 1.43–2.51]; $P<0.01$), based on data from the National Inpatient Sample.[3] Furthermore, population studies have demonstrated that women have higher rates of CTEPH and other post-thromboembolism syndromes and lower rates of intervention.[3,59,60] For example, in a study with 170 021 VTE cases, the cumulative incidence of pulmonary hypertension 2 years after VTE among women was 3.9% (CI, 3.8%–4.1%) compared with 3.2% (CI, 3.4%–3.7%) for men.[60] In addition, in an evaluation of 679 patients with established CTEPH, women were less likely than men to receive pulmonary endarterectomy (54% versus 65%, respectively; absolute risk difference, −11.0% [CI, −18.2 to −3.6]).[75] The data in contemporary literature from the National Inpatient Sample and other registries cannot account for the underlying mechanisms for their findings. The impact of potential sex-dependent biologic differences on the PE complications described is unclear and requires further research. Moreover, the definition of post-PE syndrome has garnered attention in recent years, and disparities across sex, gender, racial, ethnic, and socioeconomic subgroups remain understudied.

Mortality

A number of investigations have consistently demonstrated higher mortality rates based on race and socioeconomic status.[16,61,76] For example, an analysis of aggregate US population data over the past 2 decades from the CDC WONDER database (Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research) found that Black individuals had a nearly 2-fold increase in pulmonary heart disease–associated mortality compared with White individuals.[76] Pulmonary heart disease was defined as diseases of pulmonary circulation affecting the right side of the heart, such as pulmonary hypertension, CTEPH, and pulmonary embolism. In another evaluation of >13 000 hospitalized patients with acute PE, Black patients had a nearly 50% higher rate of all-cause mortality compared with White patients (15.0% versus 10.7%, respectively).[61] Hispanic patients also face higher odds of in-hospital mortality compared with White men (OR, 1.34 [CI, 1.09–1.64]; $P<0.01$ for Hispanic men and OR, 1.30 [CI, 1.08–1.55]; $P<0.01$ for Hispanic women) based on National Inpatient Sample data.[3]

Across nearly all evaluations, adverse social determinants of health and lack of access to private insurance were associated with a higher risk for in-hospital mortality.[56] In a study of 1 124 204 patients hospitalized for PE, patients with Medicare or Medicaid insurance had greater lengths of hospital stay and incurred higher hospitalization charges compared with privately insured patients, and those in the lowest income quartile had a nearly 10% absolute increase in mortality risk, even after adjusting for comorbities.[56] In an evaluation of >53 000 Medicare fee-for-service beneficiaries, patients from socioeconomically disadvantaged populations (those dually enrolled in Medicare and Medicaid due to poverty) were more likely to be female and less likely to receive advanced therapies.[57] In addition, the 90-day readmission rate among Medicare patients from socioeconomically disadvantaged populations after a PE admission was 32.4%, compared with 24.1% among patients not from socioeconomically disadvantaged populations, which was statistically significant. Women may also have higher rates of PE-related mortality (hazard ratio, 1.24

[CI, 1.04–1.47]).[23] The exact factors and mechanistic drivers behind these observations require further elucidation. Yet, taken together, these observations confirm the need for additional investigation and strategies to mitigate disparities in acute PE outcomes.

There is evidence suggesting that rural-dwelling individuals have higher mortality rates than the urban-dwelling population. Zghouzi et al[77] analyzed the CDC WONDER database and identified 109 992 PE-related deaths from 2006 through 2019. The authors found that the age-adjusted mortality rate per 100 000 was higher among patients from rural settings (OR, 4.07 [CI, 4.02–4.12]) than metropolitan areas (OR, 2.32 [CI, 2.30–2.34]). Furthermore, data show that although age-adjusted mortality rates have decreased over the years, the rate of decrease among urban-dwelling patients was 1.8% per year from 1999 through 2020, but only 1.0% per year in rural-dwelling patients.[78] Knowledge of trends in reperfusion and other management strategies of critically ill patients with PE in different regions is limited and requires more study. However, there is evidence demonstrating that rural hospitals use thrombolytics significantly less often than metropolitan hospitals (OR, 0.48 [CI, 0.43–0.52]; $P<0.01$).[79] Interhospital transfer of patients with PE is not standardized as it is for myocardial infarction or stroke, and data on outcomes of patients with PE requiring transfer need further investigation.

Future Needs

Addressing Disparities

The population-wide disparities described in this scientific statement include those in diagnosis, treatment, outcomes, and long-term consequences of PE. Poorer outcomes seem to correlate with less health care access; reasons may include longer time to diagnosis, higher severity at presentation, longer time to initiation of anticoagulation once a PE diagnosis is made, and less access to advanced interventional and supportive care (Figure 2).

First, these populations need to be educated on the signs and symptoms of PE, as well as what to do if PE is suspected. Male, uninsured, low-income, and Hispanic patients are historically less aware of how cardiovascular diseases such as myocardial infarction present.[80] Thus, PE educational materials should account for these populations, and be congruent with race, ethnicity, sex, and gender. Individuals with higher PE risk, such as women taking oral contraceptives, should be prioritized in receiving education. The educational materials should be disseminated in venues and through media that are frequently accessed by these groups. The health literacy of these populations needs to be considered and the readability of these materials should not be overly complex. One way of ensuring the educational content is appropriate is to evaluate and test it with patient stakeholders and content experts.[81] Other strategies, such as interactive text messaging and graphic or video media, may help overcome some health literacy and geographic challenges.

Second, health care workers who care for these populations should be educated on best practices once PE is diagnosed. For example, randomized trials have shown a <2% mortality rate in the intermediate–high-risk PE population with prompt initiation of anticoagulation and close observation.[82] Thus, all patients with

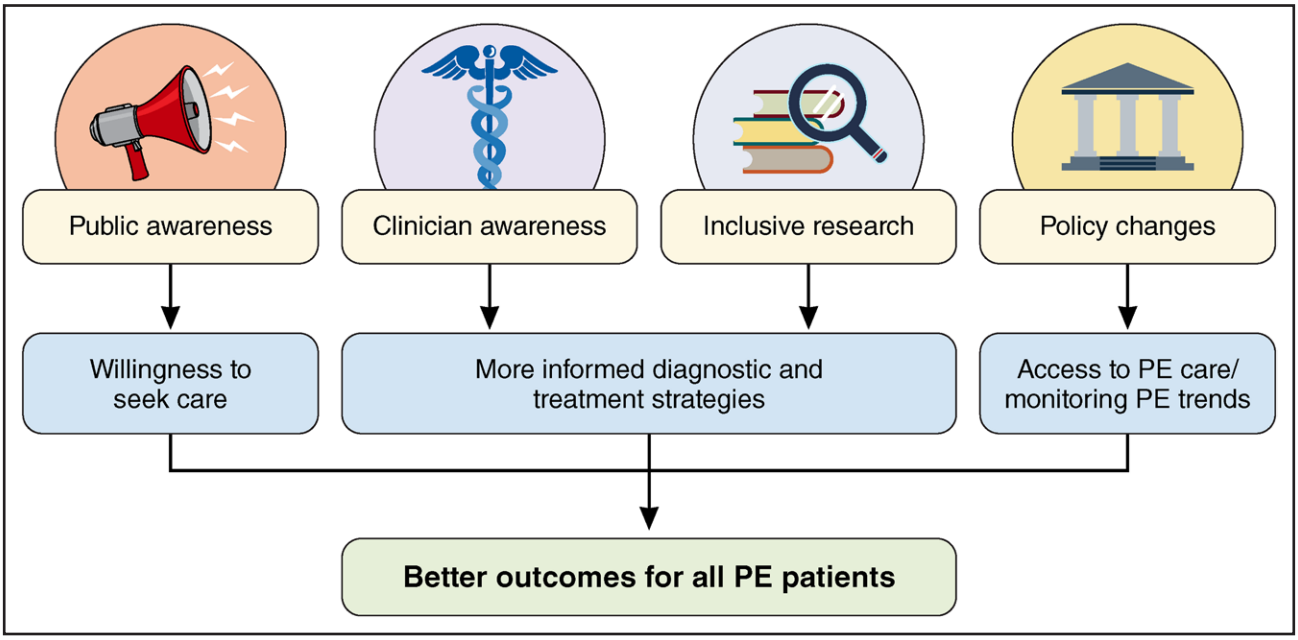

Figure 2. Strategies for addressing disparities in pulmonary embolism management.
PE indicates pulmonary embolism.

PE should immediately receive anticoagulation upon diagnosis unless anticoagulants are absolutely contraindicated, and intermediate-risk PE patients should be closely monitored for signs of deterioration that may warrant reperfusion therapy.[83] Reserving IVC filtration for patients who have failed or have contraindications to anticoagulation, as stated by guidelines, is important to prevent unnecessary procedures and inconsistences in IVC filter placement.[84] Societal guidelines also recommend that high-risk patients with PE receive escalation of care with some combination of reperfusion therapy (eg, systemic thrombolysis, CDT, surgical embolectomy) and mechanical circulatory and ventilatory support.[83,85] Therefore, rural or community hospitals need to have access to adequate resources and expertise to manage non–life-threatening PE and interhospital transfer for critically ill patients requiring advanced therapies. Clear algorithms are necessary to define when and how to access these resources. Over the past decade, PE response teams have emerged to manage the challenges of severe PE, but the majority are in urban settings with academic or tertiary care hospitals.[86] Because PE is no longer considered simply an acute disease, as chronic symptoms or physiologic impairment may be present in 30% to 50% of PE survivors,[87,88] all patients with PE should receive follow-up in the months to years after PE, to monitor their symptoms as well as intensity and duration of anticoagulation. Some populations described in this scientific statement may be at higher risk of loss to follow-up, which may account for higher rates of recurrent PE and CTEPH, and lower rates of pulmonary endarterectomy.

Third, health policy should be directed toward improving public awareness and health care access. Collaborative initiatives across public health, clinical practice, and private sectors to improve public awareness of VTE are supported by the American Heart Association and may improve symptom recognition, medication adherence, and education.[89] Professional organizations can assist these efforts by establishing public health policy priorities through advocacy, creating guidelines and policy statements, and supporting scientific research to identify actionable issues. National tracking programs for PE incidence may identify broader trends in diagnosis and treatment. In addition, programs improving follow-up for rural-dwelling or low-income patients may improve longer-term outcomes in PE survivors.[90] Public policies that address income inequality may improve health equity, as evidenced by better outcomes among individuals not from socioeconomically disadvantaged populations.[91] Furthermore, public health policy can improve health care access through insurance coverage, such as by incentivizing the expansion of Medicaid programs to low-income adults among states that have not already done so, which would allow for better PE follow-up care.[92] Telehealth supported by payment parity laws may improve long-term monitoring and medication compliance among patients with geographic barriers.[93]

Improving the Body of Knowledge

Females generally constitute <50% of participants in clinical trials of anticoagulation for VTE.[94] Furthermore, there are limited sex-specific issues reported in outcomes, such as the impact of pregnancy or hormone therapy. The largest systemic thrombolytic RCT[82] and previous CDT RCTs[95,96] only describe sex and not race, with roughly equal numbers of males and females included. Three prospective single-arm CDT studies conducted in the United States describe race, with Black participants representing 16% to 31% of the trial population.[97–99]

The aforementioned studies are limited by both a lack of randomization and a small sample size, but they highlight the potential for US RCTs to enroll a considerable number of understudied populations. To capitalize on this potential, upcoming RCTs should consider inclusion of clinical trial sites with diverse populations and those in rural areas and community settings, actively recruit these populations, and include women and underrepresented physicians and patients on research leadership committees. Cohort identification should be automated, potentially using artificial intelligence or other electronic methods to identify all patients with qualifying PE who present at a trial site.[100] Trust must be established among prospective participants. Lack of trust, which might be characterized as distrust or mistrust, can affect willingness to enroll and compliance with study protocols, or influence placebo effects.[101] Participants from underrepresented racial or ethnic communities may have higher rates of mistrust in trials due to the history of mistreatment in unethical medical research.[102] Thus, the consent process should be done in a culturally sensitive manner, preferably by a team member with whom the potential participant can identify. Known cultural barriers to participation in research should be actively addressed, assuring potential participants the human subjects protection inherent in rigorous randomized trials with expansive regulatory oversight.

As described previously, race and sex disparities exist in the use of CDT and IVC filters in acute PE. White men receive both at higher rates than Black patients or females. However, neither CDT nor IVC filters has shown clear benefit in the treatment of PE.[103] In response, RCTs of CDT have been initiated by both federally funded independent investigators (PE-TRACT [Pulmonary Embolism—Thrombus Removal With Catheter-Directed Therapy; https://www.clinicaltrials.gov; unique identifier: NCT05591118]) and industry sponsors (HI-PEITHO [Ultrasound-Facilitated, Catheter-Directed, Thrombolysis in Intermediate–High-Risk Pulmonary Embolism; https://www.clinicaltrials.gov; unique identifier: NCT04790370] and PEERLESS

II [PEERLESS II: RCT of FlowTriever vs Anticoagulation Alone in Pulmonary Embolism; https://www.clinicaltrials.gov; unique identifier: NCT06055920]). These trials represent an opportunity to improve knowledge of understudied populations.

Once underrepresented patients enter trials, all means to retain them in the study should be used, including automated reminders, close follow-up, and strong communication between the participant and study team. If these measures are achieved, meaningful subgroup analyses may be conducted that will illuminate both the presentation and natural history of PE in these populations as well as their responses to therapy. If necessary, further funding to study these data should be sought. Any signals identified in subgroup analyses should be followed with additional rigorous, hypothesis-driven trials.

CONCLUSION

PE affects individuals from all backgrounds. Race, ethnicity, sex, gender, and socioeconomic status influence all aspects of PE, from incidence to diagnosis, treatment, and outcomes. The available data show that women, transfeminine individuals, patients from underrepresented racial or ethnic groups, and patients from socioeconomically disadvantaged populations experience higher rates of PE with less access to timely imaging and therapeutic interventions. These groups bear a disproportionate burden of morbidity and mortality.

Addressing the disparities related to PE management represents a formidable challenge. Recognizing the issues and appreciating the pervasiveness of differences in health care delivery is the first step to ensuring equitable care for all patients. Monitoring these issues over time with new data can help elucidate trends and inform clinical practices. Making equitable care a reality will require collaborative efforts from all stakeholders involved in PE management. Furthermore, deliberate emphasis on inclusivity in research will ensure that data will be more representative and help close knowledge gaps on the impact of race, sex, and other important social factors on PE management.

ARTICLE INFORMATION

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

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Disclosures

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*Modest.

†Significant.

Reviewer Disclosures

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*Modest.

†Significant.

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