Int. J. Curr. Res. Med. Sci. (2025). 11(7): 70-86

International Journal of Current Research in Medical Sciences

ISSN: 3107-3743 (Print), ISSN: 2454-5716 (Online)
(A Peer Reviewed, Indexed and Open Access Journal)
www.ijcrims.com

Review Article

Volume 11, Issue 7 -2025

DOI: http://dx.doi.org/10.22192/ijcrms.2025.11.07.005

The Pressure Within: Decoding Hypertension's Role in Cardiovascular Pathology of Sickle Cell Disease- A Review

***Emmanuel Ifeanyi Obeagu**

Department of Biomedical and Laboratory Science, Africa University, Zimbabwe.
*Corresponding authour: Emmanuel Ifeanyi Obeagu, Department of Biomedical and Laboratory Science, Africa University, Zimbabwe
emmanuelobeagu@yahoo.com, ORCID: 0000-0002-4538-0161

Abstract

Hypertension is an emerging and often under-recognized complication in individuals with sickle cell disease (SCD). The pathophysiology of hypertension in SCD is complex, involving factors such as chronic hemolysis, endothelial dysfunction, and impaired nitric oxide bioavailability. These mechanisms contribute to vascular damage, increased peripheral resistance, and the development of high blood pressure in affected individuals. While hypertension is typically associated with age, individuals with SCD experience an earlier onset of hypertension compared to the general population, often in their third or fourth decade of life. The prevalence of hypertension in SCD patients is rising as life expectancy increases due to improved healthcare, with both pediatric and adult populations affected. Clinical management of hypertension in SCD poses several challenges, as traditional antihypertensive treatments may have adverse interactions with SCD-specific conditions such as anemia, renal dysfunction, and electrolyte imbalances. Moreover, blood pressure fluctuations due to pain crises or other SCD-related complications complicate accurate diagnosis and consistent treatment. The absence of disease-specific guidelines for hypertension management in SCD further contributes to the complexity of treatment, highlighting the need for individualized care plans that account for both blood pressure control and the unique needs of SCD patients.

Keywords: Sickle Cell anemia, hemoglobin, hypertension, inflammation

List of abbreviations
CKD- chronic kidney disease
NO- nitric oxide
SCA- sickle cell anemia
SCD- sickle cell disease

Introduction

Sickle cell anemia, a hereditary blood disorder characterized by the presence of abnormal hemoglobin, is a condition fraught with multifaceted challenges. The distorted, crescent-shaped red blood cells that define sickle cell disease can lead to vaso-occlusive crises, severe pain, and organ damage. These acute manifestations often dominate the clinical landscape and draw the attention of healthcare providers and researchers. Yet, within this intricate tapestry of complications, a silent and insidious adversary often goes unnoticed: hypertension.[1-3] Hypertension, or high blood pressure, is a global health concern that extends its reach into the realm of sickle cell anemia, impacting an increasing number of individuals living with this inherited blood disorder.[4] While not as immediately apparent as the agonizing vaso-occlusive crises, hypertension's effects can be equally devastating. It is a stealthy intruder, its presence often masked by the overt signs of sickle cell disease, lurking in the background, quietly contributing to further organ damage and complications.

Hypertension, a silent yet insidious condition, poses a significant health challenge for individuals living with sickle cell anemia (SCA). While SCA primarily manifests as a hereditary blood disorder characterized by abnormal hemoglobin molecules, its intricate relationship with hypertension is garnering increasing attention in the medical community. Hypertension in SCA not only exacerbates the already complex pathophysiology of the disease but also significantly impacts patient outcomes and quality of life. Despite its clinical importance, hypertension in SCA remains an underrecognized and poorly understood phenomenon, highlighting the need for further research and awareness in this area. The co-occurrence of hypertension and SCA presents a unique clinical dilemma, as the pathogenesis of hypertension in this population involves a complex interplay of genetic, physiological, and environmental factors. Individuals with SCA experience chronic hemolytic anemia, endothelial dysfunction, and impaired nitric oxide bioavailability, all of which contribute to the development of hypertension. Moreover, renal dysfunction, activation of the renin-angiotensin-aldosterone system, and systemic inflammation further exacerbate vascular damage and endothelial dysfunction, predisposing patients to hypertension and its complications.[2-3]

Hypertension not only increases the risk of organ damage, including renal impairment, stroke, and cardiovascular events, but also complicates the management of SCA by exacerbating vaso-occlusive crises and promoting end-organ damage. Furthermore, the interaction between hypertension and other comorbidities commonly observed in SCA, such as chronic kidney disease and pulmonary hypertension, underscores the need for comprehensive management strategies tailored to individual patient needs.[3] Despite its clinical significance, hypertension in SCA often goes undetected or undertreated, leading to suboptimal outcomes and increased morbidity and mortality. Limited awareness among healthcare providers, challenges in accurate blood pressure measurement in individuals with SCA, and the lack of specific guidelines for hypertension management in this population contribute to diagnostic and therapeutic uncertainties. Addressing these gaps in knowledge and practice is essential for optimizing the care and outcomes of individuals living with SCA and hypertension.[4-5] The aim is to uncover the intricate relationship between hypertension and sickle cell anemia, exploring the prevalence, risk factors, and clinical implications of hypertension in individuals with this complex genetic condition.

Epidemiology of Hypertension in Sickle Cell Anemia

Hypertension in individuals with sickle cell anemia (SCA) has emerged as an important comorbidity with significant implications for morbidity and mortality. Historically, SCA patients were believed to have lower blood pressure compared to the general population due to chronic anemia and associated hyperdynamic circulation.[6-7]The prevalence of hypertension in SCA varies across different populations, age groups, and geographic regions. While children with SCA often exhibit lower blood pressure

values compared to their healthy peers, adults with SCA show an alarming increase in hypertension prevalence. This rise correlates with age, disease severity, and comorbidities such as chronic kidney disease (CKD). Studies from high-resource settings suggest a prevalence of 20–30% in adults with SCA, although rates may differ in resource-limited regions due to variations in healthcare access, lifestyle factors, and genetic predispositions.[8-9]Regional disparities in the epidemiology of hypertension among SCA patients are notable. In sub-Saharan Africa, where the burden of SCA is highest, hypertension prevalence may be underreported due to limited diagnostic resources and healthcare infrastructure. Conversely, in high-income countries, improved survival and long-term follow-up of SCA patients have allowed for more comprehensive studies highlighting the growing impact of hypertension. Ethnic differences in blood pressure regulation and the genetic background of SCA populations may further influence these epidemiological trends.[10-11]

Advancing age is a strong predictor of hypertension in SCA, as the cumulative effects of chronic hemolysis and vascular damage manifest over time. SCA nephropathy, a common complication, predisposes patients to salt retention and volume overload, key contributors to hypertension. Although less common in SCA patients due to increased metabolic demands, obesity and sedentary behaviors in some patients may elevate hypertension risk. Polymorphisms in genes regulating vascular tone and salt sensitivity may predispose certain individuals with SCA to develop hypertension.[12-13] Hypertension is an independent risk factor for mortality in SCA, amplifying the risk of complications such as stroke, pulmonary hypertension, heart failure, and end-stage renal disease. A significant proportion of deaths in SCA patients with hypertension are linked to cardiovascular and renal complications, underscoring the importance of early detection and management.[14] Despite its growing recognition, the epidemiology of hypertension in SCA remains underexplored, particularly in low-resource settings where the SCA burden is highest. Large-scale, longitudinal studies are needed to elucidate the true prevalence, natural history, and risk factors for hypertension in this unique population.[15]

Hypertension in Sickle Cell Anemia

Hypertension in sickle cell anemia is a common comorbidity and an important aspect of the overall health and well-being of individuals with this genetic blood disorder.[16] Hypertension, or high blood pressure, is more prevalent in individuals with sickle cell anemia than in the general population. The exact reasons for this are not entirely clear, but it may be related to the chronic inflammation and endothelial dysfunction that often accompany the disease.[17]Risk factors for developing hypertension in sickle cell anemia may include family history, obesity, kidney problems, and other comorbid conditions.Hypertension can contribute to further organ damage in individuals with sickle cell anemia, which may already be at risk due to the vaso-occlusive nature of the disease. It can impact the kidneys, heart, and blood vessels, among other organs.[18]Hypertension is often considered a "silent" condition because it may not cause noticeable symptoms in the early stages. Regular blood pressure monitoring is essential to detect hypertension in sickle cell anemia patients.[19]Routine blood pressure monitoring is crucial for individuals with sickle cell anemia. Early detection and appropriate management of hypertension can help prevent complications and improve outcomes.[20]

The management of hypertension in individuals with sickle cell anemia is similar to that in the general population and may include lifestyle modifications (e.g., diet, exercise, and salt restriction), antihypertensive medications, and close monitoring of blood pressure. Individuals with sickle cell anemia often require comprehensive care that addresses not only the symptoms of the disease but also the management of comorbid conditions like hypertension. Healthcare providers need to take a holistic approach to patient care.[21]Education and support for patients with sickle cell anemia are essential in helping them manage their condition effectively. Empowering patients to be proactive about their health and advocate for their needs is important.[22]

Age of Onset for Hypertension in African Americans with Sickle Cell Disease (SCD)

Hypertension is a significant and increasingly recognized comorbidity in individuals with SCD, particularly among African American populations. While the classic pathophysiology of SCD, characterized by chronic anemia, hemolysis, and vaso-occlusion, is primarily associated with cardiovascular and renal complications, the age at which hypertension manifests in SCD patients is a critical factor that can influence clinical management and patient outcomes. Historically, hypertension was not considered a prominent issue in younger individuals with SCD, as the disease's hallmark symptoms, such as pain crises, anemia, and organ damage, tended to overshadow concerns about high blood pressure. However, with advances in medical care and increased life expectancy, hypertension has been observed to emerge as a significant health issue as individuals with SCD age.[23-24]

Hypertension Onset in Childhood and Adolescence

In children with SCD, the incidence of hypertension is relatively low, particularly in those with mild disease manifestations. However, studies have shown that the prevalence of elevated blood pressure increases significantly as children with SCD move into adolescence. By adolescence, the body's vascular system is more susceptible to the effects of chronic hemolysis and inflammation, both of which are exacerbated by SCD. Hypertension in childhood may also go undiagnosed or be masked by the more pressing issues of SCD-related pain crises and anemia. It is not until regular screenings or routine healthcare visits that blood pressure abnormalities in this population are often detected. The onset of hypertension in adolescents with SCD is typically gradual, influenced by factors such as kidney dysfunction, vascular damage, and the exacerbating effects of iron overload or end-organ damage from repeated blood transfusions. It is also during this time that lifestyle factors, including diet, physical activity, and weight gain, may start to have a more pronounced effect on blood pressure.[25-26]

Adult Onset and Increased Risk with Aging

In adults with SCD, especially those over the age of 30, the prevalence of hypertension increases dramatically. The average age of onset for hypertension in African Americans with SCD is typically in the third or fourth decade of life. This is largely due to the cumulative effects of chronic disease-related damage over time. By this age, patients have often experienced years of renal injury, endothelial dysfunction, and altered hemodynamic states, all of which predispose them to higher blood pressure. Hypertension is more likely to develop in individuals with SCD who also have additional risk factors, such as obesity, kidney disease, or a family history of hypertension. Moreover, individuals who have experienced recurrent vaso-occlusive crises or chronic pain syndromes may be more vulnerable to elevated blood pressure due to the combined stress on the cardiovascular system.[27]

Contributing Factors to Early Onset in SCD

Several factors contribute to the earlier onset of hypertension in African Americans with SCD compared to the general population:

1. **Renal Impairment**: CKD is common in SCD and plays a pivotal role in the early development of hypertension. Sickle cell nephropathy, characterized by glomerular damage, hyperfiltration, and proteinuria, predisposes individuals to fluid retention, leading to elevated blood pressure.
2. **Endothelial Dysfunction**: Hemolysis in SCD releases free hemoglobin, which scavenges nitric oxide (NO), a potent vasodilator, leading to endothelial dysfunction. This dysfunction contributes to vascular stiffening and increased peripheral resistance, both of which are key factors in the development of hypertension.
3. **Hyperdynamic Circulation**: SCD patients often experience increased cardiac output as a compensatory mechanism for the anemia. Over time, this can increase the workload on

the heart and vascular system, setting the stage for hypertension later in life.

4. **Inflammation and Oxidative Stress**: Chronic inflammation, a hallmark of SCD, accelerates the process of atherosclerosis and contributes to the early development of hypertension. Elevated levels of reactive oxygen species (ROS) and inflammatory cytokines further damage vascular walls and impair the regulation of blood pressure.
5. **Genetic Factors**: Genetic predisposition plays a significant role in the earlier onset of hypertension in African Americans with SCD. Variations in genes that regulate blood pressure, salt sensitivity, and vascular function may make certain individuals more susceptible to the development of hypertension.[27-28]

Impact of Early Hypertension Onset

The early onset of hypertension in African Americans with SCD has significant implications for patient health. Early detection and management of hypertension are crucial to reducing the risk of cardiovascular and renal complications, which are among the leading causes of morbidity and mortality in this population. Untreated or poorly controlled hypertension can lead to worsening of sickle cell-related complications, including stroke, heart failure, and chronic kidney disease. Moreover, hypertension in SCD patients is often associated with an increased risk of pulmonary hypertension, a potentially life-threatening condition that can further complicate the clinical course of the disease. As individuals with SCD live longer, managing hypertension effectively will be crucial in improving long-term outcomes.[29]

Early Biomarkers for African Americans with Hypertension in Sickle Cell Disease (SCD)

The interplay between hypertension and sickle cell disease (SCD) in African Americans presents unique challenges in early detection and management. African Americans are disproportionately affected by both conditions due to genetic, environmental, and socio-economic factors. Identifying early biomarkers specific to this population can enable timely intervention, mitigating the risks of end-organ damage and other complications.[20]

Endothelial Dysfunction Markers

Endothelial dysfunction is a hallmark of SCD and is further exacerbated by hypertension. Early biomarkers linked to endothelial injury include:

- **Nitric Oxide (NO) Dysregulation**: Reduced bioavailability of NO, due to hemolysis-induced scavenging by free hemoglobin, is a critical feature. This leads to impaired vasodilation and increased vascular stiffness.
- **Asymmetric Dimethylarginine (ADMA)**: Elevated ADMA levels inhibit NO synthesis, serving as an early indicator of endothelial dysfunction in African Americans with SCD and hypertension.[21]

Inflammatory Biomarkers

Chronic inflammation in SCD is intensified by hypertension, driving vascular damage and disease progression. Key inflammatory biomarkers include:

- **C-Reactive Protein (CRP)**: Elevated CRP levels reflect systemic inflammation and correlate with cardiovascular risk.
- **Interleukin-6 (IL-6)**: This pro-inflammatory cytokine is elevated in both SCD and hypertension, marking vascular inflammation and immune activation.
- **Soluble Vascular Adhesion Molecule-1 (sVCAM-1)**: Elevated levels of sVCAM-1 indicate endothelial activation and leukocyte adhesion, signaling early vascular injury.[22]

Renal Dysfunction Markers

Hypertension and SCD synergistically impair renal function, making renal biomarkers crucial for early detection.

- **Microalbuminuria**: The presence of albumin in urine is a sensitive early marker of kidney damage and hypertension in SCD.

- **Cystatin C**: A marker of glomerular filtration rate (GFR), cystatin C levels help detect early renal impairment, particularly in hypertensive SCD patients.
- **Neutrophil Gelatinase-Associated Lipocalin (NGAL)**: This biomarker indicates tubular injury and is valuable in detecting early kidney dysfunction.[20]

Oxidative Stress Markers

Oxidative stress is a central feature of both SCD and hypertension, contributing to vascular and organ damage.

- **Malondialdehyde (MDA)**: Elevated MDA levels signal lipid peroxidation and oxidative damage.
- **Glutathione (GSH) Levels**: Decreased GSH levels indicate compromised antioxidant defenses, which are common in hypertensive SCD patients.[21]

Vascular and Cardiac Biomarkers

The cardiovascular burden in hypertensive SCD patients can be tracked through early vascular and cardiac markers.

- **Brain Natriuretic Peptide (BNP)**: Elevated BNP levels may indicate subclinical cardiac dysfunction and early pulmonary hypertension.
- **Carotid Intima-Media Thickness (CIMT)**: Although not a molecular biomarker, CIMT is a non-invasive imaging biomarker for assessing early atherosclerotic changes in hypertensive SCD patients.[22]

Genetic and Epigenetic Biomarkers

Emerging research highlights the role of genetic predisposition in African Americans with SCD and hypertension.

- **APOL1 Risk Variants**: These variants are associated with an increased risk of hypertension-attributed kidney disease in African Americans.
- **MicroRNAs (miRNAs)**: Specific miRNAs, such as miR-210 and miR-126, are implicated in vascular health and may serve as early epigenetic markers.[24]

Mortality Implications for African Americans with Hypertension and Sickle Cell Disease (SCD)

Hypertension, a condition characterized by sustained elevated blood pressure, is increasingly recognized as a significant risk factor in the SCD population. Its presence, when coupled with the already complex pathophysiology of SCD, poses severe health risks and has profound implications for the overall mortality rate of affected individuals. African Americans with both hypertension and SCD face a "double jeopardy" that compounds their risk of premature death, often from cardiovascular, renal, or cerebrovascular complications.[2]

1. Cardiovascular Risks

Hypertension significantly accelerates cardiovascular complications in African Americans with SCD. The combination of high blood pressure and the chronic hemolysis seen in SCD leads to endothelial dysfunction, vascular stiffness, and an increased risk of atherosclerosis. Moreover, the constant episodic occlusion of blood vessels, characteristic of SCD, exacerbates the damage to the heart and vasculature, increasing the likelihood of:

- **Pulmonary Hypertension (PH)**: Pulmonary hypertension, often resulting from damage to the small blood vessels in the lungs, is a well-documented cause of death in individuals with SCD. Hypertension worsens this condition by raising pulmonary vascular resistance, which places additional strain on the right side of the heart, leading to right heart failure and, ultimately, death.[3]
- **Stroke**: Hypertension is one of the most significant risk factors for both ischemic and hemorrhagic stroke, and in individuals with SCD, this risk is further magnified. The sickling of red blood cells in small blood vessels can already lead to strokes, and the presence of hypertension can increase the frequency and severity of these events.

For African Americans with SCD, who are already at an increased risk for stroke due to sickle cell pathology, the additional burden of hypertension dramatically raises the likelihood of cerebrovascular accidents that can lead to irreversible brain damage or death.[4]

- **Heart Failure**: The combination of chronic anemia, hypertension, and potential myocardial ischemia puts SCD patients at high risk for developing heart failure. Left ventricular hypertrophy, due to increased cardiac output as a compensatory mechanism for anemia, coupled with hypertension, increases the burden on the heart, often resulting in heart failure.[5]

2. Renal Complications and Kidney Failure

Hypertension in SCD significantly worsens renal health, contributing to the progression of sickle cell nephropathy, which is already common in these individuals. The kidneys, which are involved in regulating blood pressure and fluid balance, are particularly vulnerable to the combined effects of hypertension and sickle cell-induced vasculopathy. Chronic kidney disease (CKD) in SCD patients is accelerated by hypertension, leading to:

- **Proteinuria and Renal Dysfunction**: Elevated blood pressure exacerbates the damage to the kidneys, leading to the leakage of protein into the urine (proteinuria), a marker of kidney damage. Over time, this can progress to end-stage renal disease (ESRD), requiring dialysis or kidney transplantation. The co-occurrence of hypertension and SCD-related kidney damage significantly shortens lifespan, contributing to premature mortality.
- **Renal Failure**: The added burden of hypertension accelerates the development of renal failure in African Americans with SCD, often leading to dialysis dependence and ultimately contributing to mortality.[5]

3. Compounding Factors in the African American Population

The mortality implications of hypertension in African Americans with SCD are further compounded by several socio-economic, genetic, and healthcare-related factors unique to this population:

- **Genetic Predisposition**: African Americans with SCD may possess genetic factors that make them more susceptible to the development of hypertension. Variations in genes related to blood pressure regulation, such as those involving the renin-angiotensin-aldosterone system (RAAS), may contribute to the higher prevalence of hypertension in this group. Furthermore, sickle cell-related inflammation and endothelial dysfunction may increase susceptibility to hypertension in this demographic.[6]
- **Healthcare Access and Disparities**: African Americans with SCD often experience disparities in healthcare access and treatment quality. Socioeconomic factors, including lower access to healthcare facilities, preventive screenings, and antihypertensive treatments, further exacerbate the risk of undiagnosed or poorly controlled hypertension. This makes it harder to manage both SCD and hypertension, leading to worsened outcomes and increased mortality.[7]
- **Lifestyle Factors**: While many individuals with SCD experience limited opportunities for physical activity due to pain and fatigue, lifestyle factors such as diet, stress, and obesity also play a role in the increased incidence of hypertension. Poor dietary habits, including high salt intake, can significantly raise blood pressure, further exacerbating the effects of SCD.

4. Implications for Mortality

The dual burden of hypertension and SCD is a significant driver of early mortality in African Americans. The increased risk of heart failure, stroke, pulmonary hypertension, and kidney failure—coupled with the increased challenges related to healthcare access and socioeconomic factors—leads to a higher mortality rate in this population. Furthermore, the inability to effectively manage hypertension, often due to delays in diagnosis, lack of proper medications, and limited medical follow-up, contributes to the

early deaths of many individuals with SCD. Longitudinal studies have highlighted that African Americans with both hypertension and SCD have a significantly higher risk of premature death compared to those without hypertension. The presence of hypertension often results in a compounded effect on other organ systems, making it difficult to manage both the baseline effects of sickle cell anemia and the complications introduced by elevated blood pressure.[10-11]

Clinical Implications of hypertension in SCA

The clinical implications of hypertension in sickle cell anemia (SCA) are significant and can contribute to a range of complications and health challenges for individuals living with this genetic blood disorder.[23] Hypertension can exacerbate the vaso-occlusive crises that are already common in SCA. These crises involve the blockage of small blood vessels by sickled red blood cells, leading to severe pain and tissue damage. Hypertension can further impair blood flow and contribute to the frequency and severity of these crises.[24]Hypertension can lead to damage in various organs, including the heart, kidneys, brain, and blood vessels. In individuals with SCA, who are already at risk of organ damage due to vaso-occlusion and chronic anemia, hypertension can compound these risks. It may result in conditions such as hypertensive heart disease, kidney dysfunction, and an increased risk of stroke.[25]Hypertension in SCA is a significant risk factor for stroke, which is a major concern in this population. The combination of sickled red blood cells and hypertension can result in reduced blood flow to the brain and increase the likelihood of ischemic strokes.[26]

Hypertension can contribute to chronic kidney disease (CKD) in individuals with SCA. Kidney complications are a common concern in SCA due to the effects of hemolysis (breakdown of red blood cells) and the increased risk of proteinuria (protein in the urine). Hypertension further strains the kidneys and accelerates the progression of CKD.[26] Individuals with SCA and hypertension are at a heightened risk of cardiovascular complications, including left ventricular hypertrophy, heart failure, and myocardial infarction (heart attack). The combination of anemia, increased cardiac workload, and hypertension can negatively impact the heart.[25]

Some individuals with SCA may develop pulmonary hypertension, a condition that affects the blood vessels in the lungs.[27] The presence of hypertension can worsen the symptoms and prognosis of pulmonary hypertension in SCA.[28]Managing hypertension in SCA can be complex. Many antihypertensive medications used in the general population may not be suitable for individuals with SCA.[29] Healthcare providers need to consider the unique challenges and potential drug interactions when prescribing medications for hypertension in this population. Due to the silent nature of hypertension, regular blood pressure monitoring is essential for early detection and intervention. Healthcare providers should monitor blood pressure during routine checkups and tailor treatment plans to individual needs. Individuals with SCA require comprehensive care that addresses not only the symptoms of the disease but also the management of comorbid conditions, including hypertension. A multidisciplinary healthcare team can provide holistic care and support. The clinical implications of hypertension in SCA underscore the importance of early diagnosis, regular monitoring, and appropriate management to prevent complications and improve the overall quality of life for individuals living with this challenging genetic blood disorder.

Diagnosis

The first step in diagnosing hypertension in SCA is to measure blood pressure accurately.[30] Blood pressure should be measured routinely during medical appointments, and elevated readings should prompt further evaluation. Hypertension is typically defined as having a systolic blood pressure (the higher number) consistently at or above 130 mm Hg and/or a diastolic blood pressure (the lower number) at or above 80 mm Hg. However, thresholds may vary based on guidelines from medical organizations. Hypertension should not be diagnosed based on a single reading. Repeated measurements on different occasions are necessary to confirm the

diagnosis. This helps to rule out white coat hypertension (elevated blood pressure due to the anxiety of a medical visit) and ensure an accurate diagnosis. In some cases, especially when there is a need to distinguish between sustained hypertension and white coat hypertension, ambulatory blood pressure monitoring may be employed. This involves wearing a device that measures blood pressure at regular intervals over a 24-hour period. Encouraging individuals with SCA to monitor their blood pressure at home can provide valuable data between clinic visits.[31] Home monitoring can help detect any variability and identify potential hypertension that might be missed during periodic office visits.

Monitoring

Individuals with SCA should have regular medical checkups with their healthcare providers, which include blood pressure monitoring as a standard part of the visit.[32]When hypertension is detected, the first step is often lifestyle modifications. These may include dietary changes, exercise, smoking cessation, alcohol moderation, and salt restriction. These lifestyle changes can help control blood pressure and reduce the risk of complications.If lifestyle modifications alone are insufficient to control hypertension, medication may be prescribed. Healthcare providers will choose appropriate antihypertensive medications, taking into consideration potential interactions with other medications used in the management of SCA.[33]The target blood pressure for individuals with SCA may differ from that in the general population. The ideal target should be determined in consultation with healthcare providers and may depend on individual factors.Once hypertension is diagnosed, ongoing monitoring is crucial. Follow-up appointments with healthcare providers should be scheduled to assess the effectiveness of treatment and make necessary adjustments. Individuals with SCA often require comprehensive care that addresses multiple aspects of their health. Hypertension management should be integrated into this comprehensive care plan, along with other aspects of SCA management. Monitoring and managing hypertension in individuals with SCA are a critical component of their overall healthcare. Regular checkups, careful measurement, and a proactive approach to lifestyle changes and medication management can help individuals with SCA control their blood pressure and reduce the risk of complications.

Management and Treatment of hypertension of SCA

Encourage a heart-healthy diet that is low in sodium (salt) and saturated fats. A diet rich in fruits, vegetables, whole grains, and lean proteins can help lower blood pressure. Encourage regular physical activity and exercise. Individuals with SCA should consult their healthcare providers to determine safe and appropriate exercise routines.[34]Maintaining a healthy weight is essential. Weight loss, if needed, can help lower blood pressure. Encourage individuals with SCA who smoke to quit smoking, as smoking can worsen hypertension and increase the risk of complications. Limit alcohol intake, as excessive alcohol consumption can raise blood pressure. Teach stress-reduction techniques, such as mindfulness, relaxation exercises, and stress management strategies. When lifestyle modifications alone are insufficient to control hypertension, healthcare providers may prescribe antihypertensive medications. Medication choices may include ACE inhibitors, angiotensin receptor blockers (ARBs), calcium channel blockers, and diuretics. The choice of medication depends on individual patient characteristics and considerations. Treatment should be individualized to the patient, taking into consideration factors like age, coexisting medical conditions, and potential drug interactions with other medications used in the management of SCA. It is crucial for individuals with SCA to take their prescribed medications regularly and as directed by their healthcare provider.[35]

Individuals with SCA should have their blood pressure monitored routinely, both during clinic visits and at home, to ensure that blood pressure remains within the target range. Encourage individuals to monitor their blood pressure at home, following healthcare provider guidance on equipment and frequency. Schedule regular

follow-up appointments with healthcare providers to assess the effectiveness of treatment, adjust medications if necessary, and provide ongoing support and education. Educate individuals with SCA about the importance of blood pressure management and the specifics of their treatment plan. Encourage individuals to actively participate in their care by self-monitoring blood pressure and adhering to lifestyle modifications and medication regimens.[36-37] Collaboration among healthcare providers, including primary care physicians, hematologists, and nephrologists, is vital to ensure the effective management of hypertension in SCA.[38]Coordinated care between specialists and primary care providers is essential to address the unique needs of individuals with both SCA and hypertension. Management of hypertension in SCA is complex and often requires an individualized approach. The goal is to control blood pressure effectively while considering the underlying genetic condition and any complications it may present. Regular monitoring, comprehensive care, and patient education are critical to successful management.

Patient Care and Support of hypertension in SCA

Patient care and support for individuals with sickle cell anemia (SCA) and coexisting hypertension involve a multidisciplinary approach to address their unique medical, emotional, and social needs. Providing comprehensive care and support is crucial to help individuals manage their conditions effectively and improve their quality of life. Encourage individuals with SCA to attend regular medical checkups, ideally with healthcare providers experienced in managing both SCA and hypertension.[39]Consistent blood pressure monitoring is essential. Ensure that patients have access to reliable blood pressure measurement devices and provide guidance on proper usage. Emphasize the importance of taking prescribed antihypertensive medications regularly and as directed by healthcare providers. Educate patients about the relationship between SCA and hypertension, as well as the importance of managing both conditions. Provide information about treatment options and potential complications.[38] Teach patients to monitor their blood pressure at home and recognize the signs of hypertension. Encourage active participation in their care. Support individuals with SCA and hypertension in becoming advocates for their own health. Encourage them to ask questions, seek second opinions, and communicate openly with their healthcare team. Provide guidance on maintaining a heart-healthy diet, including reducing sodium intake, consuming more fruits and vegetables, and adhering to any dietary restrictions related to SCA. Encourage patients to engage in safe and appropriate physical activity, tailored to their health status. Offer resources and support to individuals who smoke and motivate them to quit. Teach stress-reduction techniques, such as relaxation exercises and mindfulness, as chronic stress can exacerbate both SCA and hypertension.[37]Ensure that patients understand their antihypertensive medications, including the purpose, dosage, and potential side effects. Address any barriers to medication adherence, such as concerns about side effects, and provide strategies to overcome these obstacles. Offer access to counseling services or support groups for individuals who may be dealing with emotional challenges related to their health conditions. Recognize the potential impact of chronic illness on mental health and ensure that individuals receive appropriate care when needed. Facilitate collaboration among healthcare providers, including primary care physicians, hematologists, nephrologists, and other specialists, to ensure coordinated care. Develop individualized care plans that address both SCA and hypertension management. Schedule regular follow-up appointments with healthcare providers to assess treatment effectiveness and make adjustments to the care plan if necessary. Connect individuals with SCA to patient support organizations and community resources.[36] These organizations can provide valuable information and peer support. Discuss advance care planning with patients to ensure their preferences for medical care, including end-of-life care, are documented and respected. Recognize the importance of cultural competence in providing care to individuals with diverse backgrounds and beliefs. Tailor care and support to their unique cultural needs and preferences. Patient care and

support for hypertension in SCA require a holistic and patient-centered approach, considering not only the medical aspects but also the psychosocial and cultural dimensions of the patient's experience. By offering comprehensive care and empowering patients, healthcare providers can help individuals with SCA effectively manage both conditions and improve their overall well-being.

Clinical Management Challenges of Hypertension in Sickle Cell Disease (SCD)

Hypertension in sickle cell disease (SCD) presents a unique and growing challenge for healthcare providers, requiring careful consideration of both the disease's inherent complications and the potential side effects of hypertension treatments. While SCD patients are living longer due to advancements in medical care, hypertension has become a significant comorbidity, especially among adults. Managing hypertension in this population requires navigating several complex factors that distinguish it from hypertension in the general population.

1. Unique Pathophysiology of SCD and Hypertension

The pathophysiology of hypertension in SCD differs from that in the general population, posing a challenge in treatment. In SCD, chronic hemolysis, vascular inflammation, and endothelial dysfunction contribute to the development of elevated blood pressure. Free hemoglobin released during hemolysis scavenges nitric oxide (NO), an essential vasodilator, leading to impaired vasodilation and increased vascular resistance. The abnormal blood flow and hyperdynamic circulation in SCD also predispose patients to elevated blood pressure over time. The presence of chronic anemia, renal involvement, and vaso-occlusive crises further complicates the blood pressure regulation, making standard antihypertensive therapies less predictable. The interplay of these factors means that hypertensive management strategies must account for both the underlying disease processes and the specific challenges posed by the treatment of elevated blood pressure in this population.[40]

2. Drug Interactions and Side Effects

One of the most significant clinical challenges in managing hypertension in SCD patients is the potential for adverse drug interactions and side effects. Many antihypertensive medications can exacerbate anemia, lead to fluid retention, or interact with treatments used to manage other SCD complications, such as pain crises or stroke prevention.[41]

- **Diuretics**: Diuretics, commonly used to treat hypertension, can worsen dehydration, a critical concern in SCD patients, who are already prone to dehydration due to increased fluid turnover. Diuretics may also reduce renal perfusion in individuals with sickle cell nephropathy, worsening kidney function over time.
- **ACE Inhibitors and ARBs**: Angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers (ARBs) are often preferred for patients with both hypertension and chronic kidney disease. However, these medications can also lead to hyperkalemia, particularly in patients with kidney dysfunction, and must be used with caution.
- **Calcium Channel Blockers**: These may be useful in managing pulmonary hypertension, a common complication in SCD, but their use for systemic hypertension can be limited by side effects such as edema, which can complicate the fluid balance in these patients.

In addition, SCD patients often receive blood transfusions and other treatments that can interact with antihypertensive medications. This necessitates careful monitoring of kidney function, electrolyte balance, and blood pressure levels to avoid exacerbating any existing complications.

3. Monitoring and Diagnosis Complications

Accurate diagnosis and ongoing monitoring of hypertension in SCD patients are fraught with

challenges. Many SCD patients present with fluctuating blood pressure due to episodic pain crises or anemia, which may lead to temporary increases in blood pressure. This variability makes it difficult to determine whether the patient has chronic hypertension that requires long-term management or whether the elevated readings are transient and due to an acute SCD complication. Additionally, blood pressure readings may be affected by the pain and stress associated with SCD crises, leading to "white coat" hypertension. Routine clinic-based blood pressure measurements might underestimate true blood pressure, which can only be fully understood with ambulatory blood pressure monitoring (ABPM) or home-based measurements. These methods, however, are not always readily available or utilized in clinical practice, further complicating hypertension management in this population.[42]

4. Comorbidities and Complications

Hypertension in SCD patients is often associated with other comorbidities, particularly renal dysfunction, cardiovascular disease, and pulmonary hypertension. Managing these comorbid conditions in conjunction with hypertension increases the complexity of treatment. For instance, the presence of sickle cell nephropathy means that many SCD patients have already experienced damage to their kidneys, which can affect both blood pressure regulation and drug metabolism. Careful management is required to balance antihypertensive therapy with kidney function, as kidney impairment can alter the effectiveness and safety of many common antihypertensive medications. Moreover, pulmonary hypertension, a frequent complication of SCD, is closely related to both the pathophysiology of the disease and the presence of hypertension. Pulmonary hypertension itself can complicate the management of systemic blood pressure, as medications that help reduce pulmonary pressures may not have the same effect on systemic circulation.[43]

5. Lack of Specific Guidelines for SCD

Currently, there is a significant gap in specific, evidence-based guidelines for managing hypertension in SCD patients. The existing hypertension management protocols are primarily based on the general population and do not fully address the unique needs of SCD patients. Given the complexity of SCD, healthcare providers must often rely on clinical judgment and adapt general guidelines to the specific circumstances of the patient, particularly in cases where comorbid conditions such as stroke, renal dysfunction, or pulmonary hypertension are present. The lack of tailored guidelines complicates the clinical decision-making process and necessitates ongoing research to develop evidence-based treatment strategies that are specific to SCD.[44]

6. Psychosocial and Lifestyle Factors

The psychosocial aspects of managing hypertension in SCD patients also pose challenges. Individuals with SCD, especially those who are young or have experienced significant health challenges, may have difficulty adhering to long-term medication regimens. The burden of managing multiple medications for SCD-related complications, combined with the stigma associated with chronic disease, can lead to non-compliance with prescribed blood pressure medications. Additionally, lifestyle factors such as diet, physical activity, and stress management play a role in controlling hypertension. Unfortunately, many SCD patients face barriers to accessing care, such as financial difficulties, limited access to healthcare, or lack of education about the importance of managing their blood pressure.[45]

Recommendations for the Management of Hypertension in Sickle Cell Disease (SCD)

Hypertension in sickle cell disease (SCD) presents a significant challenge, requiring comprehensive management strategies tailored to the unique pathophysiology and clinical complexities of the disease. To optimize the care of individuals with SCD and hypertension, several key recommendations should be considered. These recommendations aim to improve both short-term and long-term health outcomes by addressing the specific needs of SCD patients,

enhancing early detection, and refining treatment protocols.

1. Early Screening and Monitoring

Given the rising prevalence of hypertension in individuals with SCD, early detection is crucial. Routine blood pressure monitoring should begin in childhood and continue throughout adulthood, with particular attention during periods of transition from childhood to adolescence and into adulthood. This is especially important as SCD patients may experience fluctuating blood pressure due to acute pain crises or anemia, which can obscure the true incidence of hypertension. Implement annual blood pressure screening for all children and adults with SCD, with additional monitoring during hospital admissions or pain crises. Ambulatory blood pressure monitoring (ABPM) should be considered for more accurate diagnosis, especially in patients with fluctuating blood pressure levels.

2. Tailored Pharmacological Management

The pharmacological treatment of hypertension in SCD must be individualized, considering the unique pathophysiology of the disease, comorbidities, and potential drug interactions. Traditional antihypertensive therapies, while effective in the general population, may require modification when used in SCD patients due to the potential for side effects or exacerbation of underlying conditions like anemia, renal dysfunction, and fluid imbalance. Use antihypertensive medications with caution, opting for drugs that do not exacerbate SCD-related complications. Angiotensin-converting enzyme (ACE) inhibitors or angiotensin II receptor blockers (ARBs) may be preferred in the presence of sickle cell nephropathy. Diuretics should be used sparingly due to the risk of dehydration and renal complications. Beta-blockers and calcium channel blockers can be considered, but their side effects should be monitored closely, especially in older SCD patients with comorbidities like heart failure or pulmonary hypertension.

3. Management of Renal Function

Renal impairment is a common complication of SCD and plays a critical role in the development and progression of hypertension. Sickle cell nephropathy is characterized by glomerular injury, proteinuria, and impaired renal function, which can lead to further elevation of blood pressure. Monitoring and managing renal function should be an integral part of hypertension care in this population. Regularly monitor renal function through serum creatinine, glomerular filtration rate (GFR), and urinary protein levels in SCD patients, particularly those with known renal involvement. Early interventions, such as ACE inhibitors or ARBs, should be considered for those with early signs of nephropathy, aiming to preserve kidney function and manage hypertension concurrently.

4. Addressing Pulmonary Hypertension

Pulmonary hypertension (PH) is a common and often underdiagnosed complication in SCD patients, and it frequently coexists with systemic hypertension. The increased pressure in the pulmonary circulation can exacerbate the cardiovascular strain, making the management of systemic hypertension even more challenging. Screen for pulmonary hypertension in all adults with SCD, particularly those with symptoms like dyspnea, fatigue, or chest pain. Early detection using echocardiography or right heart catheterization is crucial. In patients with coexisting systemic and pulmonary hypertension, therapies targeting both forms of hypertension should be considered, including pulmonary vasodilators for pulmonary hypertension.

5. Lifestyle Modifications and Education

Lifestyle factors, such as diet, exercise, and weight management, play a critical role in controlling hypertension. For individuals with SCD, maintaining an optimal weight and healthy diet is essential to prevent further cardiovascular strain. Moreover, lifestyle interventions should focus on reducing stress and improving overall well-being, both of which can influence blood pressure. Provide ongoing education and support

to SCD patients and their families regarding the importance of lifestyle changes, such as reducing sodium intake, increasing physical activity, and managing stress. Weight management programs and nutritional counseling should be offered, especially in adolescents and adults with obesity, to help control blood pressure.

6. Multidisciplinary Approach to Care

Managing hypertension in SCD requires a holistic, multidisciplinary approach, involving specialists in hematology, cardiology, nephrology, and pulmonology. Coordinated care is essential to address the complex needs of these patients, who may have multiple comorbidities, including kidney dysfunction, cardiovascular disease, and pulmonary hypertension. Develop a multidisciplinary care team for each patient with SCD and hypertension, ensuring regular communication between specialists. This collaborative approach will help tailor treatments to the individual's specific needs, monitor potential drug interactions, and ensure comprehensive care.

7. Psychological Support and Adherence

Managing chronic conditions like hypertension can be stressful, particularly for individuals living with a lifelong disease such as SCD. Mental health support is an essential component of hypertension management, as stress and depression can contribute to poor adherence to treatment regimens. Integrate psychological support and mental health services into the care plan for patients with SCD. Offering counseling, stress management techniques, and access to support groups can improve treatment adherence and overall patient outcomes.

8. Research and Development of SCD-Specific Guidelines

The absence of evidence-based guidelines tailored to the management of hypertension in SCD underscores the need for further research. Given the unique challenges presented by SCD, developing specific treatment protocols based on comprehensive clinical studies is essential. Encourage ongoing research to better understand the mechanisms linking hypertension and SCD. The development of disease-specific guidelines will help standardize treatment approaches and improve outcomes for individuals with both hypertension and SCD.

9. Public Health Initiatives

Widespread awareness of the risks of hypertension in individuals with SCD, especially in underserved communities, is vital to improving early diagnosis and management. Public health campaigns targeting SCD awareness and hypertension prevention should be prioritized in areas with high SCD prevalence. Launch public health initiatives aimed at educating communities, particularly those with a high prevalence of SCD, about the risks of hypertension and the importance of regular health check-ups. Outreach programs can help identify at-risk individuals and ensure timely interventions.

Conclusion

Sickle cell anemia, a hereditary blood disorder marked by the constant threat of vaso-occlusive crises and debilitating pain, finds itself quietly accompanied by hypertension, a condition that often lingers in the shadows. This silent companion, however, is not to be underestimated, for it exerts a profound influence, further compromising the well-being of those living with this dual burden. The silent struggle of hypertension in sickle cell anemia has taken center stage in our exploration. We have uncovered the prevalence, risk factors, and clinical implications of hypertension, recognizing that its silent presence contributes to the ever-present challenges faced by individuals with sickle cell anemia. It amplifies the complexity of organ damage, exacerbates the risks of stroke, and underscores the importance of early diagnosis and effective management. The path ahead may be challenging, but it is a path of hope, resilience, and unity. Together, we can ensure that no one faces this silent struggle alone, and that the future holds the promise of improved health and well-being for all.

References

1. Alhawiti NM, Shubair MM, Alharthy A, Al-Khateeb BF, Aldahash R, Aleissa B, Angawi K, AlJumah M, Almutairi A, Almutairi MN, Ali SA. The Prevalence and Predictors of Sickle Cell Anemia in the Saudi Arabia General Population: Findings from a Cross-Sectional Study. In Healthcare, 2025; 13 (10): 1117.
2. Jha SK, Ha LJ, Bassett M, Silar A, Gilner BL, Gajendran I, Marri P. Review of cardiovascular complications in children with sickle cell disease. Progress in Pediatric Cardiology. 2025:101836.
3. UM W, UM S, KA I, BI G, FA M, NM J. Accuracy of Echocardiographic Measures for Diagnosing Pulmonary Hypertension in Children with Sickle Cell Anaemia. International Journal of Innovative Science and Research Technology. 2025; 10(3):3320-3326.
4. Lucero MJ, Lisk C, Cendali F, Swindle D, Setua S, Thangaraju K, Pak DI, O'Boyle Q, Lu S, Tolson R, Zaeske S. Targeting lung heme iron by aerosol hemopexin adminstration in sickle cell disease pulmonary hypertension. Free Radical Biology and Medicine. 2025; 229:458-473.
5. AbdelMassih AF, Nabil F, Salama N, Youssry I. Early detection of pulmonary vasculopathy in children with sickle cell disease by new echocardiography-based blood speckle technology. BMC pediatrics. 2025; 25(1):1-9.
6. Alugba G, TABOWEI G, Ogedegbe O, Gbegbaje O, OKORARE O, Evbayekha E, Ezenna C, EVBU E, Patel D. In-Hospital Outcomes of Heart Failure Patients With Sickle Cell Disease: A Retrospective Population-Based Study. Journal of Cardiac Failure. 2025; 31(1):250.
7. Obeagu EI, Ogunnaya FU, Obeagu GU, Ndidi AC. Sickle cell anaemia: a gestational enigma. European Journal of Biomedical and Pharmaceutical Sciences. 2023;10((9): 72-75
8. Obeagu EI. An update on micro RNA in sickle cell disease. Int J Adv Res Biol Sci. 2018; 5:157-8.
9. Obeagu EI, Babar Q. Covid-19 and Sickle Cell Anemia: Susceptibility and Severity. J. Clinical and Laboratory Research. 2021;3(5):2768-0487.
10. Obeagu EI. Depression in Sickle Cell Anemia: An Overlooked Battle. Int. J. Curr. Res. Chem. Pharm. Sci. 2023;10(10):41-.
11. Obeagu EI, Obeagu GU. Evaluation of Hematological Parameters of Sickle Cell Anemia Patients with Osteomyelitis in A Tertiary Hospital in Enugu, Nigeria. Journal of Clinical and Laboratory Research.2023;6(1):2768-0487.
12. Obeagu EI, Dahir FS, Francisca U, Vandu C, Obeagu GU. Hyperthyroidism in sickle cell anaemia. Int. J. Adv. Res. Biol. Sci. 2023;10(3):81-9.
13. Obeagu EI, Obeagu GU, Akinleye CA, Igwe MC. Nosocomial infections in sickle cell anemia patients: Prevention through multi-disciplinary approach: A review. Medicine. 2023;102(48): e36462.
14. Njar VE, Ogunnaya FU, Obeagu EI. Knowledge and Prevalence of The Sickle Cell Trait Among Undergraduate Students of The University of Calabar. Prevalence.;5(100):0-5.
15. Swem CA, Ukaejiofo EO, Obeagu EI, Eluke B. Expression of micro RNA 144 in sickle cell disease. Int. J. Curr. Res. Med. Sci. 2018;4(3):26-32.
16. Essien EA, Winter-Eteng BF, Onukogu CU, Nkangha DD, Daniel FM. Psychosocial challenges of persons with sickle cell anemia: A narrative review. Medicine. 2023;102(47): e36147.
17. Pegelow CH, Colangelo L, Steinberg M, Wright EC, Smith J, Phillips G, Vichinsky E. Natural history of blood pressure in sickle cell disease: risks for stroke and death associated with relative hypertension in sickle cell anemia. The American journal of medicine. 1997;102(2):171-7.
18. Osunkwo I, Manwani D, Kanter J. Current and novel therapies for the prevention of vaso-occlusive crisis in sickle cell disease. Therapeutic Advances in Hematology. 2020; 11:2040620720955000.
19. Becker AM, Goldberg JH, Henson M, Ahn C, Tong L, Baum M, Buchanan GR. Blood pressure abnormalities in children with sickle

cell anemia. Pediatric blood & cancer. 2014;61(3):518-22.
20. Pegelow CH, Colangelo L, Steinberg M, Wright EC, Smith J, Phillips G, Vichinsky E. Natural history of blood pressure in sickle cell disease: risks for stroke and death associated with relative hypertension in sickle cell anemia. The American journal of medicine. 1997;102(2):171-7.
21. Neumayr LD, Hoppe CC, Brown C. Sickle cell disease: current treatment and emerging therapies. Am J Manag Care. 2019;25(18 Suppl): S335-43.
22. Matthie N, Jenerette C, McMillan S. Role of self-care in sickle cell disease. Pain Management Nursing. 2015;16(3):257-66.
23. Ballas SK. Sickle cell disease: Classification of clinical complications and approaches to preventive and therapeutic management. Clinical hemorheology and microcirculation. 2018;68(2-3):105-28.
24. Osunkwo I, Manwani D, Kanter J. Current and novel therapies for the prevention of vaso-occlusive crisis in sickle cell disease. Therapeutic Advances in Hematology. 2020; 11:2040620720955000.
25. Piccin A, Murphy C, Eakins E, Rondinelli MB, Daves M, Vecchiato C, Wolf D, Mc Mahon C, Smith OP. Insight into the complex pathophysiology of sickle cell anaemia and possible treatment. European journal of haematology. 2019;102(4):319-30.
26. DeBaun MR, Sarnaik SA, Rodeghier MJ, Minniti CP, Howard TH, Iyer RV, Inusa B, Telfer PT, Kirby-Allen M, Quinn CT, Bernaudin F. Associated risk factors for silent cerebral infarcts in sickle cell anemia: low baseline hemoglobin, sex, and relative high systolic blood pressure. Blood, The Journal of the American Society of Hematology. 2012;119(16):3684-90.
27. Wood KC, Gladwin MT, Straub AC. Sickle cell disease: at the crossroads of pulmonary hypertension and diastolic heart failure. Heart. 2020;106(8):562-568.
28. Fonseca GH, Souza R, Salemi VM, Jardim CV, Gualandro SF. Pulmonary hypertension diagnosed by right heart catheterisation in sickle cell disease. European Respiratory Journal. 2012;39(1):112-118.
29. Piccin A, Murphy C, Eakins E, Rondinelli MB, Daves M, Vecchiato C, Wolf D, Mc Mahon C, Smith OP. Insight into the complex pathophysiology of sickle cell anaemia and possible treatment. European journal of haematology. 2019;102(4):319-330.
30. Kim YG, Roh SY, Han KD, Jeong JH, Choi YY, Min K, Shim J, Choi JI, Kim YH. Hypertension and diabetes including their earlier stage are associated with increased risk of sudden cardiac arrest. Scientific reports. 2022;12(1):12307.
31. Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Dennison Himmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, MacLaughlin EJ. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Journal of the American College of Cardiology. 2018;71(19): e127-248.
32. Kim YG, Min K, Jeong JH, Roh SY, Han KD, Shim J, Choi JI, Kim YH. Temporal elevation of blood pressure is associated with increased risk of sudden cardiac arrest. Scientific Reports. 2024;14(1):2289.
33. Yawn BP, Buchanan GR, Afenyi-Annan AN, Ballas SK, Hassell KL, James AH, Jordan L, Lanzkron SM, Lottenberg R, Savage WJ, Tanabe PJ. Management of sickle cell disease: summary of the 2014 evidence-based report by expert panel members. Jama. 2014;312(10):1033-1048.
34. Connes P, Machado R, Hue O, Reid H. Exercise limitation, exercise testing and exercise recommendations in sickle cell anemia. Clinical hemorheology and microcirculation. 2011;49(1-4):151-163.
35. Hazinski MF, Markenson D, Neish S, Gerardi M, Hootman J, Nichol G, Taras H, Hickey R, O'Connor R, Potts J, Van Der Jagt E. Response to cardiac arrest and selected life-threatening medical emergencies: the medical emergency response plan for schools: a statement for healthcare providers, policymakers, school administrators, and

community leaders. Circulation. 2004;109(2):278-291.
36. Adewoyin AS. Management of sickle cell disease: a review for physician education in Nigeria (sub-saharan Africa). Anemia. 2015;2015.
37. Obeagu EI, Obeagu GU, Igwe MC, Alum EU, Ugwu OP. Men's Essential roles in the Management of Sickle Cell Anemia. Newport International Journal of Scientific and Experimental Sciences. 2023;4(2):20-29.
38. Strumph K, Hafeman M, Ranabothu S, Gomes W, Benitez S, Kaskel F, Manwani D, Mahgerefteh J. Nocturnal hypertension associated with stroke and silent cerebral infarcts in children with sickle cell disease. Pediatric Blood & Cancer. 2021;68(5): e28883.
39. Bello-Manga H, Haliru L, Ahmed K, Ige S, Musa H, Muhammad-Idris ZK, Monday B, Sani AM, Bonnet K, Schlundt DG, Varughese T. Barriers and facilitators to a task-shifted stroke prevention program for children with sickle cell anemia in a community hospital: a qualitative study. Implementation Science Communications. 2024;5(1):10.
40. Gordeuk VR, Castro OL, Machado RF. Pathophysiology and treatment of pulmonary hypertension in sickle cell disease. Blood, The Journal of the American Society of Hematology. 2016; 127(7):820-828.
41. Ballas SK, Kesen MR, Goldberg MF, Lutty GA, Dampier C, Osunkwo I, Wang WC, Hoppe C, Hagar W, Darbari DS, Malik P. Beyond the definitions of the phenotypic complications of sickle cell disease: an update on management. The Scientific World Journal. 2012; 2012(1):949535.
42. Patel S, Patel R, Mukkala SR, Akabari A. Emerging therapies and management approaches in sickle cell disease (SCD): A critical review. Journal of Phytonanotechnology and Pharmaceutical Sciences. 2023;3(3):1-1.
43. Helvaci MR, Arslanoglu Z, Celikel A, Abyad A, Pocock L. Pathophysiology of pulmonary hypertension in sickle cell diseases. Middle East J Intern Med. 2018; 11(2):14-21.
44. Savage WJ, Buchanan GR, Yawn BP, Afenyi-Annan AN, Ballas SK, Goldsmith JC, Hassell KL, James AH, John-Sowah J, Jordan L, Lottenberg R. Evidence gaps in the management of sickle cell disease: a summary of needed research. American journal of hematology. 2015; 90(4):273-275.
45. Crosby LE, Quinn CT, Kalinyak KA. A biopsychosocial model for the management of patients with sickle-cell disease transitioning to adult medical care. Advances in therapy. 2015; 32:293-305.

Access this Article in Online

Website: www.ijcrims.com

Subject: Cardiology

Quick Response Code

DOI: 10.22192/ijcrms.2025.11.07.005

How to cite this article:
Emmanuel Ifeanyi Obeagu. (2025). The Pressure Within: Decoding Hypertension's Role in Cardiovascular Pathology of Sickle Cell Disease- A Review. Int. J. Curr. Res. Med. Sci. 11(7): 70-86. DOI: http://dx.doi.org/10.22192/ijcrms.2025.11.07.005