

Implementation Effectiveness of a Vulnerable Population Health Insurance Program on Sickle Cell Disease Outcomes: Evidence from the AbbaCare Initiative in Kano, northern Nigeria

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Abstract

Background

Sickle Cell Disease (SCD) leads to major health challenges and significant financial burdens in Sub-Saharan Africa. Government health insurance programs, such as the AbbaCare Equity Fund in Kano State, Nigeria, support vulnerable groups and help move toward Universal Health Coverage (UHC). Still, there is limited evidence about how effective these programs are and how well they are implemented.

Methods

We conducted a Hybrid type-2 stepped-wedge cluster randomised trial in three accredited health facility clusters in Kano State. Over 24 months, we enrolled 1,200 SCD patients in a 2:1:1 ratio at Murtala Muhammad Specialist Hospital (MMSH), Khalifa Isyaka Rabi'u Paediatrics Hospital (KSIPH), and Hasiya Bayero Paediatrics Hospital (HBPH), based on patient attendance. The clusters transitioned sequentially every four months, each cluster moved from standard fee-for-service care to the AbbaCare Initiative, which gave full premium exemption to registered SCD patients. The main clinical outcomes were annual rates of vaso-occlusive crises (VOC) and emergency hospital admissions, analysed with Generalised Linear Mixed Models (GLMM). The main economic outcome was Catastrophic Health Expenditure (CHE), defined as out-of-pocket spending greater than 10% of household income. We used a mixed methods approach and the Consolidated Framework for Implementation Research (CFIR) to assess implementation outcomes.

Results

Out of the 1,200 SCD patients, those enrolled in AbbaCare saw a 38% drop in annual VOC crises (aRR = 0.62, 95% CI 0.54–0.71, $p < 0.001$) and a 44% drop in emergency admissions (aRR = 0.56, 95% CI 0.48–0.66, $p < 0.001$). The percentage of patients with good Hydroxyurea adherence (MPR 80%) rose from 21.4% to 68.2% ($p < 0.001$). The share of households facing catastrophic health expenses (CHE) fell from 64.8% to 8.3% after joining AbbaCare (aOR = 0.09, 95% CI 0.06–0.14, $p < 0.001$). Qualitative results showed strong policy support, but challenges like rural facility exclusion and National Identification Number (NIN) requirements limited the program's reach.

Conclusion

The AbbaCare Equity Fund was associated with improved clinical outcomes, medication access, and financial protection among people with SCD. Strengthening drug supply chains, expanding rural facility coverage, and simplifying enrolment requirements may facilitate scale-up of equitable social health insurance in resource-constrained settings.

Introduction

Sickle Cell Disease (SCD) is a common inherited blood disorder that affects millions of people and their families worldwide [1–2]. Sub-Saharan Africa carries the largest burden, with 5.7 million cases and 50–90% of SCD-related deaths among children [1, 3]. Nigeria has the highest SCD rates in Africa, with a population prevalence of 1–3% (up to 4% in a recent pediatric meta-analysis) and about 150,000 affected babies [4–6]. The SCD trait is most common in the Northwest (7%), followed by the Southwest (5.0%), and is lowest in the Southeast (2.0%) [4]. In northern states like Kano, high carrier rates and social barriers lead to frequent complications, high child mortality, and severe financial hardship due to out-of-pocket payments.

The Kano State Contributory Healthcare Management Agency (KSCHMA) set up the AbbaCare Initiative to run the Vulnerable Group Fund, as required by State health insurance laws. The goal is to make sure vulnerable groups, like verified SCD patients, do not have to pay premiums. This allows them to get basic primary and secondary healthcare, regular treatments such as Hydroxyurea, and emergency care [7].

While demand-side health financing has potential, large gaps often exist between policy design and real-world implementation. It is not always clear how enrolling in health insurance improves disease control or protects families from financial risk in decentralised health systems.

This study assesses how well the AbbaCare Equity Fund improves clinical outcomes for sickle cell disease and prevents catastrophic health expenses. It also examines facilitators or barriers of implementation, using the Consolidated Framework for Implementation Research (CFIR), as shown in Table 1 below [8].

Table 1
CFIR Implementation Assessment Framework

CFIR 2.0 Domain	Core Evaluation Focus & Key Indicators	Target Implementation Sub-Constructs	Primary Data Collection Method
Innovation	Perceived value, relative advantage, and Hydroxyurea coverage adequacy	Relative Advantage, Design Quality & Cost	Focus Group Discussions (FGDs) with Enrollees & Caregivers
Outer Setting	Equity Fund policy alignment, statutory funding stability, and NIN verification barriers	Critical Events, Local Policies & External Partnerships	Key Informant Interviews (KIIs) with KSCHMA Leadership & Ministry Officials
Inner Setting	Accredited healthcare out of drug syndrome, capitation velocity, and referral pathways	Available Resources, Structural Characteristics & Communications	Facility Audits & Facility In-charge KIIs
Individuals	Healthcare worker knowledge (KAP), protocol adherence, patient trust, and community stigma	Provider Capability, Opportunity & Motivation	Provider KAP Surveys & Patient Diagnostic FGDs
Process	Enrollment velocity, NIN registration friction, and claims adjudication fidelity	Engaging, Executing & Reflecting	Process Mapping & Administrative Record Extractions

>> Insert Table 1 >>

Methods

Study Design & Randomisation

We conducted a Hybrid type-2 stepped-wedge cluster randomised trial across 3 accredited facility clusters for AbbaCare within the metropolitan area of Kano State, namely Murtala Muhammad Specialist Hospital (MMSH), Khalifa Sheik Isyaka Rabiu Paediatrics Hospital (KSIRH) and Hasiya Bayero Paediatrics Hospital (HBPH) over 24 months. The facilities were randomly assigned by each KSCHMA desk officer selecting one of the papers numbered (1 to 3). The order in which the clusters started the intervention was determined by the number drawn; the cluster that obtained number 1 was the first to begin, the one with number 2 came next, and the one with number 3 followed, with four crossover phases (three clusters in each phase), as shown in the CFIR implementation framework in Table 2 below.

Table 2
Stepped- wedge cluster RCT.

Cluster/Period	M1–4	M5–8	M9–12	M13–16	M17–20	M21–24
MMSH – Sequence 1	Control	AbbaCare	AbbaCare	AbbaCare	AbbaCare	AbbaCare
HBPH – Sequence 2	Control	Control	AbbaCare	AbbaCare	AbbaCare	AbbaCare
KSIPH – Sequence 3	Control	Control	Control	AbbaCare	AbbaCare	AbbaCare
Study activities	Baseline + effectiveness & implementation assessment	Effectiveness + implementation assessment	Effectiveness + implementation assessment	Effectiveness + implementation assessment	Effectiveness + implementation assessment	Post-rollout assessment

>> Insert Table 2 >>

The clusters began in the control phase (standard care under OOP payments) and then moved into the intervention phase (the AbbaCare premium exemption and activation of capitation/fee-for-service coverage) at four-month intervals.

Participants & Eligibility

Eligible participants were all SCD paediatric patients (≥ 2 years) and adult patients with laboratory-confirmed SCD (HbSS or HbS-thalassemia) residing in cluster catchment areas. Exclusions included severe non-SCD co-morbidities (e.g., end-stage renal disease unrelated to sickle nephropathy) or plans to relocate outside Kano State during the study period.

Intervention

The AbbaCare intervention provided fully subsidised health insurance coverage encompassing:

- Routine outpatient care, laboratory monitoring, and essential pharmaceuticals (Hydroxyurea, Folic Acid, Penicillin V, Antimalarial Prophylaxis, Ciklavir).
 - Emergency management of acute Vaso-Occlusive Crises (VOC), pain management, blood transfusions, and inpatient hospitalisations.
 - Provider reimbursement via a hybrid capitation model for primary facilities and fee-for-service (FFS) for secondary hospitals.

Sample size estimation

We calculated a sample size of 1,200 participants using the formula for comparing two proportions. Where $P_1 = 28\%$ proportion of improved health status among insured SCD patients in Kano, with an assumed effect size of 10%, 95% power, and a 95% confidence interval [9].

Data Collection

We collected quantitative data electronically using mobile devices and the **Open Data Kit (ODK)**. The quantitative tools recorded information on households' socioeconomic status, out-of-pocket expenditures, clinical event logs, emergency room visits, and pharmacy refill records.

Implementation Workplan

Phase 1: Facility Audits, Protocol Harmonization & Ethical Approvals

Ethical approval

was obtained from the Kano State Ministry of Health (Ethical Approval Number: SHREC/2026/8336) Facility records, household survey instruments, and qualitative data collection guides were digitised using Open Data Kit (ODK) and Kobo Toolbox to facilitate standardised data collection and management. Three representative accredited health facilities were selected to participate in the study.

Phase 2: Retrospective Extraction & Quantitative Primary Data Capture

Clinical records were extracted for the 12-month pre-enrolment and post-enrolment periods for 1,200 participants consecutively selected from the enrolment registers based on the availability of complete pre- and post-enrolment data. The sample comprised 600 participants from MMSH, 300 from KSIPH, and 300 from HBPH. Data extracted included VOC, blood transfusions, and emergency admissions. Household economic surveys were also conducted among the selected participants. Facility drug registries were audited to assess the duration of Hydroxyurea stock-outs and determine Medication Possession Ratios (MPRs)

Phase 3: CFIR Qualitative Diagnostics & Process Mapping

Key Informant Interviews (12–16) were conducted with KSCHMA directors, facility in-charges, and healthcare providers. Three Focus Group Discussion sessions (8–12 participants per session) were conducted with enrolled patients, caregivers, and Sickie Cell Club leaders across three facilities. Claims processing velocity, capitation payout timelines, and NIN registration bottleneck logs were analyzed.

Phase 4: Statistical & Implementation Analysis

Quantitative Analysis

We conducted a descriptive analysis using frequencies, percentages, means (standard deviation), and medians (interquartile range) and summarised socio-demographic characteristics. Primary effectiveness analyses followed the Intention-to-Treat principle. We analysed annualised VOC rates and emergency admissions using a Generalised Linear Mixed Model (GLMM) with a Log link function and Negative Binomial distribution to account for overdispersion and temporal clustering. We modelled Catastrophic Health Expenditure using a GLMM with a Logit link, defining CHE as total household healthcare expenditure exceeding 10% of household income.

Qualitative Analysis

We translated audio transcripts, transcribed them verbatim, and analysed them in **NVivo (v14)**. Coding applied a combined deductive (CFIR constructs) and inductive thematic approach. Two authors, experienced qualitative researchers, synthesised findings alongside quantitative outcomes, and triangulated them using joint display matrices.

Results

1.0 Sociodemographic Characteristics of the Participants

A total of N = 1,200 participants were enrolled across 3 clusters (mean age: 14.2 years [SD 8.6]. The majority were female (51.3%). Baseline demographic characteristics were balanced across the trial arms, as shown in Table 3.

Table 3
Sociodemographic Characteristics of the Participants

Characteristic	Frequency (n = 1,200)	Percentages (%)
Age (Years), Mean (SD)	14.2 (8.6)	
Sex	616	51.3
Female	584	48.7
Male		
Place of Residence	588	49.0
Rural	612	51.0
Urban		
Income/month	480	40.0
< NGN 70,000	720	60.0
>NGN 70,000		
NIN Verification Complete	732	61.0
Yes	468	39.0
No		
NGN- Nigerian Naira, NIN- National Identification Number		

>> Insert Table 3 >>

2.0 Clinical Outcomes

Enrollment in AbbaCare resulted in statistically significant improvements across all primary clinical parameters. Figure 1 visually compares baseline and post-enrollment clinical outcomes from the AbbaCare Sickle Cell Disease evaluation.

- **Vaso-Occlusive Crises:** The mean annual rate of vaso-occlusive crises (VOC) fell from 5.2 crises per patient per year in the control period to 3.2 in the intervention period. In the GLMM model, which took into account time trends and cluster random effects, enrollment in AbbaCare was associated with a 38% reduction in VOC frequency [aRR = 0.62; 95% CI (0.54–0.71); $p < 0.001$].
- **Emergency admissions:** for emergency admissions, the number of inpatient hospitalisations fell from 2.8 to 1.4 admissions per patient each year (this representing a 44% reduction) [aRR = 0.56; 95% CI (0.48–0.66); $p < 0.001$], as illustrated in Fig. 1; the qualitative interviews also indicate this.

“Before AbbaCare insurance, my daughter would be admitted with VOC crises for a minimum of 6–8 every year, but now ‘All praise be to God’ for the past one year she had only two VOC crises” (FGD-P02, SCD patient’s mother).

“In our facility, we observed a considerable reduction in SCD patients’ admissions for emergency care; we can say a 50% reduction actually with AbbaCare insurance implementation.”(KII-01 Facility Manager).

“Many of our members that are enrolled in AbbaCare programme have experienced reduction in emergency admissions over the past year. In fact, some of our members are now working as administrative staff of the programme.” (FDG-P05, SCD Club leader)

>> Insert Fig. 1>>

Medication Adherence

The proportion of patients attaining optimal Hydroxyurea adherence (MPR 80%) increased significantly from 21.4% at baseline to 68.2% under AbbaCare (p < 0.001) (Fig. 2). This corresponds with key informants’ quotes.

“We have strategies in place from KSCHMA to support people living with SCD with Hydroxyurea through Kano State Health Trust Fund (KHETFUND) procurement of Hydroxyurea, which is free for SCD patients. The drug reduces the risk of sickle cell disease complications.” (KII-07- KSCHMA Admin)

>> Insert Fig. 2>>

3.0 Financial Protection Outcomes

Out-of-pocket healthcare costs decreased substantially following the intervention. The mean monthly household OOP expenditure for SCD care declined from NGN 56,780.00 (24.32) to NGN 5,477.12 (4,542.40), as shown in Table 4. These quantitative findings correspond with the qualitative comments below.

Table 4 Financial Protection Outcomes				
Economic Outcome Metric	Control Steps	Intervention Steps	Effect Estimate (Adjusted)	p-value
Catastrophic Health Expenditure (CHE > 10%)	64.8%	8.3%	[aOR = 0.09, 95% CI [0.06, 0.14]	< 0.001
Impoverishment Rate (Post-OOP Poverty)	41.2%	5.1%	[aOR = 0.11, 95% CI [0.07, 0.18]	< 0.001
Distress Financing (Asset Selling / Borrowing)	58.3%	6.7%	[aOR = 0.08, 95% CI [0.05, 0.13]	< 0.001
Bold – Statistically significant				

“Whenever I am sick, my parents spent nothing less than NGN 50,000 for my medical bills in one admission, but now with AbbaCare we pay nothing for all drugs and services” (FGD; P05- SCD patient)

“Our members’ access to AbbaCare drastically dropped our spending on medical bills and admissions by 100%; I can tell you without hesitation that we got all our drugs and services free. However, the only challenge experienced by our members is enrollment issues with the NIN requirement, especially those coming from rural areas who have no documentation like birth certificates.” (FGD – P01, SCD Club leader)

“Kano State Government has dedicated a part of Basic Healthcare Provision Fund (BHCPF) to SCD care. Also, the Governor has passed the mandatory pre-marital screening law including Hb genotype to reduce SCD burden in the state.” (KII-09 KSCHMA Admin)

>> Insert Table 4 >>

4.0 Implementation Evaluation (CFIR Triangulation)

Qualitative findings mapped across CFIR domains provided critical context for the quantitative effectiveness metrics:

- 1. **Outer Setting (Policy & Administrative Alignment):** Political backing for the Equity Fund provided stable financing. However, strict mandatory National Identification Number (NIN) verification created administrative obstacles and delayed initial enrollment for rural pediatric patients who lacked formal birth documentation.
- 2. **Inner Setting (Supply Chain & Infrastructure):** Secondary specialist hospitals in urban areas (e.g., Murtala Muhammad Specialist Hospital) received specialised services and executed fee-for-service care efficiently. Conversely, peripheral Primary Health Centres (PHCs) experienced hitches, although all 44 LGAs benefited from SCD care intervention from BHCPF; full AbbaCare services were limited to three secondary care facilities.

3. **Process (Stakeholder Engagement):** Engaging local Sickle Cell Clubs and community leaders substantially increased enrollment rates and addressed misconceptions about long-term Hydroxyurea therapy.

>> Insert Table 5 >>

Table 5
Implementation Evaluation Findings (CFIR Triangulation Matrix)

CFIR 2.0 Domain	Key Facilitator	Implementation Bottleneck / Barrier	Policy & Operational Impact
Outer Setting	Strong political commitment and dedicated legislative backing for the state Equity Fund.	Mandatory National Identification Number (NIN) verification requirements created administrative enrollment delays.	High high-level policy support, but rural pediatric populations experienced enrollment barriers due to missing birth documentation.
Inner Setting	Timely primary care capitation payouts incentivized basic healthcare delivery across centers.	Periodic out-of-stock of routine pharmaceuticals (e.g., Hydroxyurea) at peripheral rural Primary Health Centers (PHCs).	Urban specialist hospitals functioned smoothly, gaps at rural PHCs forced SCD patients in rural area to resort to out-of-pocket purchases at commercial chemists.
Characteristics of Individuals	High community trust in KSCHMA and active support from local Sickle Cell Patient Clubs.	Suboptimal provider knowledge regarding pediatric Hydroxyurea dosing protocols among non-specialist staff.	Peer support networks improved patient retention, but clinical knowledge gaps among lower-tier healthcare workers required targeted training.
Process Execution	Engagement of community leaders and patient advocacy groups accelerated outreach efficiency.	Inconsistent fee-for-service (FFS) reimbursement processing times for secondary and tertiary referral hospitals.	Community engagement boosted uptake, but delayed claim processing risks disincentivizing secondary facility participation over time.

Discussion

This study provides empirical evidence that including vulnerable Sickle Cell Disease populations in a State social health insurance scheme yields substantial clinical and financial benefits. Enrollment in the AbbaCare Initiative led to a (38%) reduction in acute vaso-occlusive crises, a (44%) decline in emergency hospital admissions, and near-complete elimination of catastrophic health expenditures among beneficiary households. A study in Kano reported similar improvements in health outcomes among insured children with SCD [9].

We documented that prior to AbbaCare, 58.3% of families suffered distress health financing, frequently forcing parents to sell livestock, farm plots, or take high-interest loans to pay for emergency admissions, blood transfusions and drugs. Under AbbaCare, those catastrophic expenditures fell to 6.70%. These findings correspond with previous studies showing that SCD imposes a major financial strain on families globally [10–11]. The Economic Intelligence Unit (2020) reported that Nigeria in Sub-Saharan Africa incurred the highest annual SCD costs (direct and indirect), estimated at USD 6.5 billion per year [12]. However, the Ekiti State Health Insurance Scheme and the AbbaCare initiative in Kano guarantee 100% insurance coverage and immediate protection of t vulnerable low-income families from sudden financial ruin during crises, as reported in this study.

Global health bodies highlight insurance as a primary vehicle for equity, especially for SCD curative options such as bone marrow transplant and gene therapy. The Medical Affairs Review Committee (MARAC) advocates that insurer globally must stop labelling these curative therapies as experimental and formally cover them to change the global mortality trajectory of SCD.[13]

Our findings correspond with implementation science literature emphasising that demand-side financial protection is a prerequisite for chronic Non-Communicable Diseases (NCD) management in resource-limited settings. [14–15] Removing point-of-care financial barriers directly improved routine Hydroxyurea adherence, which in turn mitigated acute crisis frequency and lessened reliance on costly inpatient care.[16]

However, implementation bottlenecks identified in this study via CFIR underscore essential operational areas for health system optimisation:

- **Administrative Barriers:** Mandatory digital identification (NIN) checks can unintentionally exclude the most vulnerable rural child populations. Flexible verification policies such as temporary biometric tagging or community verification are recommended during early rollout phases.
- **Supply Chain Integrity:** Demand-side coverage must be matched by supply-side reliability. Drugs out of stock at accredited facilities and rural PHCs excluded from the initiative risk shifting costs back to enrollees. Institutionalising dedicated central procurement channels for essential NCD medicines is necessary to preserve financial protection gains.

Strengths & Limitations

Strengths of this evaluation include the randomised stepped-wedge design, which controlled for secular time trends, combined with strong implementation data structured around CFIR 2.0. Limitations encompass potential recall bias in self-reported household expenditure data (mitigated by 4-month survey intervals).

Conclusion & Policy Recommendations

The AbbaCare Equity Initiative in Kano State demonstrates that social health insurance is an effective policy tool for controlling Sickle Cell Disease and protecting vulnerable households from medical impoverishment.

Key Recommendations for Scale-Up

- **Policy Continuity:** Secure long-term state legislative appropriations for the Equity Fund to guarantee continuous coverage for chronic inherited conditions.
- **Supply Chain Reform:** Integrate routine SCD pharmaceuticals into state essential medicines logistics systems to prevent facility-level out-of-stock syndrome.
- **Administrative Flexibility:** Streamline enrollment verification guidelines for vulnerable child populations lacking formal identification documents.

Abbreviations

CFIR

Consolidated Framework for Implementation Research

CHE

Catastrophic Health Expenditure

GLMM

Generalized Linear Mixed Model

HBPH

Hasiya Bayero Paediatrics Hospital

KSIPH

Khalifa Isyaka Rabi Paediatrics Hospital

MMSH

Murtala Muhammad Specialist Hospital

PHC

Primary Health Centres

SCD

Sickle Cell Disease

VOC

Vaso-Occlusive Crises

Declarations

Clinical Trial number

Not Applicable

Ethics Approval and Consent to Participate

The Health Research Ethics Committee (HREC) of the Kano State Ministry of Health granted ethical approval for this study (NHREC/17/03/2018; Reference number: SHREC/2026/8336). We obtained administrative clearance from KSCHMA and participating health facility managers. We extracted all data from facility HMIS logs and administrative claims databases, aggregated it, and fully anonymised it before analysis. We obtained written informed consent from individual participants aged 18 years, parental informed consent for those < 8 years, and assent from SCD patients aged 8–17 years.

Consent for Publication

Not applicable

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Author Contribution

Authors' Contributions:[ZA, ALO] conceptualised the study, led data analysis, and drafted the manuscript. [RAM, ZA, JM] facilitated data collection and facility access. [ZA, ALO] performed statistical modelling and critical revision. All authors read and approved the final manuscript.

Data Availability

Data generated and analyzed will be available on reasonable request from the corresponding author and upon approval by KSCHMA and Kano Ministry of Health

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Figures

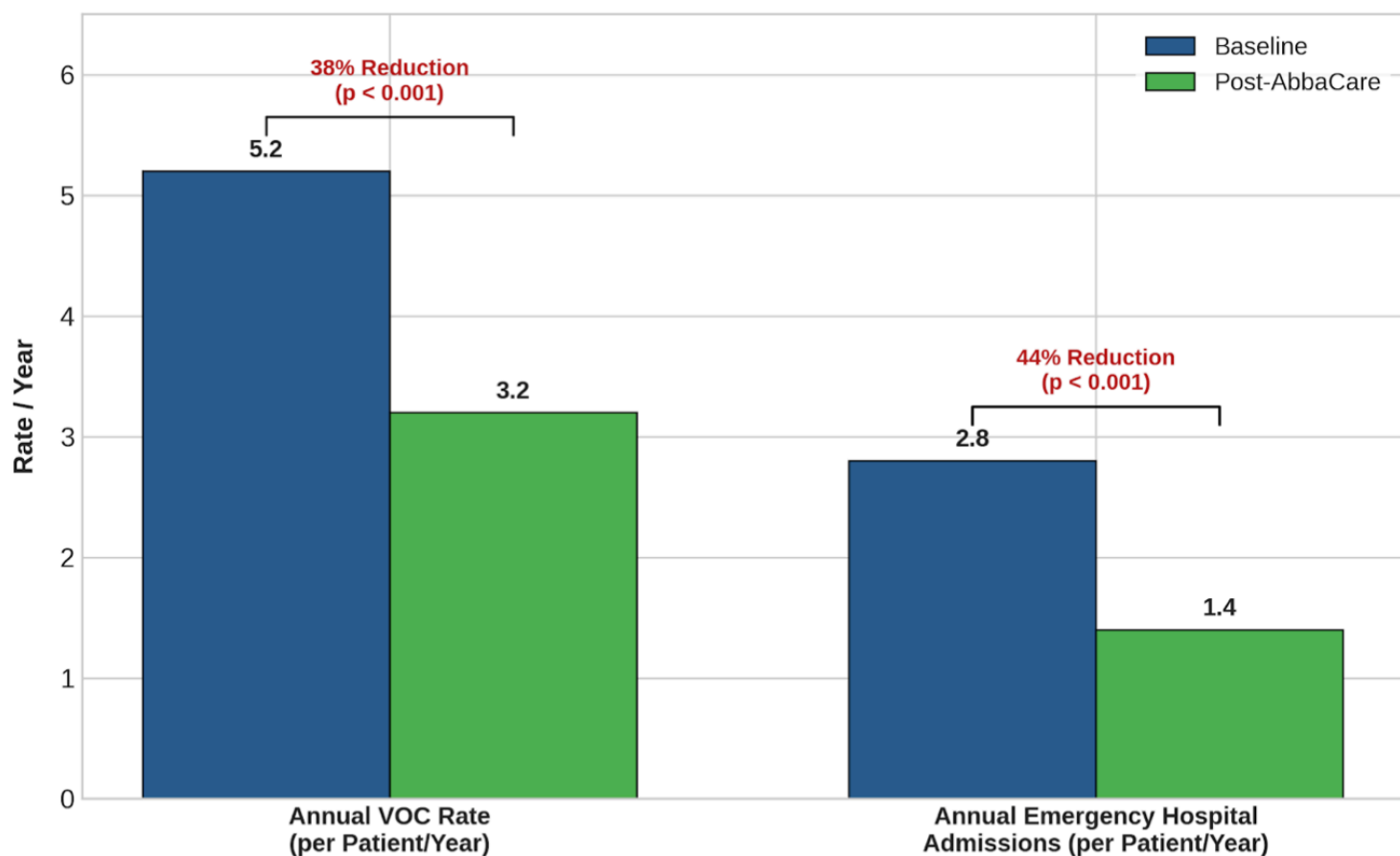


Figure 1

Annual Vaso-Occlusive Crises (VOC) and Emergency Hospital Admissions Rate per Patient/Year

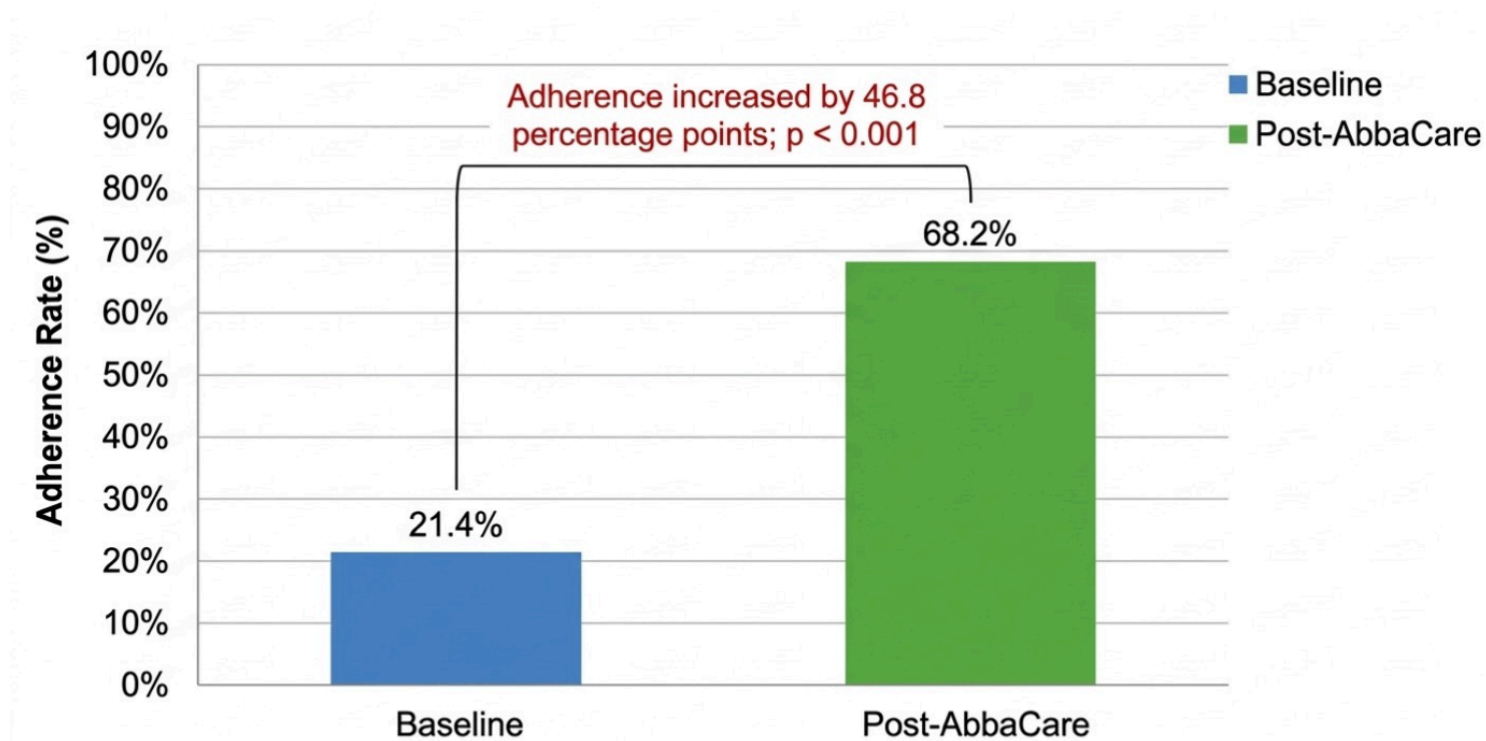


Figure 2

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