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Examining Health Disparities: An Observational Study on Peripheral Vascular Access Outcomes among Hospitalized Patients

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Introduction

Peripheral intravenous catheter (PIVC) placement is the most common invasive procedure performed in healthcare, with an estimated 90% of hospitalized patients requiring PIVC access during their stay. This equates to around two billion PIVCs used annually.[1–3] Studies report 36% to 63% of catheters fail due to a variety of complications, including infiltration, occlusion, phlebitis, dislodgment, and infection.[2–6] These failures not only cause immediate patient discomfort and increased clinical workload but also have wider implications such as prolonged hospital stays and delays in critical treatments.[2] The factors contributing to PIVC failure are multifaceted, involving clinical presentation, patient anatomy, provider skill level, and procedural circumstances. One significant determinant that has not been comprehensively addressed within the literature is healthcare inequities. These inequities permeate the healthcare system, adversely influencing outcomes across a spectrum of conditions and interventions.[7,8] It is well-documented that such disparities contribute to differential rates of chronic diseases and mortality; yet, their impact on PIVC placement and outcomes has not been similarly scrutinized.

Objectives

The objective of this study is to explore the relationship between healthcare disparities and PIVC outcomes. Specifically, we seek to identify the demographic and socioeconomic factors that correlate with increased PIVC failures and complications.

Methods

The study included all patients over age 18 who presented to one of four Corewell Health System emergency departments between January 1st, 2021, and January 31st, 2023, that underwent PIVC placement during their emergency room encounter. For each individual encounter, epidemiological, demographic, therapeutic, clinical, and outcomes data were collected. Participants were excluded if there was missing PIVC placement documentation. The primary outcome is the proportion of PIVC dwell time to hospitalization length of stay, which is expressed as the proportion of dwell time (hours) to hospital stay (hours) x 100%. Secondary outcomes include PIVC dwell time, time from ED arrival to PIVC placement, and reason for removal of the PIVC. After multivariable linear regression, multivariate linear regression analysis was utilized to adjust for confounders and best estimate the true effect of each variable.

Terms	Estimate	(95% CI)	*p* value
Demographics			
Age, category			
18-64	Reference		
65-80	-0.062	(-0.078 - -0.046)	<0.001
>80	-0.109	(-0.127 - -0.091)	<0.001
Sex			
Male	Reference		
Female	-0.098	(-0.109 - -0.086)	<0.001
Race			
White or Caucasian	Reference		
Black or African American	-0.049	(-0.069 - -0.029)	<0.001
Asian	0.131	(0.072 - 0.190)	<0.001
American Indian or Alaska Native	0.079	(-0.057 - 0.215)	0.256
Other	0.101	(0.057 - 0.146)	<0.001
Body mass index, category			
Healthy weight	Reference		
Underweight	-0.137	(-0.164 - -0.109)	<0.001
Overweight	0.048	(0.034 - 0.063)	<0.001
Obesity	0.023	(0.009 - 0.037)	0.001
NIMHD Health Disparities			
Percentage of population with an income to poverty ratio under 1.00			
0-19%	Reference		
20-39%	-0.016	(-0.033 - 0.001)	0.072
40-59%	-0.018	(-0.072 - 0.035)	0.507
60-79%	0.401	(-1.610 - 2.412)	0.696
Medical History			
Charlson Comorbidity Index			
≥5	Reference		
0	0.091	(0.069 - 0.114)	<0.001
1-2	0.018	(-0.005 - 0.042)	0.124
3-4	0.020	(-0.006 - 0.045)	0.132
Missing	0.060	(0.033 - 0.087)	<0.001
Hospital Course			
Emergency Severity Index	0.038	(0.029 - 0.048)	<0.001
Use of Intravenous Vesicant			
No			
Yes	-0.007	(-0.020 - 0.006)	0.296
PIVC Characteristics			
Gauge			
18	Reference		
20	0.012	(-0.003 - 0.026)	0.116
22	-0.208	(-0.236 - -0.180)	<0.001
24	-0.380	(-0.493 - -0.267)	<0.001
Insertion Method			
Traditional	Reference		
Ultrasound Guided	-0.205	(-0.232 - -0.179)	<0.001
Orientation			
Left	Reference		
Right	-0.014	(-0.025 - -0.003)	0.014
Location			
Antecubital	Reference		
Forearm	0.059	(0.045 - 0.072)	<0.001
Hand/Wrist	-0.158	(-0.189 - -0.128)	<0.001
Upper Arm	-0.131	(-0.160 - -0.102)	<0.001
Other	-0.192	(-0.215 - -0.169)	<0.001
Interaction of Age and Race			
Age Group=65-80: Race=Black or African American	-0.044	(-0.072 - -0.015)	0.003
Age Group=80+: Race=Black or African American	-0.052	(-0.088 - -0.016)	0.005
Age Group=65-80: Race=Asian	0.013	(-0.076 - 0.103)	0.772
Age Group=80+: Race=Asian	-0.087	(-0.190 - 0.017)	0.100
Age Group=65-80: Race=American Indian or Alaska Native	-0.142	(-0.366 - 0.081)	0.212
Age Group=80+: Race=American Indian or Alaska Native	-0.107	(-0.354 - 0.139)	0.394
Age Group=65-80: Race=Other	-0.085	(-0.154 - -0.017)	0.015
Age Group=80+: Race=Other	-0.147	(-0.226 - -0.069)	<0.001

Table 1. Multivariable linear regression with age and race interaction analysis of the proportion of dwell time to hospital length of stay for admitted patients.

Results

Between January 1st, 2021, and January 31st, 2023, there were 144,524 ED encounters that met inclusion criteria. The average age was 65.7 years and 53.4% were female. 97,069 (67.2%) encounters identified as White or Caucasian, 38,956 (27.0%) identified as Black or African American, 2,908 (2.0%) identified as Asian, 484 (0.3%) identified as American Indian or Alaska Native, and 5,107 (3.5%) identified as a race other than the four predominant categories. The majority of encounters occurred at a large, academic, tertiary care center (55362 [38.3%]). The median proportion of PIVC dwell time to hospital length of stay for the entire cohort was 0.88; individuals identifying as Asian had the highest value (0.94) while individuals identifying as Black or African American had the lowest value (0.82). The median PIVC dwell time was 68.3 hours. The median proportion of PIVC dwell time to hospital length of stay among Black females was 0.76, compared to White males at 0.93 (p<0.001). Failure as the reason for PIVC removal was highest in Black females (39.5%), followed by White females (37.5%), Black males (33.7%), and White males (31.2%; p<0.001).

A multivariable linear regression analysis with confounding variables for the outcome of proportion of PIVC dwell time to hospital length of stay was used in conjunction with a random forest model to determine appropriate variables for the multivariable linear regression analysis and the variables' contribution to the models' predictive accuracy, respectively. Multivariable linear regression with sex and race interaction variable analysis of the proportion of dwell time to hospital length of stay demonstrated that compared to Black females, Black males had 10.0% greater proportion of dwell to stay (p<0.001) and White males were 19.6% greater (p<0.001). (Table 1)

Conclusions

Overall, this observational cohort study of over 140,000 PIVC's in hospitalized patients demonstrated that significant health disparities exist within PIVC survivability. Black females face the highest risk of compromised PIVC functionality, resulting in approximately one full day less of reliable PIVC access than White males. Additional research is required to improve the understanding of the impact on health disparities and PIVC outcomes as well as potential solutions.

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Acknowledgements: Thank you, Dr. Amit Bahl for your mentorship, and thank you Dr. Nicholas Mielke for your constant support and advice. This project would not be possible without them. Thank you Dr. Kara Sawarynski and Dr. Dwayne Baxa for all the work and time you put into running the Embark course.