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ORIGINAL RESEARCH

Optimizing Strategies for Managing Difficult Intravenous Access

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Background: Difficult intravenous (IV) access (DIVA) remains a significant challenge in healthcare, leading to treatment delays, patient discomfort, and adverse outcomes. Contributing factors include patient conditions (eg, obesity, dehydration, anatomical variations) and provider-related challenges (eg, inadequate training, improper technique). Addressing DIVA requires a structured, data-driven approach.

Purpose: This study examines the root causes of IV access complications, their prevalence, and distribution across healthcare settings. It evaluates the impact of an escalation pathway and data-driven strategies to improve IV success rates, provider training, and process standardization.

Patients and Methods: A retrospective analysis was conducted on 311 DIVA patients at Sheikh Shakhbout Medical City (SSMC), Abu Dhabi, UAE, over seven months (June–December 2023). Data were obtained from electronic medical records (EMR) and Intensive Care Outreach Nurse (ICON) consultation forms. A novel IV escalation pathway and documentation system facilitated data collection on patient demographics, IV access reasons, and primary diagnoses.

Results: Among ICON-assisted patients, 74.6% had a known DIVA history, with cancer and renal disease being common conditions. ICONs achieved a first-attempt success rate of 68.8%, underscoring the need for improved floor nurse training. The most frequent IV access indications were medication administration, antibiotics, laboratory tests, and analgesia. Additionally, 57.3% of ICON consultations occurred outside standard hours, highlighting resource allocation challenges.

Conclusion: Structured escalation pathways, advanced nurse training, and data-driven decision-making are critical in addressing DIVA. Recommendations include a dedicated IV access team, ultrasound-guided cannulation, and predictive analytics to identify high-risk patients, ultimately enhancing patient outcomes and healthcare efficiency.

Keywords: patient safety, patient experience, healthcare quality, difficult intravenous access, healthcare operations, risk management, IV escalation pathway

Introduction

Difficult intravenous access (DIVA) is characterized by failed attempts at peripheral intravenous (PIV) insertion using standard techniques, often due to challenges such as the absence of visible or palpable veins identified through physical examination or a personal history of DIVA. In most cases, after an initial failed attempt, additional attempts—typically three—are made, with more experienced clinicians frequently called upon to secure access after multiple failures.[1] Establishing intravenous (IV) access is crucial in any hospital setting, as it facilitates the administration of medications, intravenous fluids, and blood products.[2] However, DIVA is an ongoing challenge within healthcare facilities, impacting patient safety and quality. Delays in securing IV access hinder prompt treatment initiation, potentially exposing patients to medical risks such as increased discomfort and anxiety levels. Managing such risks is crucial in medical settings

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because of the severe adverse outcomes if these hazards are not effectively prevented or controlled.[3,4] Tackling this problem is expected to reduce waste and improve operational efficiency.[5]

The difficulty in placing IVs often stems from patient-specific factors such as obesity, dehydration, and hypotension. These conditions can obscure veins, leading to higher rates of unsuccessful IV placements.[6] In older adults, reduced venous compliance and pressure often compound these hurdles.[7] Factors attributed to healthcare providers also contribute to difficulty obtaining IV access and encompass limited experience, improper techniques, and inadequate equipment usage. Some providers may lack adequate training or familiarity with IV insertion techniques. Errors in techniques such as improper tourniquet application or vein anchoring worsen the situation. Additionally, the existence of suitable tools such as ultrasound guidance or appropriately sized catheters improves IV access success.[8,9]

Adding to patient and provider variables, certain medications, notably chemotherapy drugs, worsen IV access by causing vein damage.[10] Prolonged IV therapy can lead to complications like phlebitis or thrombosis, hindering subsequent vein access.[6] The implications of difficult IV access encompass treatment delays, heightened patient discomfort, and potential recourse to more invasive procedures like central line placement or intraosseous access. Such delays negatively impact patient safety, satisfaction, and the quality of care. Patients in whom IV access is difficult might require multiple needle insertions, heightening discomfort and distress.[11] Delays in treatment due to failed IV placements significantly impact conditions such as sepsis or dehydration. Patients in whom IV access is difficult may require multiple needle insertions, and prolonged IV attempts escalate patient discomfort, distress, and delayed diagnosis, adding complexity to care.[10,12]

Numerous strategies have aimed to improve the success rates of IV access. Ultrasound guidance, for instance, enhances success rates and minimizes the need for multiple needle insertions.[7,13] Implementing tailored protocols for challenging IV access direct providers to alternative sites or to use specialized techniques.[14] Exploring alternate sites, like the forearm or hand, has shown promise.[15] Moreover, educating and training healthcare providers on proper IV insertion techniques and equipment use are pivotal in improving IV access success rates.[16,17]

This study presents a first-of-its-kind initiative emerging from the Gulf region, specifically addressing the difficult IV challenge, which is not a local but a global problem. The study aims to investigate the extent of IV access cases in Sheikh Shakhbout Medical City (SSMC) by creating an Electronic Medical Record for and analyzing the collected data, highlighting potential solutions to the problem.

Material and Methods

SSMC is one of the largest hospitals in the region, established in 2020, and is equipped with state-of-the-art medical technology and facilities, with a capacity of 400 beds. It is managed by SEHA, the Abu Dhabi Health Services Company, responsible for overseeing various public healthcare facilities in the United Arab Emirates (UAE).[18] SSMC offers a comprehensive range of medical services, including emergency care, critical care, medical, surgery, radiology, laboratory services, and specialized treatments in areas such as cardiac care, neuroscience, oncology, and pediatrics.

The historical IV access practice of the hospital was that if floor nurses could not obtain IV access, they would contact the intensive care outreach nurses (ICON). The ICON was the first responder of the rapid response team at the hospital. ICON is a specialized nurse who provides critical care and support when a patient shows signs of deterioration or a sudden change in condition in hospital wards or other areas of the healthcare facility. The ICON is trained to assess the patient, provide immediate interventions, and stabilize the patient's condition, while coordinating with other healthcare providers to ensure appropriate care. As ICON has expertise in dealing with fragile or unhealthy veins, it became the default resource called to provide support in placing IV access for patients in whom it was difficult to do so, a practice far from what is followed in literature.[19]

In Phase 1 of our project, the focus was to create a streamlined process for obtaining difficult IV access and digitizing it in an Electronic Medical Record (EMR) system to capture important metrics. This phase involves several elements with the goal of organizing and optimizing the efficiency of existing resources to implement a more streamlined process. This has resulted in the implementation of a new IV Access escalation pathway.

The difficult Intravenous Access Pathway begins with determining the patient's need for IV access and categorizing the required type, such as peripheral, central venous, or PICC line/tunneled catheter. If a PICC line or a tunneled catheter

is needed, interventional radiology (IR) is consulted. For peripheral or central access, the next step depends on the patient's history of DIVA. If no such history exists, the unit nurse attempts IV placement, limited to two attempts. If the nurse is successful, the procedure concludes without further action. If unsuccessful or if there is a known history of DIVA, the DIVA pathway is activated, involving a consultation with the ICON. The ICON makes up to two additional attempts at IV access and documents the intervention in the Electronic Medical Record (EMR) system and complete a "Difficult IV Consultation Form". If IV placement is still unsuccessful, the attending physician consults the anesthesia team for advanced access methods. Successful placement at any step terminates the process. The flowchart provides a clear, hierarchical approach to ensuring efficient and safe IV access for patients, emphasizing escalation of expertise in cases of difficulty. All interventions, whether successful or not, are recorded in the EHR, and the data collected informs training requirements for floor nurses while highlighting trends in patient-specific challenges. These insights are reviewed regularly, driving updates to hospital policies. The pathway is detailed in Figure 1.

This dedicated process ensured that any concerns or difficulties associated with intravenous access were promptly addressed and resolved. The variables considered in the escalation pathway included indication for IV access, whether two or more attempts at IV placement had already been made by the floor nurse, and whether the patient had a history of difficult IV placement.

As part of the IV Access escalation pathway, if the ICON was asked to attempt an IV, they were required to complete the Difficult IV Consultation Form (Figure 2) located in the EHR, regardless of the outcome of their attempt. This form captured patient demographics, reasons for admission, primary disease, purpose of IV access, awareness of any prior history of difficult IV access, duration of interaction with the patient, and date and time of insertion. This form helped track and characterize patients with difficult IV access, such as the primary diagnoses they had as well as the most frequently cited difficulties in obtaining IV access.

In Phase 2 of the project, the focus shifted towards nursing training and development. The key elements of this phase are as follows.

1. Capturing patient groups and areas of need: Over a period of 14 months (November 2022 to December 2023), data were collected from consultation forms. Thorough statistical analysis and interpretation of the data were performed to derive valuable insights into the effectiveness of the IV access pathway. The analysis shown was implemented for data from June 2023 to December 2023 only because the form was continuously improved until it reached its final version, as shown in Figure 2, in May 2023.

2. Current Procedural Terminology (CPT) code: To effectively track and analyze the training activities, we implemented a system in which specific CPT codes were assigned.

3. Nursing Education Department courses:

a. IV Best Practices Workshop: This course is designed for all nurses and focused on enhancing their understanding and application of the best practices related to IV procedures. It aims to improve students' skills and knowledge in order to ensure safe and efficient IV access.

b. US-guided course IV cannulation for advanced nurse practitioners: This specialized course is specifically designed for advanced nurse practitioners and focuses on ultrasound-guided IV cannulation techniques. It aims to enhance proficiency in performing this advanced procedure, thereby promoting patient comfort and safety.

4. Capture use of point-of-care ultrasound to cannulate: We then enhanced our IV access form to capture where ultrasound was used to obtain IV access, obtain more granular details, and also help generate data to create a business case for a dedicated IV access team.

Results

In this section, we present the outcomes of our analysis of the call data received by ICONs over a seven-month period from June 2023 to December 2023. The results offer a detailed examination of various facets, including the temporal distribution of calls, the frequency of calls during working and non-working hours, and insights into patients' histories of difficult IV access. Additionally, we investigated the success rates of IV access attempts, reasons for consultations, and primary diseases among patients requiring ICON intervention. These findings collectively provide a comprehensive understanding of the operational dynamics, challenges, and opportunities within the ICON service. The data-driven

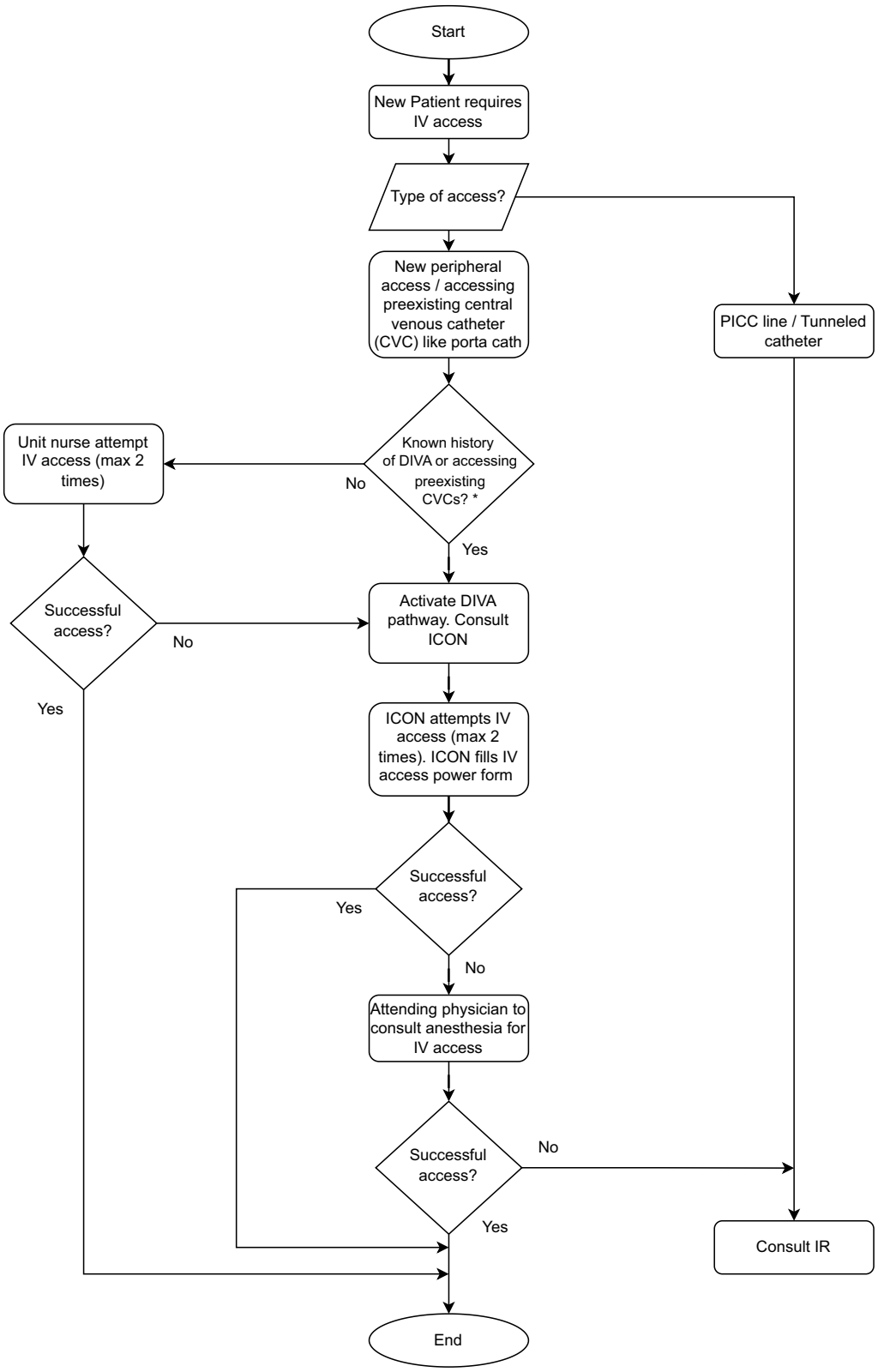

Figure 1 IV Access Pathway including DIVA escalation.

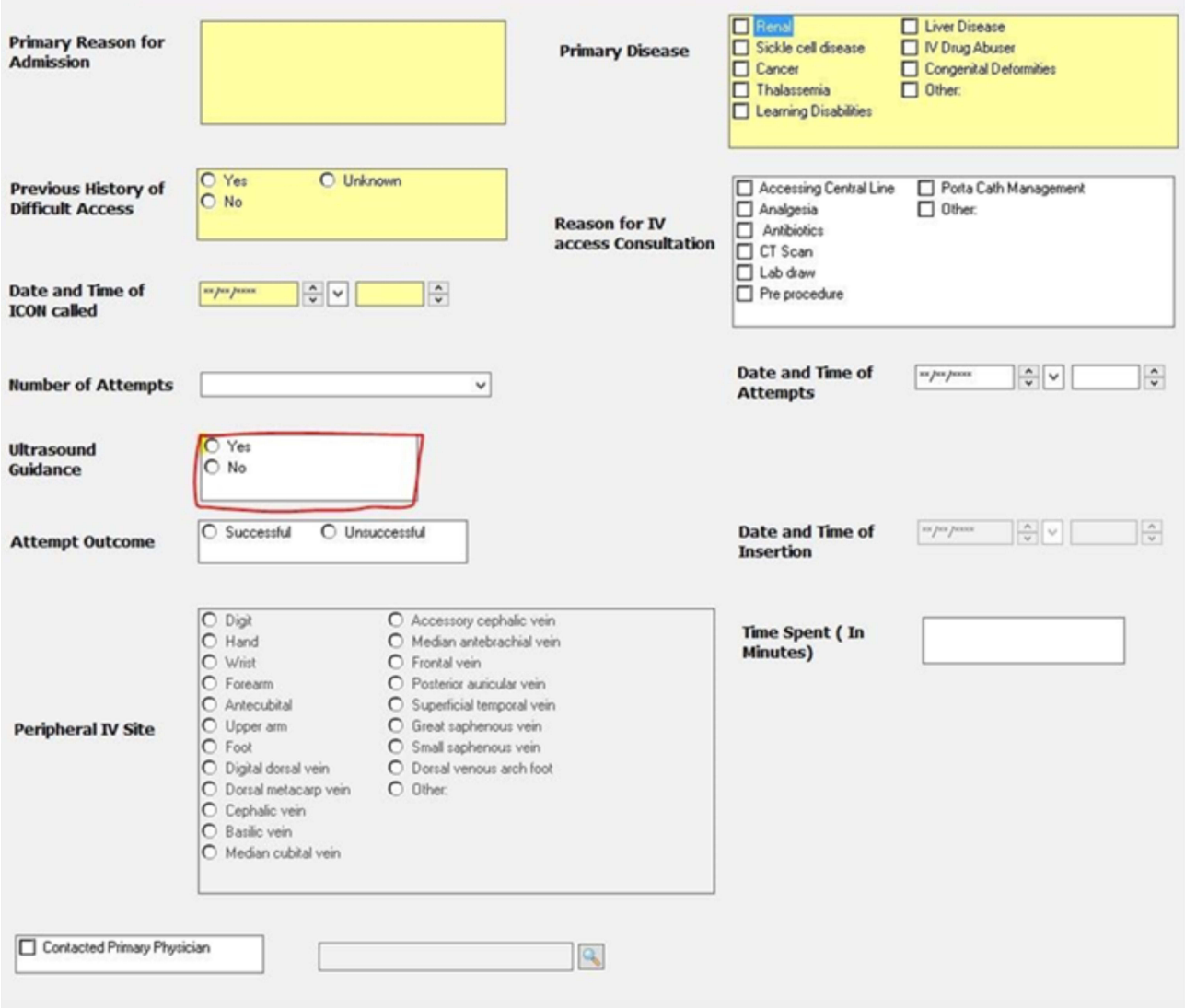

Figure 2 Difficult IV consultation form.
Note: The red box indicates the availability of ultrasound guidance.

insights presented here aim to inform strategic decision making, resource allocation, and training enhancements for the benefit of both ICONs and their patients.

As shown in the consultation form in Figure 2, a choice regarding previous history of difficult IV access has to be made, as "yes", "no", or "unknown". Table 1 shows the number of patients who were known to have a previous difficult

Table 1 Number and Percentages of Patients With Known Vs Unknown Difficult IV Access Over the Studied Period

Difficult IV Access?	Yes	No	Unknown	Total
June	31	2	8	41
July	28	0	10	38
August	37	6	10	53

(*Continued*)

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Table 1 (Continued).

Difficult IV Access?	Yes	No	Unknown	Total
September	39	2	6	47
October	19	1	4	24
November	50	3	9	62
December	28	4	14	46
Total	232 (74.6%)	18 (5.8%)	61 (19.6%)	311

IV access, those who were known not to have a difficult IV access, and those who were not known whether they had a difficult IV access. This shows that out of the 311 patients, only 232 had a known history of difficult IV access.

Table 1 shows the aggregate percentages of each patient type from June 2023 to December 2023. It has been shown that 74.6% of patients who needed an ICON intervention were already known to have a history of difficult IV access. For patients who represent 74.6% of the total number with a known history of difficult IV access, special considerations must be considered when attempting insertion. For instance, an insertion can be intended during the working hours of an ICON so that the working ICON can quickly respond to a call if a problem is faced during insertion, which is probable given the patient's known history.

Each time an ICON received a call to help access one of these patients, the time of the call was classified as inside working hours, from 08:00 to 04:00, or outside of working hours. As shown below, only 99 of 232 calls (42.7%) were made during the working hours of ICONs, which shows limited preparation for these patients. Figure 3 shows the number of calls received by ICONs during and outside working hours from June 2023 to December 2023.

As shown in Figure 3, outside-working-hour calls were significantly higher than inside-working-hour calls (57.3%). This can be used for better control of the times during which patients, especially those with known difficult IV access history, are allocated IV insertions during the working hours of ICONs.

For the seven-month study period, an ICON could achieve successful IV access of the patient by a single attempt at 68.8% (214 out of 311) of the times they were called (see Table 2). This suggests that the patients in those calls did not have difficult IV access, but the nurses attempting the insertion were not sufficiently qualified.

Furthermore, ICONs achieved successful IV access after the second attempt at 27.7% of the time they were called. These statistics can be used to show that with very basic and fundamental training for nurses, they could spare at least 68.8% of the calls they made for the ICONs.

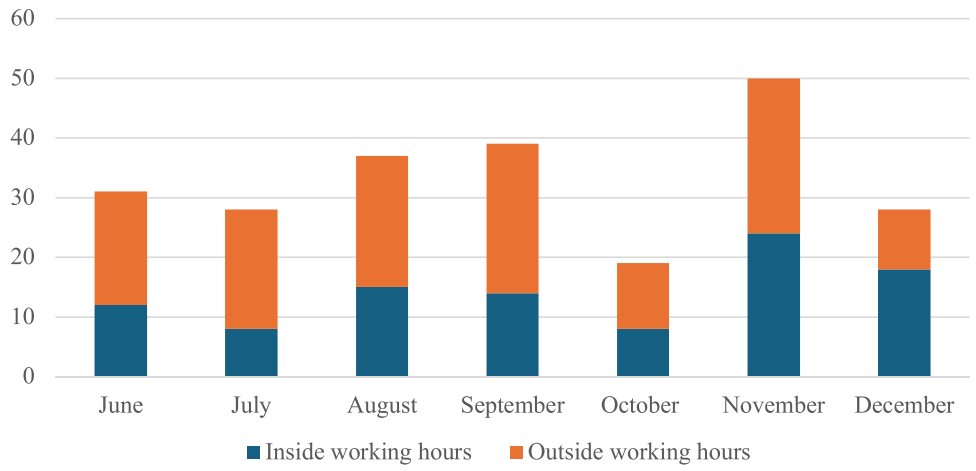

Figure 3 Number of calls received by ICONs inside working hours and outside working hours during the study period.

Table 2 Number and Percentage of Patients Known of a Difficult Access, a No-Difficult Access, or Unknown Difficult Access During the Study Period

Number of Attempts	Once	Twice	More than Twice	Total
June	29	11	1	**41**
July	27	11	0	**38**
August	35	16	2	**53**
September	29	16	2	**47**
October	18	4	2	**24**
November	43	17	2	**62**
December	33	11	2	**46**
Total	**214 (68.8%)**	**86 (27.7%)**	**11 (3.5%)**	**311**

Table 3 shows the number of each reason for IV access for patients who required ICON intervention from June 2023 until December 2023. The most common reasons for IV access include medication, antibiotics, analgesia, and laboratory tests. These four categories collectively account for more than 70% of the patients who require ICON intervention for IV

Table 3 Reasons for IV Access Consultation

Reason for IV Access Consultation	
Other: medication	66
Antibiotics	53
Analgesia	53
Lab draw	40
Porta Cath Management	26
CT Scan	17
Pre procedure	10
Other: blood transfusion	8
Other: iv fluid	3
Other: Central line removal	2
Other: MRI/Contrast	2
Other: PPN	2
Other: Transfusion	2
Other: Blood and Medication	1
Other: fluid andelectrolyte	1
Other: Hydration and Medication	1
Other: Inotropes	1
Other: Left femoral dialysis	1
Right femoral dialysis	1

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Table 4 Primary Diseases

Primary_Disease	
Cancer	62
Renal	26
Sepsis	9
Liver Disease	5
Sickle cell disease	5
Thalassemia	5
Congenital Deformities	4
Learning Disabilities	4

Note: Table shows the number of each primary disease for which patients requiring IV access were admitted.

access. The Pareto chart highlights the most significant reasons why management efforts are directed toward significant changes.

According to Table 4, cancer and renal are the most frequently repeated diseases among patients requiring IV access intervention. Both diseases account for more than 70% of the patients.

Finally, a Pareto chart representing the most frequent ward numbers for patients requiring IV access is shown in Figure 4. The descriptions of the wards shown in Figure 4 are provided below.

B5: Cardiology, hepatology, and nephrology/general medical patients requiring telemetry monitoring (more acute patients).

B6 & B7: General medical ward.

C4: General surgical ward.

A7 & A8: gynecology and Obstetrics wards.

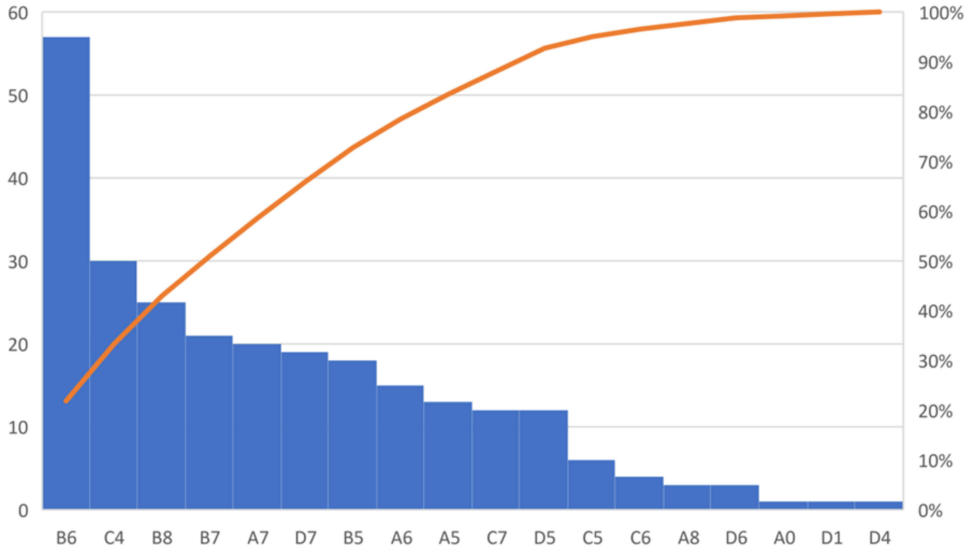

Figure 4 Pareto chart for the ward numbers.

According to the Pareto chart, most patients requiring IV access intervention from the ICON were admitted to wards B6, C4, B8, B7, A7, D7, and B5. These six wards contain more than 70% of the patients; consequently, more attention should be paid to these wards by senior management.

Discussion and Conclusions

This study represents the initial phase of a series of efforts aimed at addressing the challenges associated with DIVA within the hospital setting. Specifically, the work focuses on developing a structured framework to identify and address internal problems collaboratively with stakeholders. To achieve this, we established an escalation pathway for DIVA management to guide nurses, ICONs, and IR/anesthesia consultants, and designed a proactive electronic medical record (EMR) form to systematically capture data on IV complications at SSMC. Over a seven-month period, data were collected and analyzed to gain insights into operational inefficiencies and provide actionable recommendations for hospital management.

The findings from the ICON call data provided critical insights into the temporal patterns, patient characteristics, and success rates of IV access interventions. A substantial proportion of ICON calls—57.3%—occurred outside regular working hours, highlighting a persistent demand for resources during non-standard shifts. Additionally, the analysis revealed that 74.6% of patients requiring ICON intervention had a documented history of DIVA, indicating the importance of tailored care plans for these patients. The primary clinical indications for IV access included medication administration, antibiotics, laboratory draws, and analgesia, while patients admitted for conditions such as cancer, renal disease, and other chronic illnesses accounted for a significant proportion of ICON interventions.

The study further highlighted the wards most frequently associated with ICON calls, including general medical (B6 and B7), general surgery (C4), gynecology and obstetrics (A7 and A8), and acute patient telemetry (B5). The findings from the Pareto charts provide a foundation for focusing improvement efforts on these wards to achieve optimal results. Importantly, the current operational model places a substantial burden on ICON staff, often detracting from their primary roles of managing critically deteriorating patients. Upskilling floor nurses, particularly in high-demand wards, and developing dedicated IV access plans for cancer and renal patients are essential measures to address these challenges.

The current operations within the department revealed inefficiencies that warrant attention, particularly in nurse training and resource allocation. The prolonged time required for IV access procedures suggests inadequate training, which adversely impacts nurse turnover, physician efficiency, and the overall hospital budget. These delays also impede the timely administration of critical treatments, such as antibiotics, thereby compromising patient care quality. Addressing these issues requires a comprehensive solution that combines enhanced training with a strategic redesign of existing workflows.

This study proposes a multi-faceted solution to improve the management of DIVA cases. The escalation pathway developed as part of this study provides a structured approach for handling DIVA, ensuring timely and efficient resource allocation. Additionally, implementing advanced training programs for nurses, equipping skilled nurses with Point-of-Care Ultrasound (POCUS) devices, and establishing a specialized IV access task force are recommended to address the challenges identified. This task force would include highly trained nurses who can refine IV access protocols and manage complex cases, reducing the reliance on anesthesia and critical care outreach nurses for routine IV access. Such a system would alleviate the workload on ICONs, allowing them to focus on critical patient care, and ultimately improve the overall efficiency of the hospital's operations.

The findings of this study also underscore the need for continuous data collection to monitor and evaluate the effectiveness of implemented solutions. With ongoing data analysis, we aim to validate the impact of the escalation pathway and related interventions in reducing ICON involvement in non-critical cases. Future research will focus on the application of advanced predictive analytics, including machine learning and deep learning algorithms, to identify patients at high risk of DIVA proactively. Such tools have the potential to optimize resource planning by ensuring that necessary resources, such as skilled nurses and appropriate equipment, are allocated in advance. These efforts are expected to enhance patient outcomes, improve resource utilization, and elevate overall patient satisfaction.

In conclusion, this study provides a robust foundation for addressing DIVA challenges through data-driven solutions and collaborative efforts. By implementing a structured pathway, targeted training programs, and predictive tools, we aim

to transform the management of IV access within the hospital setting. These findings pave the way for improved resource utilization, enhanced patient care, and a sustainable framework for managing future challenges in DIVA. Further studies will explore the broader implications of these interventions and assess their scalability in diverse healthcare environments.

Ethics Approval

The study protocol was approved by the Institutional Review Board (IRB) of Sheikh Shakhbout Medical City (SSMCREC-481) and Khalifa University of Science and Technology (H24-034). Due to the nature of the study, involving retrospective and de-identified data, the ethics committee exempted the requirement for patient consent. This study was conducted in accordance with the principles of the Declaration of Helsinki.

Disclosure

The authors report no conflicts of interest in this work.

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