

Transforming Intravenous (IV) Care: Zero Harm Through Comprehensive - Difficult Intravenous Access (C-DIVA) Strategies

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Abstract

Background: Intravenous (IV) therapy is among the most commonly executed clinical procedures; however, challenges such as difficult intravenous access (DIVA), repeated cannulation attempts, infiltration, extravasation, patient discomfort, and IV-related complications persistently undermine patient safety and healthcare quality. Aim: This quality improvement initiative sought to enhance the safety of IV therapy, reduce IV-related complications, improve cannulation practices, and achieve zero harm through the implementation of Comprehensive Difficult Intravenous Access (C-DIVA) strategies at Armed Forces Hospital Dhahran, Saudi Arabia. Methods: The project employed the Institute for

Healthcare Improvement (IHI) Model and Plan-Do-Study-Act (PDSA) methodology. Root cause analysis was conducted using the Ishikawa approach. Interventions included the adaptation of the C-DIVA assessment tool, policy review, competency assessment, staff education, incident report analysis, workflow redesign, implementation of IV nurse specialist support, and continuous monitoring through key performance indicators (KPIs). Results: The implementation of the C-DIVA strategy improved the standardisation of IV therapy practices, enhanced staff competency, strengthened patient safety measures, and reduced IV infiltration incidents during the implementation period. The structured risk assessment process facilitated the early identification of patients with difficult IV access and improved escalation to experienced clinicians. The initiative also improved operational workflow, staff engagement, and evidence-based IV management practices. Conclusion: Comprehensive C-DIVA implementation demonstrated positive outcomes in improving IV therapy quality, reducing preventable harm, enhancing operational efficiency, and supporting evidence-based nursing practice. Continuous monitoring, interdisciplinary collaboration, staff engagement, and ongoing education are essential to sustain improvements and optimise patient outcomes in IV therapy management.

Keywords: Evidence-Based Practice, Intravenous Care, Patient Safety, Comprehensive - Difficult Intravenous Vascular Access (C-Diva), Quality Improvement

Introduction

Intravenous access is one of the most widely used medical procedure and close to 80% of hospitalized patients undergo it [1, 2]. But, in some, nearly 35% of patients face a lot of concern regarding difficult access for IV access [3]. Where two or more unsuccessful IV access attempts occur or a practitioner with greater expertise is needed for IV access to be established, we would consider this to be classified under this category [3, 4]. Extensive multi-country collaboration reported that complications actually befall around one-third recipients. As much as 70% of these may be preventable [5]. Most cases of damage through intravenous (IV) therapy are classified under the general purview of IV infiltration, which accounts for approximated figures of over 50% of failures related to the use of IV lines; with infiltration or extravasation attributing to every other one-fifth of these failures [6].

Research has shown that such things as Central Venous Access Devices (CVAD) are generally accepted by patients and these devices are very much expected because they reduce the number of painful cannulations repeated for patients. However, recent doctoral researches showed insertion was not always associated with difficulty into cannulation attempts with the said devices [7-10]. It was found that 90% of patients carried painful memories from the numerous attempts done on them through peripheral vein access as caused by the absence of Vascular Access Devices (VAD). Nurses and doctors would normally require two to five attempts to cannulate a patient successfully, usually followed by swelling and pain on the hands. The fatigue, stress, and trauma may put a patient into a negative mindset about repeated attempts to gain IV access [11]. Most of these effects and side effects are attributed to errors and incompetency among healthcare providers. It is believed that many of the adverse effects of DIVA are grossly underestimated by healthcare practitioners [11-15]. Hence invents new DIVA tools that will ameliorate traumatic experiences.

Peripheral Intravenous Catheter (PIVC) failure poses substantial issues in healthcare, affecting costs and patient satisfaction. Older patients with hard-to-find veins are particularly susceptible to multiple IV attempts, leading to material waste and costs averaging around USD 1.76 per patient [16]. Short peripheral catheters (SPCs) often fail due to complications like phlebitis and infiltration, especially when inserted in the wrist or upper arm [17]. Wasted materials from unsuccessful insertions account for roughly 30% of total costs [18]. Conversely, Long Peripheral Catheters (LPCs), especially those inserted with ultrasound guidance, are more cost-effective for patients with difficult vascular access. Multimodal interventions, such as optimal PIVC flushing, transparent dressings, quality improvement initiatives using engineered securement devices, and removing SPCs only when clinically indicated, significantly decrease failure rates and associated costs [19-21].

In Saudi Arabia, complications from IV catheters, such as phlebitis, infiltration, extravasation, and hematoma, increased healthcare expenses and patient discomfort, with high incidence rates, particularly in Jazan and military healthcare facilities [22-24]. Switching to clinically indicated catheter replacements in Makkah could save approximately 709,999.56 SAR annually while extending the average catheter lifespan without raising complication rates, thus presenting a cost-effective approach [25].

Factors like female gender, fore/upper arm insertion, and medical infusion predict catheter complications, highlighting the need for targeted interventions [22]. Addressing PIVC failure with clinically indicated replacement strategies can significantly reduce costs and improve patient outcomes in Saudi Arabia. However, broader economic challenges, including the costs of chronic diseases such as heart failure, predominantly due to hospitalisations, must also be considered for effective resource allocation [26]. Specialised IV nurses ensure patients receive timely IV therapy, increasing patient satisfaction. This specialised approach also reduces the risks associated with IV access, promoting safer patient care [27-29].

Materials and Methods

The initiative was launched at AFHDH using the Institute for Healthcare Improvement (IHI) Model as part of a Process Quality Improvement (QI) strategy, which thoroughly assessed current intravenous (IV) therapy practices through the Ishikawa methodology (refer to Figure 1). This methodology enables the recognition of root causes for IV infiltrations and builds on a culture of continuous improvement in the healthcare environment. The diagram separates the root causes across four dimensions: Measurements, Management, Manpower, and Material. Each category suggests specific encumbrances or weaknesses that may affect IV infiltrations. The review surveyed the IV cannulation policy, staff education and training programmes, and incident reports from all inpatient units.

In conclusion, the whole structured process aims to foster IV patient care with minimal complications and errors (see Figure 1). The flowchart proposes a structured way of improving IV care to reduce complications and improve patient outcomes. It begins with assessing safety and effectiveness of IV practices, incorporates tools and evidence-based best practices, provides specific education and training for nurses that will use these tools, and sets up key performance indicators to monitor performance and systematically collect data on progress.

It also identifies a further area for process improvement in communication, to clarify instructions and improve workflow. After initial implementation, the performance is assessed against established targets, followed by surveys that capture feedback. These results feed into the ongoing monitoring process. This continuous cycle reaffirms a commitment to improving IV care through data-driven decision-making and sustained feedback mechanisms.

Figure 1: Ishikawa Fishbone Diagram

Score	Visual Appearance	Palpable Sites	History Of Difficult Access	Clinical Factors
0	Many Visible veins	Many Palpable Veins	No Difficulty	Not applicable
1	Few Visible veins	Few Palpable Veins	Reported difficulty or recent missed attempts	Paediatric patients: Urgent conditions
2	No Visible veins	No Palpable Veins	History of major difficulty as evidenced by previous central lines PICCs	Comorbidities: emergency conditions
SUM	Write score here	Write score here	Write score here	Write score here
Score	Risk	Action	Instruction For Use	
0-3	Low	Obtain IV access	- An objective scoring tool to determine best course of action to obtain appropriate vascular access. - Score is additive - Give 0-2 points on each category for a overall score of 0-8. - Trained IV Nurse - One form per patient (to be utilized throughout the hospital course / until patient discharge)	
4-5	Medium	Obtain access with competent nurse or consider IV Nurse		
6-8	High	IV Nurse Immediately; refer to MRP; Emergence Intervention (CVL)		

Date	Time	Visual Appearance	Palpable Sites	History of Difficult Access	Clinical Factors	Score	Initial / Employee No

The PDSA cycle, which encompassed educational interventions highlighting the significance of IV therapy and minimising adverse events, played a pivotal role in identifying opportunities for enhancement and facilitating necessary changes (Appendix A). Furthermore, the implementation of a Comprehensive Difficult IV Access (C-DIVA) assessment form was initiated. Permission was secured from the author [12, 13] to adapt this form to address the specific challenges associated with difficult IV access.

Necessary adjustments were made to improve patient care and safety. The integration of incident reports, nursing competency assessments, infection control practice competency, and data on IV cannulations, blood extractions, central lines, and total IV Total Parenteral Nutrition (TPN) administration was integral to this analysis. Such a thorough review process ensures the validity and reliability of our findings.

Through comprehensive strategies and implementations, ensure consistent, high-quality IV access procedures and minimise the risk of complications. This not only enhances operational efficiency within the nursing department but also holds the potential to significantly improve patient outcomes, fostering optimism about the future of IV therapy. A C-DIVA form was piloted for two weeks with guidance and assistance from an IV nurse specialist during working hours. With their specialised knowledge and skills, the IV nurse specialists have been instrumental in teaching the team through the pilot and will continue to offer assistance thereafter. It outlines the qualifications for Certified Registered Nurse (CRN) licensed in Saudi Arabia. The interested candidates must be certified by the Saudi Council for Health Specialists (SCFHS) and must have worked as a nurse in direct connection with IV cannulation in paediatric and adult patients for the last three years. Along with general nursing competency assessment yearly, they should also have worked for a minimum of two years concerning infection control competency in Armed Forces Hospital, Dhahran (AFHDH). Find additional information regarding the certification in Registered Nurse Infusion-CRN at the link provided.

Surveys are to be conducted to know the staff's awareness of incident reporting relative to IV infiltration and familiarity with the C-DIVA tools. The aims are to increase the quality and safety of IV therapy, to positively affect patient outcomes, and to further optimise the efficiency of the nursing department in managing access to IV therapy. An IV nurse specialist would be appointed according to specific criteria and job responsibilities which included guidance, training, and support for the management of difficult IV access cases and to enhance the engagement and competence of all clinical nurses. IV nurse specialists are pivotal in augmenting patient satisfaction and engagement; their specialised knowledge and dedicated care become an illumination of hope for patients and the pride of the healthcare system. The same specialists also act as a valuable and fruitful resource for clinical staff by giving guidance, training, and support in challenging IV access and enhancing clinical nurse involvement and competence.

Intervention

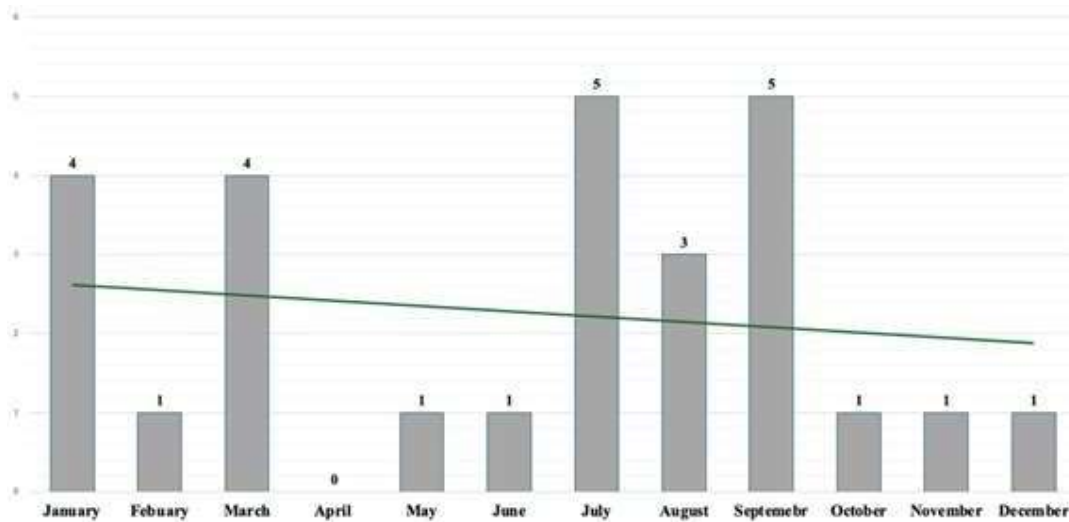
The remedial measures are based on the past-determined causes of the problem. The team came up with a sorted idea list of solutions (Appendix B) to compare the previous and present method of obtaining peripheral intravenous (IV) access. Old practice starts by exploring other ways when IV access is needed. If access is required within thirty-six-three days, an appropriate vascular device is used to the distal branch, allowing a registered nurse to attempt two times only, with further attempts by an experienced clinician.

The customary practice would contrast the systematic approach of the new practice. A Comprehensive-Difficulty IV Access (C-DIVA)-assessment of an individual patient places a patient into the low, medium, or high risk group. Low-risk patients would have only one attempt; medium risk would have two, and high risk are referred immediately to a competent nurse or unless considered an IV nurse. In addition to all these, patient safety and care are emphasised by the new process in recommending the removal of an IV peripheral catheter when indicated.

Results

Aside from analysing Incident Reports (IRs), nursing forum Competency Assessments (NCAs), Infection Control Practice (ICP) competency, and cannulation, blood sampling, central line insertion, and total IV TPN administration data, the implementation of the PDSA (Plan-Do-Study-Act) cycle has incorporated an educational component stressing the importance of intravenous (IV) therapy in order to mitigate adverse events. Evidence-based C-DIVA assessment form development aims to create a strong backing toward standardisation of quality assurance for IV access procedures while minimising complications. Operational improvements seek to enhance staff training and optimise IV therapy workflows to increase patient satisfaction and cost-effectiveness. Recruitment of an IV Nurse means selecting a nurse specialist with defined responsibilities and criteria for enhancing patient satisfaction and engagement through the use of specialised knowledge in IV therapy. The IV nurse specialist functions as a vital resource for clinical staff in providing expertise, training, and support for advanced IV access challenges.

Key initiatives included adapting and developing the C-DIVA assessment form to address difficult IV access. Another significant step was recruiting an IV nurse specialist whose role was instrumental in bolstering operational efficiency within the nursing department. Integrating data from incident reports and competency assessments is essential to inform these interventions, alongside a post-pilot survey designed to evaluate staff awareness and knowledge of the new C-DIVA tools (Figure 2). It serves as a scoring system for the C-DIVA tool to be adapted and adopted to evaluate a patient's venous access potential and their history of difficulties with access. It includes four main categories: Visual Appearance, Palpable Sites, History of Difficult Access, and Clinical Factors. Each category is scored from zero to two, with lower scores indicating better conditions, such as many visible or palpable veins and no reported difficulties. The total score determines the risk level: zero to three indicates low risk, four to five indicates medium risk, and six to eight indicates high risk.



Engaging patients and their families during hospitalisation is paramount for effectively communicating the advantages of supplementary physical health assessments. This engagement not only empowers patients to participate in their care actively but also considers their mental health conditions and legal detention constraints. Furthermore, extensive training and developing relevant policies will enhance staff competence and confidence in monitoring physical health. Obtaining feedback is vital to ensure the clinic remains 'fit for purpose' while minimising administrative tasks that detract from direct patient care.

In comparison to Figure 1, the data reveals several significant insights. The highest incidence of IV infiltrations, totalling four, was recorded in January, November, and December 2023. Moderate levels of three incidents were documented in April, June, and September 2023. Conversely, the months with the fewest incidents—February, May, and October 2023—each reported only one incident. The graph illustrates a fluctuating pattern of IV infiltration throughout the year, indicating that certain months experienced elevated rates, possibly due to underlying factors.

Four incidents were documented in January and March 2024, with a significant reduction to a single incident occurring in February. From April to June 2024, the facility sustained a consistent rate of one incident per month, illustrating a discernible downward trend over the year (Figure 3). The consistency of this data is notable since it implies that the facility has stabilised performance after what may have been a period of higher or variable incident rates. The words "clearly shows a downward trend for the year" would suggest that the facility was experiencing a precipitous rise in incident rates prior to this period. This incident rate is now down to a steady one incident per month, which indicates that the quality measures instituted have been effective. These quality improvement measures would entail training, materials, protocols, or whatever has been instituted to reduce incidents in IV care or any healthcare practice.

Observed reductions in the IV infiltration incidents throughout 2024 indicate that this organisation has successfully enacted effective measures to redress the situation, thus improving the quality of care provided at the facility overall. The notable decrease of IV infiltration incidents during the course of this year indeed indicates that the organisation has succeeded greatly in imposing effective intervention mechanisms against this trouble, thus uplifting the quality of care offered at the facility. Continued vigilance and a proactive approach will virtually be necessary to maintain such improvements and further optimise patient outcomes at this facility.

It certainly accentuates the entire commitment of that institution towards patient safety and the quality of care delivered. This is an example of the proactive initiative towards identifying and tackling issues

hence bettering patient outcomes. Some of these may include improvement in the process, advanced development of the staff, and strong monitoring and reporting systems. Sustainability of the improvement and enhancement of patients safety is contingent upon constant evaluation and refinement of these implemented interventions.

Such an approach is also significant to all healthcare professionals. It just clears the very ways one can take decisions to be most transparent about a decision-making process enhancing the patient's safety, satisfaction, and care. The application of the C-DIVA tool at healthcare workers exhibits their full commitment to providing patient care. Each form shall be issued for the use of one patient only and will remain valid up until that patient's discharge from the healthcare facility. Improvement should always continue to ensure that care is consistent and thorough throughout the hospital stay of a patient. This commitment to improvement, therefore, strengthens the quality of care and fits within the broad objective of delivering optimal patient outcomes.

Discussion

Effective leadership involvement through transformational strategies fosters support and commitment among frontline staff, encouraging nurses' buy-in and dedication to achieving patient best practice outcomes. Leadership that promotes collaboration and communication among staff fosters a supportive environment, essential for implementing Total Quality Management (TQM) practices [34]. Effective leaders actively involve stakeholders, including teachers, parents, and the community, which leads to better management of quality improvement initiatives [35].

This project acknowledges the multifaceted nature of IV therapy challenges. It implements a multi-pronged intervention approach aimed at sustainable quality improvement. Data-driven decision-making, incorporating incident reports, nursing competency assessments, and infection control practices, underscores the significance of evidence-based strategies in enhancing care quality. By empowering and engaging frontline staff, the project focuses on increasing awareness, improving reporting practices, and recognising the vital role of nursing personnel.

Furthermore, the expertise of dedicated IV nurse specialists and the allocation of designated resources are crucial in driving and sustaining improvement efforts. However, sustaining these advancements and promoting continuous change is essential to overcome the challenges of maintaining long-term improvements in the complex healthcare environment. This approach aims to enhance patient safety and satisfaction. It contributes to increased patient volumes and revenue, bolstering the healthcare facility's reputation.

Implications

The IV Therapy Improvement Initiative is a holistic, comprehensive plan for cost-effective improvement of the quality of intravenous service. Establishing the C-DIVA assessment tool, hiring highly skilled IV-specialised nurses, and direct focus on empowerment and engagement of staff are the most important components of this initiative. This initiative is underscored by a commitment to Evidence-Based action and continuous improvement. A study in the past underscores that a comprehensive approach might use a detailed assessment along with strategic interventions by executing the deployment of skilled IV nurses to address challenging issues surrounding Intravenous Catheters (IVC). More strategies merged into this multifaceted approach would set up clinically indicated replacement protocols and include practice areas such as flushing and dressing the catheters. Keeping these principles in mind helps the healthcare provider enhance the efficiency of catheter care and maintenance, reduce complications, and increase patient satisfaction, thus raising the overall quality of care. Efficiency is maximised, unnecessary hospitalisation is minimised, and the healthcare service's overall productivity is thus enhanced with this cost-effective focus.

Limitations

The IV therapy enhancement project at the AFHHDH facility faced several limitations which might bring about some detriments in its overall effect and applicability. The interventions are limited to the inpatient unit and hence limit the generalizability of the findings to other areas of care in healthcare. The short duration of the pilot phase for the C-DIVA assessment tool would also limit a robust evaluation of its long-term sustainability. Moreover, it relies on self-reported data from the post-pilot survey, which introduces bias, while also having no solid outcome measures complicating the true assessment of the interventions' efficacy.

Conclusions

In conclusion, an adult analysis of all IV infiltration events is required in order to achieve the safety of a patient. Extension in the C-DIVA assessment would allow better understanding of the long-term effectiveness of collecting and integrating data on IV-associated adverse events. Implementation of strong outcome measures associated with massive training of all nursing personnel would increase competency in the management of IV therapy. Clear policies, ongoing evaluation processes, and expansion of the project across diverse care settings would accrue to the generalizability of findings and enrich collective knowledge on IV therapy quality and safety. The IV improvement effort might also be broadened to care settings, like outpatient clinics or community-based facilities, making the findings more generalizable. Opportunities to learn from the organization's experiences and lessons would also be available for sharing with other health care organizations in order to build the general base on improving IV therapy quality and safety.

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Ethical approval

Ethical approval for this study was obtained from the Institutional Review Board (IRB) of Armed Forces Hospital, Dhahran (AFHER-IRB-2025-002), approved on September 2, 2025. The study was conducted in accordance with applicable ethical standards and institutional guidelines.

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