

Optimizing Geriatric Venipuncture: A DRG-Compatible Team-Based Reengineering Strategy

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Objective: This study evaluates a reengineered intervention aimed at improving the clinical management of intravenous indwelling needles in geriatric patients, focusing on cost-efficiency within the Diagnosis-Related Group (DRG) payment framework.

Methods: The intervention was assessed through a comparative study involving 387 elderly patients in the Geriatric Department of Xuanwu Hospital, between June 2021 and March 2022. The study contrasted outcomes between patients treated before and after implementing a new team-based management protocol in November 2021.

Results: Findings indicate enhanced first-attempt venipuncture success, reduced consumable costs, and decreased complication rates in the post-intervention group ($P < 0.001$), compared to controls.

Conclusion: The intervention demonstrates significant benefits in venipuncture efficiency, cost reduction, and patient safety, suggesting its potential for broader adoption in geriatric care.

Keywords: clinical management, intravenous indwelling needles, geriatric wards, process reengineering, DRG Payment, consumables control

Introduction

The adoption of the Diagnosis-Related Group (DRG) payment system globally marks a shift towards more cost-effective healthcare models, emphasizing the need for efficient financial management within healthcare institutions.¹ This prospective payment model, which categorizes hospital payments based on clinical and demographic characteristics, has been pivotal in driving medical reforms and optimizing resource allocation.^{2,3} While the system's adoption has been widespread, from developed nations such as the USA, Germany, and Australia to emerging economies like Brazil, Mexico, Iran, and China, it presents a complex challenge: ensuring the delivery of high-quality medical care and patient safety within the constraints of cost management.⁴⁻⁷ Significant within the context of these systemic changes is the demographic trend towards an aging population, particularly impacting geriatric care. The management of peripheral venous infusions stands out as a critical issue, compounded by the unique physiological characteristics of elderly patients, such as diminished vascular elasticity and loose skin. These factors exacerbate the difficulty of successful venous puncture, highlighting the need for innovative care strategies.⁸ In China, where healthcare reform and the refinement of the DRG system are ongoing, addressing the financial and clinical challenges of intravenous therapy in geriatric wards has become a priority.⁹

Our study introduces a targeted intervention within this framework, aiming to reengineer the clinical management of intravenous indwelling needles in geriatric wards. By focusing on enhancing the success rate of first-attempt venipuncture and extending the durability of indwelling needles, the intervention seeks to mitigate consumable costs and standardize nursing practices.¹⁰⁻¹² This approach is informed by the substantial portion of hospital budgets consumed by intravenous therapy-related expenses and the critical need for cost-effective, quality care solutions.^{8,10,11} Developed in response to both

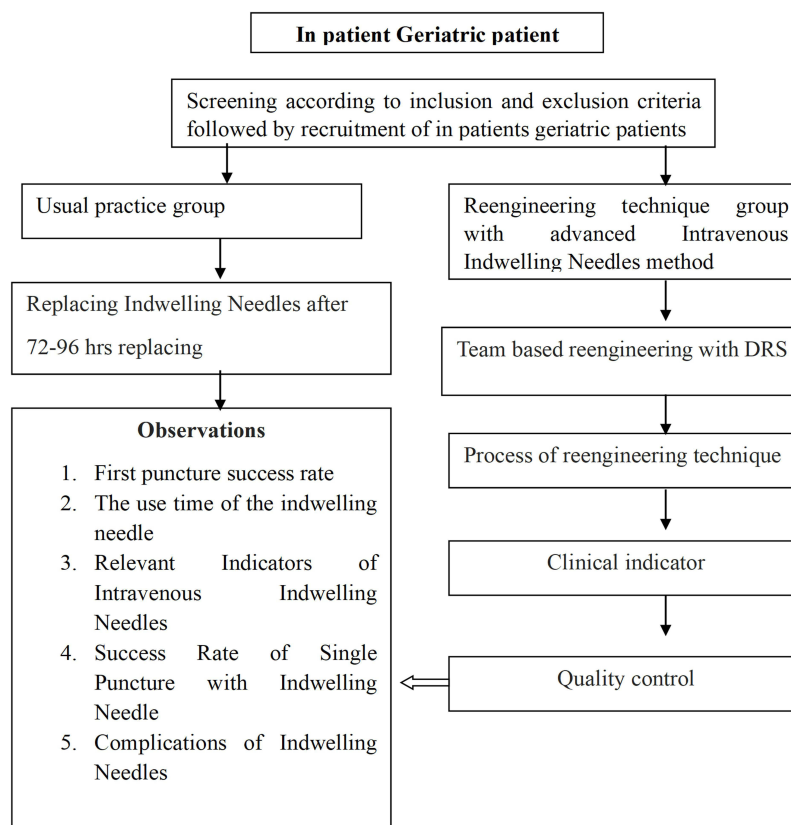


Figure 1 Study design.

the specific challenges of DRG implementation and the practical needs of elderly patient care, our study leverages a team-based clinical management strategy. It incorporates advanced venipuncture techniques, specialized equipment, and comprehensive staff training to improve patient outcomes and operational efficiency. This initiative represents a significant advancement in the field of geriatric nursing, offering a practical solution to the intertwined challenges of managing healthcare costs and maintaining high standards of patient care within the DRG payment system context.

Through this study, we aim to contribute valuable insights into the efficacy of process reengineering in clinical management practices, with the potential to inform policy-making, enhance patient care outcomes, and support the sustainable implementation of the DRG payment system, particularly in the setting of geriatric intravenous therapy.

In (Figure 1) study design is presented:

Material and Methods

Study Design and Population

This observational study enrolled 387 geriatric patients (age ≥ 60 years) at the Department of Geriatrics, Xuanwu Hospital, Capital Medical University from June 2021 to March 2022.¹³ Patients were divided into two groups: 189 patients received usual care from June to October 2021, while 198 patients were included in the reengineered technique group from November 2021 to March 2022.

Intervention Description

Usual Practice Group: Followed China's 2014 "Intravenous Therapy Nursing Technical Operation Standards",^{14–16} with indwelling needles replaced every 72–96 hours. Infrared vascular imaging was utilized after more than two unsuccessful attempts. (Figure 2)

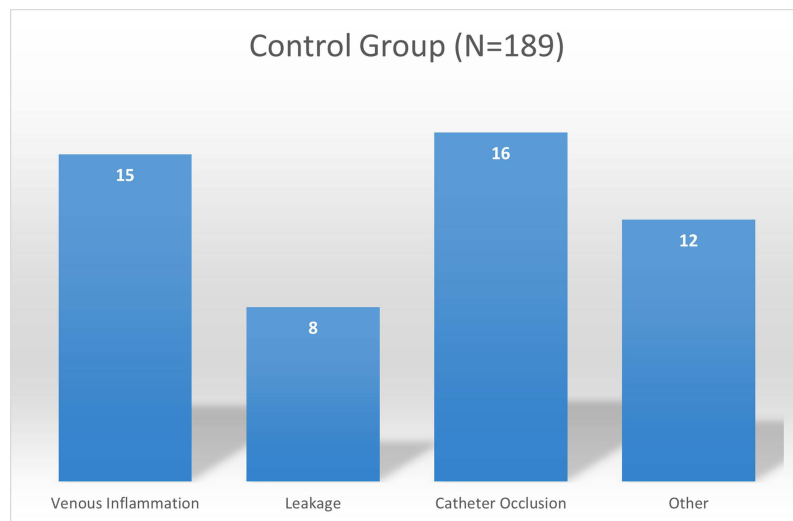


Figure 2 Control Group according to the Complication showed control group according to complication that are include Venous Inflammation, Leakage, Catheter Occlusion and Other.

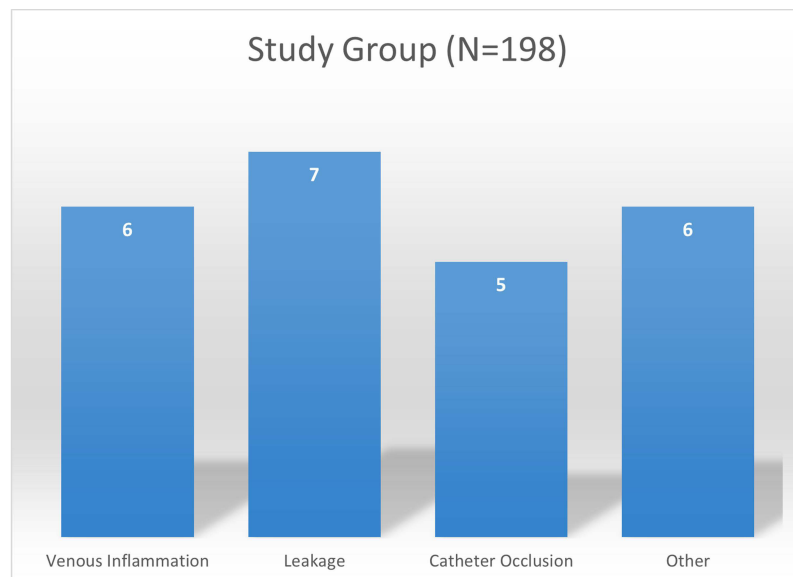


Figure 3 Study Group according to the Complication showed Study Group according to complication that are include Venous Inflammation, Leakage, Catheter Occlusion and Other.

Reengineering Technique Group: Implemented a multidisciplinary intervention focusing on process reengineering, including staff training, technique improvement, and patient education, to enhance indwelling needle management.^{17,18} (Figure 3)

Inclusion and Exclusion Criteria

Included were patients aged 60 years or older, expected to require infusion for at least four days, and voluntarily participating in the study. Exclusion criteria included mental disorders, incompatible infusion drug properties, chemotherapy via peripheral needles, catheter-associated infections, or planned needle removal within 24 hours.

Clinical Observation Indicators

Primary outcomes measured were the first puncture success rate and indwelling needle use time. Secondary outcomes included adverse reactions such as phlebitis, exudation, and blockage, meticulously recorded by the nursing staff.¹⁹

Materials

Treatment was administered using a 24G peripheral intravenous indwelling needle (BD, USA), connected to a VYGON balanced pressure infusion connector (France). Puncture sites were dressed with Sush self-adhesive film FL-III type catheters for easy observation.¹³

Sample Size

The sample size calculation used the formula

$$n = \frac{z^2 \times \hat{p}(1 - \hat{p})}{\varepsilon^2}$$

where z is the

z score ε is the margin of error

n is the population size

\hat{p} is the population proportion.

Aiming for a 95% confidence level and a 5% margin of error with an estimated outcome proportion of 25%. This ensured sufficient power to detect significant differences between groups, leading to a total sample size of 387 patients.

Statistical Methods

SPSS 22.0 statistical software was used, with measured data presented as mean \pm standard deviation (\pm S). An independent sample Normality test was used to compare measurement data between groups. The comparison of the one-time puncture success rate and the incidence rate of complications from intravenous indwelling needle infusion between the two groups of patients uses the chi-square (χ^2) test, with $P < 0.05$ indicating a statistically significant difference.

Ethical Consideration

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki and relevant Chinese regulations, under the supervision and inspection of the Ethics Committee. Written informed consent was obtained from all participants or their legal guardians prior to their participation. The study was approved by the Ethics Committee of XUANWU Hospital Capital Medical University (Approval Number: 2021-0132). All data collected were anonymized and managed in strict compliance with data privacy and confidentiality guidelines. All efforts were made to protect the dignity, autonomy, and privacy of the research participants.

Results

General Condition and Consumable Comparison

There was no significant statistical difference in the general condition and length of hospital stay between the two groups, which were comparable ($P > 0.05$) (see [Table 1](#)).

Comparison of Relevant Indicators of Intravenous Indwelling Needles

The use of consumables, the cost, and the average daily cost of consumables in the reengineering technique group were significantly lower than those in the usual practice. The duration of intravenous indwelling needle usage in the reengineering technique group was significantly longer than that in the usual practice ($P < 0.001$), with the longest duration reaching 378 hours (see [Table 2](#)).

Comparison of the Success Rate of Single Puncture with Indwelling Needle

In the usual practice, a total of 189 patients underwent 956 punctures, with 774 successful on the first try, resulting in a success rate of 80.96%. In contrast, the reengineering technique group consisted of 198 patients with 818 punctures, out of which 701 were successful on the first try, yielding a success rate of 85.70% ([Table 3](#)). Thus, the success rate of a single puncture of intravenous indwelling needles in the reengineering technique group was significantly higher than in

Table 1 Comparison of General Characteristics Between the Control Group and the Study Group

	Control group	Study Group	χ^2/t	P-value
Gender (male/female).	115/74	126/73	0.251	0.616
Age (years)	78.84±10.44	79.87±10.54	-0.963	0.336
Length of hospital stay (days)	14.95±8.37	16.45±7.51	-1.861	0.064

Notes: χ^2 represents the chi-square test, t represents the independent sample Normality test, and P-value indicates the statistical significance.

Table 2 Comparison of Relevant Indicators of Intravenous Indwelling Needles in the Two Groups

	Control Group	Study Group	χ^2/t	P-value
Indwelling Needles (number)	5.61±3.01	4.35±1.92	4.860	<0.001
Infusion Connectors (number)	5.10±2.63	4.09±1.70	4.440	<0.001
Adhesive Dressings (number)	5.06±2.58	4.13±1.69	4.159	<0.001
Duration of Use (hours)	69.78±13.48	95.80±26.49	12.274	<0.001
Total Cost (RMB)	410.68±213.95	325.74±137.53	4.662	<0.001
Average Daily Cost (RMB)	29.09±8.18	21.49±7.67	9.425	<0.001

Notes: χ^2 represents the chi-square test, t represents the independent sample Normality test, and P-value indicates the statistical significance.

Table 3 Comparison of the First-Attempt Success Rate of Venous Indwelling Needle and the Usage of Imaging Device Between the Control Group and the Study Group

	Control Group	Study Group	χ^2	P-value
Total Attempts	956	818		
First-attempt Success (rate)	774 (80.96%)	701 (85.70%)	7.051	0.009
Imaging Device Usage (rate)	231 (24.2%)	234 (28.6%)	4.499	0.041

Notes: A comparative analysis between the control and study groups regarding the first-attempt success rate of venous indwelling needle insertion and the usage rates of imaging devices during the procedure. The "Control Group" column reflects data from standard procedure practices, while the "Study Group" column shows data following the implementation of the reengineered intervention. This comparison aims to demonstrate the effectiveness of the intervention in enhancing procedural success and potentially reducing the need for imaging device assistance. All data are presented as numbers with percentages in parentheses. χ^2 represents the chi-square test, and P-value indicates the statistical significance.

the usual practice. The usage of infrared imagers in the reengineering technique group was also significantly higher than in the usual practice ($P<0.05$).

Comparison of the Occurrence of Complications of Indwelling Needles

The incidence of venous needle puncture complications in the usual practice was significantly higher than in the reengineering technique group. Additionally, the incidence of phlebitis and occlusion complications in the reengineering technique group was significantly lower than in the usual practice ($P<0.05$) (see [Table 4](#)).

Table 4 Comparison of Complications Related to Venous Catheterization Between the Two Groups

Complication	Control Group (N=189)	Study Group (N=198)	χ^2	P-value
Venous Inflammation	15 (7.94%)	6 (3.03%)	4.586	0.032
Leakage	8 (4.23%)	7 (3.54%)	0.126	0.722
Catheter Occlusion	16 (8.47%)	5 (2.53%)	6.649	0.010
Other	12 (6.35%)	6 (3.03%)	2.402	0.121
Total	51 (27.0%)	25 (12.6%)	12.631	<0.001

Notes: χ^2 represents the chi-square test, and P-value indicates the statistical significance. Percentages are calculated based on the total number of patients in each group. The study group demonstrated significantly lower incidence rates of venous inflammation and catheter occlusion compared to the control group ($P < 0.05$). It's important to note that some patients experienced more than one type of complication, which means the total complication rate for each group accounts for unique patients affected, not the sum of individual complication instances.

Discussion

The implementation of the DRG/DIP payment reform and the increasing emphasis on cost control in healthcare has prompted hospitals to seek ways to optimize the management of medical consumables. Peripheral venous catheters are commonly used in clinical practice, particularly in elderly patients, whose population is growing due to aging demographics. However, the conventional nursing model for peripheral venous catheter care may no longer meet the requirements of the evolving payment system and cost containment goals.⁸ In December 2016, the China State Council issued the Notice on Printing and Distributing the 13th Five-Year Plan for Deepening the Reform of the Medical and Health System. This plan aimed to control the unreasonable growth of medical expenses and reduce the revenue from consumables by 100 yuan. The expenditure part of the 100-yuan index includes both chargeable and non-chargeable medical consumables.²⁰ In the case of indwelling needle procedures, only the indwelling needles and infusion joints can be charged separately, while items such as films, pads, disinfectant swabs, tourniquets, and hand disinfectants are considered non-chargeable. However, due to reimbursement policy restrictions, the usage and consumption of indwelling needles and additional infusion to greater economic loss for the hospital in this aspect. It is evident that the traditional intravenous indwelling needle care model is no longer suitable for the new payment system. Thus, a clinical management process reconstruction model is required to control the cost of indwelling needle consumables while ensuring patient safety.

Previous studies have highlighted the importance of improving nursing skills and implementing standardized nursing procedures to reduce medical costs. Dall et al found that enhancing nurses' professional competency can contribute to cost reduction.²¹ Cho et al demonstrated that standardized nursing operating procedures can reduce the use of non-chargeable materials and decrease the average procedure time, resulting in improved work efficiency and cost savings.²² The benefits of refined nursing in prolonging the lifespan of peripheral venous catheters and reducing complications are well emphasized in literature.^{23,24}

In line with these findings, our study aimed to investigate the impact of a reengineered clinical management process for peripheral venous catheters on consumable usage, costs, puncture success rates, and complication rates. The process reengineering model was developed based on a comprehensive review of relevant literature and consultations with infusion therapy experts. The intervention was implemented in two phases. In the first phase, a team of experts in geriatrics, nursing, and quality improvement developed a new process for the management of intravenous indwelling needles (IVINs). The new process was designed to improve the safety and efficiency of IVINs management. In the second phase, the new process was implemented in two geriatric wards. The implementation of the new process was evaluated using a mixed-methods approach.

The results of our study revealed several significant findings. Firstly, the implementation of the reengineered management process led to a substantial reduction in consumable usage, costs, and daily average consumable costs in

the reengineering technique group compared to the usual practice. These findings align with the goal of cost control in healthcare and are consistent with previous studies emphasizing the importance of efficient resource utilization.¹¹

Secondly, the reengineering technique group demonstrated a significantly higher success rate of first-time puncture compared to the usual practice. This improvement in puncture success can be attributed to several factors addressed in the reengineered process. The pre-assessment stage involved a thorough evaluation of patient-specific vascular conditions and the selection of appropriate infusion tools, enhancing the chances of successful puncture. Additionally, the utilization of visual aids, such as infrared vascular imaging, in cases of difficult venous access contributed to improved decision-making and increased success rates. These results support the notion that the reengineering process effectively enhances the quality of peripheral venous catheter care.^{7,12}

Furthermore, the reengineering technique group exhibited a significantly longer duration of catheter use compared to the usual practice. This extended duration, with the longest catheter use reaching 378 hours, indicates that the reengineered process successfully prolongs the lifespan of peripheral venous catheters. This finding is consistent with a multicenter randomized controlled study that demonstrated the benefits of clinical indications-based catheter removal, as opposed to routine removal, in terms of prolonged catheter duration without a significant increase in complications.¹³

Lastly, the reengineered management process resulted in a significant reduction in the incidence of complications associated with peripheral venous catheters in the reengineering technique group compared to the usual practice. Specifically, the occurrence of venous inflammation and catheter occlusion was significantly lower in the reengineering technique group. These findings support the effectiveness of the reengineered process in improving patient safety and reducing the costs associated with managing catheter-related complications.¹³

The findings of this study suggest that process reengineering can be an effective way to improve the clinical management of IVIN in geriatric wards. The new process developed in this study was associated with a significant improvement in the safety and efficiency of IVINs management. The new process was also well-received by the nurses who implemented it. These findings suggest that process reengineering may be a promising approach for improving the clinical management of IVINs in other settings.

The introduction of DRG payment has had a significant impact on the clinical management of IVINs. DRG payment is a prospective payment system that reimburses hospitals a fixed amount for each patient admitted to the hospital. This payment system incentivizes hospitals to reduce the length of stay and the cost of care for each patient.

The introduction of DRG payment has led to an increase in the number of patients who are discharged from the hospital with IVINs. This is because IVINs can help to reduce the length of stay by allowing patients to receive medications and fluids at home. However, the use of IVINs also increases the risk of complications, such as infection and phlebitis.

The introduction of DRG payment has highlighted the need for process reengineering in IVINs management. Process reengineering is a systematic approach to improving the way work is done. It involves identifying and eliminating unnecessary steps, improving communication and collaboration, and automating tasks.

Process reengineering can boost the safety and efficiency of IVINs management by mitigating complication risks. Our study developed a standardized approach for vein selection in IVINs placement, reducing phlebitis risk. Additionally, we improved communication between nurses and physicians before IVINs removal, ensuring safe and patient-specific procedures. By employing an electronic medical record system for IVINs tracking, we also freed nurses to attend to other aspects of patient care.

Conclusion

In conclusion, the application of clinical management process team based reengineering for peripheral venous catheters have demonstrated significant effectiveness with DRG payment. By adopting the team based reengineered management model, hospitals can enhance nurses' knowledge of infusion therapy through training; improve their pre-assessment skills to select appropriate infusion tools. Therefore, the clinical promotion of the team based reengineered process holds great promise. Future studies could be conducted to evaluate the challenges and barriers to implementing process reengineering in other settings.

Data Sharing Statement

Data for this study is available from the corresponding author upon reasonable request.

Ethics Approval and Informed Consent

The studies involving humans were approved by the Research Ethics Committee of Xuanwu Hospital, Capital Medical University (approval no. 2021-0132). The studies were conducted in accordance with the local legislation and institutional requirements, and with the Helsinki Declaration of 1964 and its later amendments. The participants provided their written informed consent to participate in this study.

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Disclosure

The authors declare no conflict of interest in this study.

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