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Original Article

The Impact of INCNS Management Model Training on the Quality of Patient Management by Residents in the Neurocritical Care Unit

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Abstract:

Objectives: The INCNS (Infection, Nutrition, Consciousness, Neurological disorders, Systemic diseases) model provides a structured approach to improve patient care. This study evaluates INCNS training versus conventional training in enhancing Neurocritical Care Unit (NCU) resident performance.

Methods: In a randomized controlled trial, 40 residents were assigned to INCNS (n=20) or conventional training (n=20). The INCNS group completed a two-week program with lectures, case discussions, and simulations. Outcomes included Patient Management Quality Score (PMQS), medical error rates, and patient outcomes (28-day mortality, ICU stay, complications).

Results: The INCNS group showed higher PMQS (89.5 ± 7.8 vs. 80.3 ± 10.6, P=0.002), lower error rates (incorrect dosing: 2.4% vs. 6.7%, P=0.003; missed diagnoses: 3.6% vs. 7.1%, P=0.028), and fewer complications (ventilator-associated pneumonia: 22.6% vs. 41.3%, P=0.042; hypoproteinemia: 18.1% vs. 23.8%, P=0.015). No differences were found in 28-day mortality or ICU stay.

Conclusions: INCNS training significantly enhances residents' patient management quality and reduces errors and complications in the NCU. Multicenter studies are needed to confirm these findings and evaluate long-term effects.

Keywords: INCNS management model, Neurocritical Care Unit, resident physicians, training, patient management quality

1. Introduction

The Neurocritical Care Unit (NCU) is a specialized environment dedicated to managing patients with life-threatening neurological conditions, such as traumatic brain injury, stroke, and status epilepticus (Wijdicks, E. F. 2017). These patients often present with multisystem involvement, requiring comprehensive and rapid clinical decision-making (Huang, M., Wang, J. et al. 2016). Resident physicians, particularly those in early training, face significant challenges due to limited experience and the high-acuity nature of NCU care (Lerner, D. P., Kim, J. et al. 2017, Marcolini, E. G., Seder, D. B. et al. 2018).

Jiang Wen et al. developed a scoring system for NCU, the INCNS score, which assesses the condition and prognosis of critically ill neurological patients based on infection, nutrition, consciousness, neurological function, and other systemic functions (Gao, Q., Yuan, F. et al. 2020, Zhao, Z., Zhang, X. et al. 2020). Building upon this scoring system, the INCNS management model was established to provide a structured framework for NCU patient care. This model emphasizes a systematic, holistic approach to

ensure comprehensive management of critical care aspects.

Previous studies have shown that structured management protocols in intensive care settings can reduce medical errors and improve patient outcomes (Bourne, R. S., Shulman, R. et al. 2018, Rodziewicz, T. L., Houseman, B. et al. 2025). However, the specific impact of the INCNS model on resident training in the NCU remains underexplored.

This study evaluates the effectiveness of INCNS model training in improving patient management quality by NCU residents through a randomized controlled trial.

2 METHODS

2.1 Participants

The study enrolled 40 residents rotating through the NCU at the First Affiliated Hospital of Chongqing Medical University between January 2023 and January 2024. Inclusion criteria comprised: (1) Residents in their second or third year of standardized training; (2) No prior critical care or INCNS model training; (3) Minimum NCU rotation duration of two months. Exclusion criteria included previous NCU rotations exceeding two months or participation in comparable structured training programs. Participants were randomly allocated to either the intervention group (INCNS training, n = 20) or the control group (standard training, n = 20) using computer-generated randomization. The study received ethical approval from the Ethics Committee of the First Affiliated Hospital of Chongqing Medical University and adhered to the Declaration of Helsinki.

2.2 Intervention

The intervention group completed a comprehensive two-week INCNS training program designed to systematically enhance NCU patient management skills. The curriculum addressed five core domains:

• Infection Management: Protocols for infection screening, diagnostic procedures (including blood cultures and cerebrospinal fluid analysis), and antibiotic stewardship.

• Nutrition Support: Comprehensive nutritional assessment, selection of appropriate enteral or parenteral nutrition routes, and monitoring for complications such as refeeding syndrome.

• Consciousness Evaluation: Utilization of validated assessment tools (Glasgow Coma Scale and FOUR Score) for consciousness monitoring.

• Neurological Disorder Management: Diagnosis and treatment protocols for common NCU conditions, including intracranial hemorrhage, seizures, and cerebral edema.

• Systemic Disease Coordination: Management strategies for concurrent cardiovascular, respiratory, and renal complications.

The training incorporated multiple educational modalities: didactic lectures (10 hours), case-based discussions (8 hours), high-fidelity simulation training (6 hours), and practical application through daily INCNS checklist completion for NCU patients. The control group received conventional NCU training consisting of bedside teaching and ad hoc lectures without a structured framework.

2.4 Outcome Measures

Primary outcomes were assessed across three domains:

1. Clinical Management Quality: Evaluated using the Patient Management Quality Score (PMQS, range 0-100), which was independently assessed by two blinded senior neuro-intensivists. The scoring system was based on completeness of patient records, appropriateness of treatment plans, and efficiency of care delivery (Supplementary Table 1).

Supplementary Table 1: Patient Management Quality Scorecard.

Dimension	Scoring Standards					Points
	0	5	10	15	20	
Infection	No screening conducted or severe errors	Partial screening	Complete screening	Complete screening with appropriate treatment	Comprehensive screening with optimized treatment	
Nutrition	No nutritional assessment or severe errors	Incomplete assessment	Complete assessment, but inappropriate support plan	Complete assessment with appropriate support plan	Comprehensive assessment with optimized support plan	
Consciousness	No assessment or severe errors	Incomplete assessment	Complete assessment, but inappropriate management	Complete assessment with appropriate management	Comprehensive assessment with optimized management	
Neurological Disorders	Missed diagnosis or severe treatment errors	Partially correct diagnosis, but inappropriate treatment	Correct diagnosis, but incomplete treatment	Correct diagnosis with appropriate treatment	Precise diagnosis with optimized treatment	
Systemic Dis-eases	Failure to identify multisystem complications	Partial identification of complications, but inappropriate management	Complete identification, but incomplete management	Complete identification with appropriate management	Comprehensive identification with optimized management	

2. Medical Error Rate: Calculated as the percentage of patient cases with documented errors (including incorrect medication dosing and missed diagnoses), identified through systematic chart reviews.

3. Patient Outcomes: Measured by 28-day mortality, length of ICU stay, and complication rates (specifically ventilator-associated pneumonia and hypoproteinemia).

Additionally, intervention group residents completed a post-training satisfaction survey utilizing a validated 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) to evaluate perceptions of the INCNS training program (instrument details in Supplementary Table 2).

Supplementary Table 2: Questionnaire of the INCNS model training

Questionnaire	Scoring Standards				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Is the content of the INCNS model training clear and understandable?					
Does the INCNS model help you systematically assess NCU patients?					
Does the INCNS model increase your confidence in infection management?					
Does the INCNS model improve your decision-making in nutritional support?					
Does the INCNS model enhance your accuracy in assessing consciousness levels?					
Does the INCNS model improve your efficiency in managing neurological disorders?					
Does the INCNS model help you better manage multi-system complications?					
Do you believe the INCNS model is applicable to daily NCU work?					
Are you willing to continue using the INCNS model in future practice?					
Would you recommend the INCNS model training to other residents?					

Likert Scale Scoring Standards Score Description: 1 point: Strongly Disagree (completely unhelpful or disagree); 2 points: Disagree (partially disagree or limited effectiveness); 3 points: Neutral (no strong opinion or moderate effectiveness); 4 points: Agree (helpful or effective) ; 5 points: Strongly Agree (highly effective or very helpful).

A mean score ≥40 indicates extremely helpful, 30–39 helpful, and <30 unhelpful.

2.5 Data Collection

Data were collected prospectively. Patient management quality was assessed for the first 5 patients managed by each resident post-training (the control group consisted of 5 patients in the same period). Each dimension is scored (0–20 points). The scores for these five dimensions contribute to the total scorecard. The final management quality score is the average across 5 patients. Medical errors were systematically identified through weekly blinded chart reviews conducted by an independent review committee. Specifically, we calculated the incorrect medication dosing rate as the proportion of erroneous dosage orders relative to total medication orders per resident-managed bed per week and the missed diagnosis rate as the proportion of undetected diagnoses relative to total diagnoses during audit. Patient outcomes were extracted from electronic medical records, including: (1) 28-day mortality rate (deaths within 28 days per total patients managed); (2) ventilator-associated pneumonia incidence (cases per ventilated patients); and (3) hypoproteinemia incidence (cases with plasma albumin <30 g/L 24 h post-admission per total patients). Resident satisfaction was evaluated via anonymous surveys administered at the end of the study period.

2.6 Statistical Analysis

Continuous variables were reported as means ± standard deviations and compared using independent t-tests. Categorical variables were

reported as percentages and analyzed using chi-square tests. All analyses were performed using SPSS 26.0, with $P<0.05$ considered statistically significant.

3 RESULTS

3.1 Baseline Characteristics

The intervention and control groups were comparable in baseline characteristics, ensuring balanced randomization. The mean age was 26.7 ± 2.1 years in the intervention group and 26.9 ± 1.9 years in the control group (P=0.743). Gender distribution showed 40% male and 60% female in the intervention group, compared to 50% male and 50% female in the control group (P=0.53). The proportion of second-year versus third-year residents was similar, with 45.5% second-year and 55.5% third-year in the intervention group and 50% second-year and 50% third-year in the control group (P=0.742) (Table 1).

Table 1: Comparison of baseline characteristics between two groups.

	Intervention group (n=20)	Control group (n=20)	*P*-value
Gender :			0.53
Male	8 (40%)	10 (50%)	
Female	12 (60%)	10 (50%)	
Age:	26.7±2.1	26.9±1.9	0.743
Year of standardized training:			0.742
Second	9 (45.5%)	10 (50%)	
Third	11 (55.5%)	10 (50%)	

3.2 Primary Outcomes

The INCNS-trained group demonstrated statistically significant improvements across multiple outcome measures compared to controls (Table 2). The intervention group achieved higher PMQS (89.5 ± 7.8 vs. 80.3 ± 10.6, P=0.002), lower medical error rates (incorrect medication dosing: 2.4% vs. 6.7%, P=0.003; missed diagnoses: 3.6% vs. 7.1%, P=0.028), and reduced complication rates (ventilator-associated pneumonia: 22.6% vs. 41.3%, P=0.042; hypoproteinemia: 18.1% vs. 23.8%, P=0.015). No significant differences were observed in 28-day mortality (2.9% vs. 2.4%, P=0.554) or length of ICU stay (6.5 ± 2.2 vs. 7.1 ± 2.5 days, P=0.071).

Table 2: Comparison of patient management quality and outcomes between two groups

Outcome	Intervention group (n=20)	Control group (n=20)	*P*-value
Management Quality Score	89.5±7.8	80.3±10.6	0.002**
Medical Error Rate (%)			
incorrect medication dosing (%)	2.4% (0%; 8.7%)	6.7% (0%; 16.1%)	0.003**
missed diagnoses (%)	3.6% (0%; 13.3%)	7.1% (0%; 15.8%)	0.028*
28-day mortality	2.9% (6/204)	2.4% (5/206)	0.554
length of ICU stay	6.5±2.2	7.1±2.5	0.071
Complication Rate (%)			
VAP	22.6% (12/53)	41.3% (19/46)	0.042*
Hypoproteinemia	18.1% (37/204)	23.8% (49/206)	0.015*

VAP, ventilator-associated pneumonia . *$P<0.05$; ** $P<0.01$.

3.3 Satisfaction Survey

The intervention group reported high satisfaction with INCNS training, with 100% rating it as "extremely helpful" (mean score 46.1 ± 2.9). Qualitative feedback highlighted the clarity and applicability of model in

structuring complex patient assessments.

4 Discussion

This study demonstrates that INCNS model training significantly enhances NCU resident performance across multiple quality metrics. The intervention group's superior outcomes in management quality scores, medical error reduction, and complication rates underscore the value of structured training frameworks in high-acuity environments like the NCU.

The INCNS model's strength lies in its systematic integration of five critical care domains into a cohesive management strategy. This approach enables residents to address the interconnected neurological and systemic complications characteristic of NCU patients (Goodman, D. J.andKumar, M. A. 2014, Goyal, K., Hazarika, A. et al. 2018). The significant improvement in PMQS reflects the model's ability to enhance the completeness and appropriateness of patient assessments and treatment plans. By providing a standardized checklist and clear protocols, the INCNS model reduces cognitive overload, allowing residents to prioritize critical interventions and minimize oversights, particularly in high-pressure environments (Marini, J. J. 2015, Meyer, F. B., Hoehne, S. N. et al. 2023).

Compared to prior studies, our findings align with evidence that protocolized care improves outcomes in intensive care settings (Cavalcanti, A. B., Bozza, F. A. et al. 2016, DerGarabedian, B., Lacovara, L. et al. 2025). Bastos LSL et al. (Bastos, L. S. L., Hamacher, S. et al. 2020) reported that structured protocols reduced error rates in general ICUs, but our study is the first to evaluate a neurocritical care-specific framework. Unlike general ICU protocols, the INCNS model is tailored to neurocritical care, addressing unique challenges such as neurological-systemic interactions.

Despite these promising results, several limitations should be acknowledged. First, the study was conducted at a single academic medical center, which may limit the generalizability of the findings to other settings with varying resource availability or patient populations. Second, the follow-up period was relatively short, and long-term impacts of the INCNS model on resident performance and patient outcomes remain unclear. Third, the intervention group's use of simulation training, a validated educational tool, may have contributed to the observed benefits, potentially confounding the effect of the INCNS model alone (Braksick, S. A., Kashani, K. et al. 2017, Morris, N. A., Czeisler, B. M. et al. 2019). Finally, unmeasured factors, such as resident motivation or prior clinical exposure, could have influenced outcomes.

Future research should expand the evaluation of the INCNS model across multiple institutions with diverse NCU environments to validate its broader applicability. Longitudinal studies are needed to assess sustained improvements in clinical outcomes and resident competency. Furthermore, investigating the model's adaptability to other critical care specialties and its integration with emerging technologies, such as AI-assisted decision support, could offer valuable insights for optimizing high-stakes medical training (Juang, W. C., Hsu, M. H. et al. 2022, Salman, S., Gu, Q. et al. 2023).

5 Conclusion

The INCNS management model training significantly improves NCU residents' patient management quality and reduces medical errors and complications. These findings support its

integration into neurocritical care training programs. Multicenter studies are recommended to validate the model's efficacy and explore its broader applicability.

Acknowledgement

Not applicable.

Conflict of interest

The authors confirm that there are no conflicts of interest.

Ethical approval

The study was approved by the Ethics Committee of the First Affiliated Hospital of Chongqing Medical University (2023-018). The study was conducted according to the Declaration of Helsinki. Informed consent was obtained from each participant before they were submitted to any study procedure.

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