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Program Evaluation of an Early Nurse Intervention Team

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ABSTRACT

Background: Many hospitals have implemented early rapid response teams to improve detection of patients at risk for decline. However, formal evaluation of these programs is rare.
Objective: To evaluate the Early Nurse Intervention Team program at a large community hospital in the southeastern United States.
Methods: A retrospective evaluation was performed of unplanned intensive care unit transfers, hospital length of stay, length of stay index, ventilator days, and mortality in 2 patient groups: those with and those without an Early Nurse Intervention Team nurse present.
Results: There was a marked decline in unplanned intensive care unit transfers as the Early Nurse Intervention Team nurse staffing increased. There were no significant interaction or main effects for length of stay, length of stay index, ventilator days, or mortality between the 2 groups.
Conclusions: This study showed a positive impact of implementation of an Early Nurse Intervention Team program, with significant savings given the cost of unplanned intensive care unit transfers.
Key words: cost-benefit analysis, length of stay, mortality, mechanical ventilation, rapid response

Early detection of clinically deteriorating patients in the hospital saves lives.[1] Failure to identify patients at risk or actively declining in the hospital can lead to in-hospital cardiac arrest (IHCA) and increased mortality rates.[1,2] Early identification of deteriorating patients can trigger appropriate management, which may reduce the need for higher-acuity care, decrease hospital length of stay, and improve survival.[1-3] There has been an ongoing effort to reduce the number of adult IHCAs and overall inpatient mortality rates through implementation of rapid response programs that focus on early detection and early intervention for clinically deteriorating patients.[4] These rapid response teams (RRTs) deliver critical care expertise to the patient's bedside earlier and more efficiently to prevent further patient decline and cardiac arrest.

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Although RRTs have resulted in improvements in IHCA rates and decreased mortality, there is room for improvement in earlier identification of patient decline.[3,5-8] Many health systems have tried to improve upon the original concept of the RRT by implementing earlier rounding to identify patients at high risk for decline; however, evidence has shown mixed results.[9-12] Two studies showed no significant difference in IHCA and related outcomes when early RRT programs were implemented. In both studies, patients at risk of clinical deterioration were identified using a specific criterion and were then followed and assessed by a member of the early RRT.[10,11] In contrast, Pain and colleagues[12] found a significant reduction in IHCA and rapid response calls over a 5-year period after implementation of the Between the Flags system, a similar pre–rapid response program. Other studies have found that proactive rounding by an RRT to identify early clinical deterioration may result in reduced unplanned intensive care unit (ICU) transfers, decreased IHCAs outside of the ICU, and reduced mortality.[13,14]

Although use of RRTs is increasingly being shown to be an effective tool in combating IHCA, it is not well established that an early or proactive RRT improves those same measures. Additionally, a common feature among these studies is a noted need to evaluate the costs of early RRT programs in relation to the questionable improvement in patient outcomes.[10,15,16]

At a large community hospital in the southeastern United States, the Early Nurse Intervention Team (ENIT) is an innovative program that expands on the RRT concept.[4,17] This program, which began in 2014, is in addition to the RRT/Code team, in which an ICU charge nurse rounds twice daily on patients on the ENIT rounding list. Patients are added to the ENIT rounding list based on various criteria, including transfer out of the ICU within the last 24 hours; having a National Early Warning Score (NEWS) of greater than 7; increasing oxygenation demands reported to the ENIT nurse; or expression of concern about a patient by a provider, ward nurse, charge nurse, or respiratory therapist. The ENIT nurse generates reports at least once every shift for NEWS scores through the electronic health record (EHR) system to aid in identification of patients.[18] The ENIT nurse is present at all rapid response and code blue calls and acts as a resource to help ICU staff with patients recently transferred from the general ward (ie, after cardiac arrest or rapid response). Additionally, the ENIT nurse provides bedside education and support to non-ICU nursing staff.

The ENIT program has evolved since it was first implemented. In 2014, the ICU charge nurse performed both charge nurse and ENIT duties, often leaving the ICU without a charge nurse for long periods. In 2016, the program was updated to include separate dedicated staff members and a separate budget funded from outside the ICU coffers. As indicated by the literature, performing an evaluation of the ENIT program may help identify opportunities for improvement and inform future growth of the program.

The purpose of this project was to evaluate the ENIT program using the following metrics: unplanned ICU transfers, hospital length of stay (LOS), length of stay index (LOS-I), ventilator days, mortality rate, patient acuity or Acute Physiology and Chronic Health Evaluation II (APACHE II) scores, and cost. This project was reviewed by the university's institutional review board and deemed exempt from the need for approval.

Project Methods

Data Collection

We performed a retrospective review of data from January 2017 through December 2019. All data collected were deidentified and stored on a password-protected computer. The ENIT program was implemented in a large community hospital with a total of 369 beds. This hospital admits adult patients in 10 units, including a 20-bed mixed medical-surgical adult ICU specializing in care for cardiac, neurologic, and geriatric patients. This community hospital is part of a large academic 3-hospital health system. The ENIT group comprises 6 registered nurses who have ICU training.

The sample population examined included all adult and geriatric patients who underwent unplanned ICU transfer. An unplanned ICU transfer was defined as any transfer of a patient to the ICU from another unit within the hospital. Patients were excluded if they were transferred from the emergency department, catheterization laboratory, postanesthesia care unit, and/or mother/baby units. Unplanned ICU transfers were identified and an EHR case review was performed to ensure that

each case met the inclusion criteria. Additionally, APACHE II scores were calculated and Medicare Severity Diagnosis Related Groups (MS-DRGs) were assigned to cases based on EHR coding per Centers for Medicare and Medicaid Services (CMS) guidelines.[19] The patient's hospital LOS, ventilator days (if applicable), and final disposition (died or transferred) were also collected. The LOS-I was calculated as LOS divided by the CMS-reported geometric LOS (GMLOS) for the MS-DRG of each case. Geometric LOS reduces the effect of outliers on the average LOS. It is calculated by multiplying the LOS for each case within a DRG together, and then taking the *n*th root of that number where *n* is the total number of cases. The GMLOS varies from year to year; thus, the data from the corresponding year reported by CMS were used for each case.

The LOS, LOS-I, ventilator days, and mortality metrics were selected for the cost-benefit analysis for multiple reasons. First, all of these metrics can be easily matched with a cost for the hospital system, as they involve use of various resources or affect hospital reimbursement. The LOS and LOS-I have direct financial implications, whether related to CMS reimbursement or simply a longer stay for an individual patient, costing the hospital more funds. The mortality of ICU patients affects the overall cost of the ICU stay; when patients die during their ICU stay, the cost of the stay is 12% higher than for patients who are transferred out alive, even when severity of illness and other contributing factors are taken into account.[20] Second, the metrics are easily attainable via any EHR system. Third, these metrics are generalizable; any hospital that implements a program similar to the ENIT can retrieve these numbers and potentially use them for a cost-benefit analysis. Lastly, early intervention via the ENIT program should have an impact on these metrics, in that earlier detection of patient decline leads to better overall outcomes.[3,8]

Comparison Groups

Two comparison groups were used to determine the impact of the ENIT program on LOS, LOS-I, ventilator days, and mortality. Because of staffing constraints, the ENIT program was not fully staffed 24 hours a day, 7 days a week. This situation provided a unique opportunity to create 2 comparison groups: patients who underwent unplanned ICU transfer with an ENIT nurse present and those who underwent such transfer with no ENIT nurse present. The dates and times of the ENIT staffing were determined through examination of the ENIT nurse logbook that detailed all activities of the ENIT nurse. Using that information and through evaluation of the unplanned ICU transfers collected from the EHR, the LOS, LOS-I, ventilator days, and mortality were compared between the 2 groups of patients. Hospital data on overall hospital acuity based on acuity calculations from the health care services company Vizient Inc and mortality, reported as mortality index, were acquired from the performance services department at the hospital for the years 2017 to 2019. Lastly, the overall budgeted cost of the ENIT program was provided by the hospital administration.

Statistical Analysis

The data were collected by quarter and by year in the 36-month period after ENIT program implementation (January 2017–December 2019). Descriptive statistics were used to analyze the total number of unplanned ICU transfers by year and to compare the ENIT staffing rate with the unplanned ICU transfer rate. An independent *t* test was performed to compare LOS, LOS-I, and ventilator days between ENIT staffing (ENIT) and no ENIT staffing (no ENIT) groups for each year separately. A 2-way analysis of variance was conducted to compare the outcomes using quarter and ENIT group as the between-subjects variables. A series of χ^2 tests were performed to compare mortality rates stratified by year and by quarter. APACHE II scores were analyzed using an independent *t* test and a series of χ^2 tests to compare patient acuity between the ENIT and no ENIT groups.

Results

The total number of unplanned ICU transfers between January 2017 and December 2019 was examined using descriptive statistics (percent change) (see Figure). Over the course of 3 years, there were a total of 830 unplanned ICU transfers that met inclusion criteria: 313 in 2017, 268 (–14.4%) in 2018, and 249 (–7.1%) in 2019.

To assess the relationship between ENIT staffing and unplanned ICU transfers, we compared the ENIT staffing rate with the

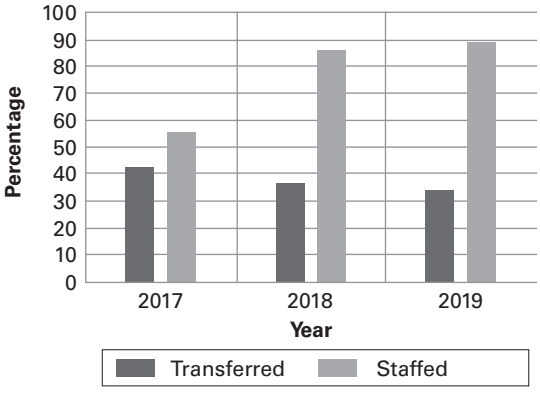

Figure: Early Nurse Intervention Team (ENIT) staffing and unplanned intensive care unit (ICU) transfers.

unplanned ICU transfer rate. The unplanned ICU transfer rate was computed as follows: (total number of unplanned ICU transfers with ENIT nurse present divided by the total number of unplanned ICU transfers) × 100. The ENIT staffing rate was computed as follows: (total number of shifts staffed with ENIT nurse divided by the total number of possible staffing shifts per year) × 100. As the ENIT staffing rate increased, the unplanned ICU transfer rate decreased (see Figure).

When evaluated by quarter and by year using a 2-way analysis of variance, there were no statistically significant interaction or main effects for ENIT versus no ENIT for LOS, LOS-I, ventilator days, or mortality (see Table 1 for evaluation by year). The average APACHE II score for the ENIT group (15.67) was significantly higher than that for the no ENIT group (14.24) ($P = .01$; Table 2). However, when the total combined patient cases for the years 2017 to 2019 were compared using the χ^2 test between the 2 groups based on APACHE II categorizations of mild (0-9), moderate (10-19), severe (20-34), and extreme (>34), there was no significant difference between the 2 groups in LOS, LOS-I, ventilator days, or mortality ($P > .05$; Table 2). The ENIT group had 5 extreme APACHE II score outliers, whereas the no ENIT group had none. The APACHE II scores were categorized to account for potential outliers that would affect the overall average of APACHE II scores between the groups.

The overall patient acuity of the hospital, as reported by the hospital and calculated by Vizient Inc, increased each year from 2017 to 2019 (Table 3). The percentage of patients with a severity of illness rated "severe" or "extreme" increased each year from 2017 to 2019. Data are available only from the first 3 quarters of 2019, as the hospital changed acuity measurement companies. The overall hospital mortality remained stable from 2017 to 2019 (Table 3).

The cost of the ENIT program was based on the budget determined by the hospital

Table 1: Length of Stay, Length of Stay Index, Ventilator Days, and Mortality of ENIT and No ENIT Groups

Year	ENIT	No ENIT	*P* value
Length of Stay, mean (SD), d			
2017	13.9 (11.9)	12.8 (10.9)	.38
2018	13.2 (11.6)	11.9 (8.4)	.51
2018	12.3 (11.1)	11.5 (9.1)	.73
Length of Stay Index, mean (SD)			
2017	3.1 (2.3)	2.8 (2.4)	.29
2018	2.7 (2.5)	2.3 (1.6)	.34
2018	2.6 (2.4)	2.5 (1.9)	.76
Ventilator Days, mean (SD)			
2017	9.4 (9.7)	8.5 (9.7)	.63
2018	8.1 (6.9)	6.8 (5.2)	.53
2018	8.9 (10.8)	4.2 (0.84)	.34
Mortality, No. (%)			
2017	21 (12.1)	16 (11.5)	.88
2018	48 (20.8)	8 (21.6)	.91
2018	47 (21.2)	5 (18.5)	.75

Abbreviation: ENIT, Early Nurse Intervention Team.

administration. The hospital budget for the ENIT program is 4.2 full-time employees to staff 1 registered nurse position 24 hours a day, 7 days a week. The total cost is estimated by multiplying the number of full-time employees by the midpoint salary for registered nurses, making the annual budgeted cost of the ENIT program $278 500 plus benefits. This cost estimation was provided and used by the hospital administration for budgeting purposes. The minimum number of nurses required to staff the ENIT program is 5 (4 full-time nurses and 1 part-time nurse all working 12-hour shifts). At this community hospital, there are 6 nurses trained for the ENIT position, all of whom also work hours in the ICU as a staff nurse.

Discussion

The most significant finding of this project was that the total number of unplanned ICU transfers decreased each year from 2017 to 2019, with the largest decline occurring when the ENIT program became more consistently staffed. From 2017 to 2018, the number of unplanned ICU transfers decreased by 45 (14.4%). The increased staffing and maturation of the program could be major factors in the performance of the ENIT program, as has been reported in the literature.[6,12]

We found no significant differences between the 2 groups in LOS, LOS-I, ventilator days, or mortality. Previous studies have shown that delaying activation of an RRT can result in increased LOS and mortality.[21,22] Thus, either the ENIT program is ineffective in activating an RRT in a timely manner or our data contradict the findings of previous studies. The use of ventilator days as an outcome metric has not been studied in previous evaluations of RRT programs, but use of mechanical ventilation has been shown to significantly increase the cost of an ICU stay.[20,23-25] Again, the lack of difference in ventilator days between the 2 groups makes it difficult to calculate any cost savings of this program. It has been shown that mortality in the ICU results in a 12% increase in overall costs, even after accounting for acuity, diagnosis, and other factors.[20] Although we did not identify any cost savings based on the metrics used, future research may find cost savings through the use of other metrics.

Table 2: Average and Categorized APACHE II Scores for ENIT and No ENIT Groups

APACHE II Category	ENIT	No ENIT	*P* value
Average score	15.67	14.24	.01
Mild (0-9), % of cases	21.2	23.6	>.05
Moderate (10-19), % of cases	50.9	56.2	>.05
Severe (20-34), % of cases	27.1	20.2	>.05
Extreme (> 34), % of cases	0.8	0	>.05

Abbreviations: APACHE II, Acute Physiology and Chronic Health Evaluation II; ENIT, Early Nurse Intervention Team.

Despite the lack of statistically significant differences found in these metrics, the descriptive data gathered suggest that the program has some impact on the population studied. The overall hospital illness acuity increased each year from 2017 to 2019, but the LOS, LOS-I, and ventilator days remained similar or decreased slightly in each group. It would stand to reason that if the hospital has patients with higher acuity, the LOS and ventilator days should increase.[24,25] The mortality percentage for both groups doubled from 2017 to 2018 and remained similar from 2018 to 2019, but the overall hospital mortality for the years 2017 to 2019 remained stable (Table 3). This finding could be because of the education provided by the ENIT nurse to non-ICU nurses. This increased education can account for the lack of difference between groups and also shed light on how the hospital was able to maintain a stable mortality index despite higher patient acuity throughout the hospital. High-acuity patients are being identified before the rapid response or code blue call

Table 3: Overall Hospital Acuity and Hospital Mortality Index, 2017-2019

	Hospital Patient Acuity, %				
Year	Mild	Moderate	Severe	Extreme	Hospital Mortality Index
2017	25.1	38.8	29.0	7.0	0.7165
2018	23.0	39.5	29.5	8.0	0.6906
2019	22.1	38.5	29.9	9.6	0.7168

and are being transferred to the ICU, where, despite the best efforts of the ICU team, they die. All 5 cases with extreme APACHE II scores were in the ENIT group, and all 5 patients died while in the ICU. It is possible that had there been no ENIT nurse present, the 5 extreme cases would still have been transferred to the ICU or, more likely, the patients would have died while still on the general ward. Examination of code blue and RRT calls combined with the patient outcomes would shed light on this question.

Given the lack of statistically significant differences between the 2 groups in terms of LOS, LOS-I, ventilator days, and mortality, the most useful information to use to calculate cost savings is the number of unplanned ICU transfers. In a multicenter study within the United States conducted in 2016, it was estimated that the average cost of an ICU stay was approximately $19 725.[20] Using these findings, the reduction in unplanned ICU transfers from 2017 to 2018 translates into a cost savings of approximately $609 125. The cost savings were calculated as the number of transfers multiplied by the mean cost of an ICU stay minus the annual cost of the ENIT program. When ENIT staffing increased by 3% in 2019, the number of unplanned ICU transfers decreased by 7%, resulting in a net cost savings of $96 275. Even when accounting for the $278 500 it costs to run the ENIT program, the hospital continues to have a cost savings owing to the decrease in unplanned ICU transfers.

Limitations

One limitation of this project is that it was retrospective and relied on secondary data sets. The patient cases were retrieved from the EHR based on the assumption that they were properly and accurately coded. Upon medical record review, it became apparent that this was not always the case. From the original data pull, 880 cases were identified; after medical record review, only 830 cases met inclusion criteria. Although only about 5% of the cases were excluded, the question arises what other potential cases were missed or not included. Additionally, to calculate the LOS-I, an accurate coding of diagnosis is required to place a case into the appropriate DRG, which is necessary to determine the GMLOS.

Additionally, multiple other factors may have affected the changes seen in the number of unplanned ICU transfers. Staffing on the non-ICU units was not investigated and could have contributed to the changes. Time of day, day of the week, and holidays could have affected ENIT staffing, non-ICU nurse staffing, and overall health care worker staffing, which in turn could affect staff members' ability to detect patient decline early and provide early intervention. As previously mentioned, the ENIT program was not fully staffed at all times. Further analysis of these staffing constraints (such as lack of ENIT staffing on off-shifts) could provide further insight into the effectiveness of the ENIT program.

Next Steps

Although the metrics used in this study give us some idea of the performance of the ENIT program, it must be evaluated from other perspectives as well. Analysis of code blue and rapid response calls should be performed. The outcomes of patients on the ENIT rounding list should be evaluated. Additionally, a qualitative study may provide valuable information to help illuminate perspectives and perceptions related to the ENIT program of all end users (eg, non-ICU nurses, advanced practice providers, medical residents, and attending physicians). Simply performing a clinical evaluation and cost analysis of the program belies the importance of nonquantifiable benefits to hospital staff members and patients.

Conclusion

The ENIT program was designed to help identify and provide intervention to patients who are clinically deteriorating before the RRT is called in order to improve patient outcomes. For some hospitals, the costs of implementing an early rapid response program may be prohibitive.[26] Cost-benefit analyses of programs such as ours are often not performed or published. In the 3 years since the full implementation of the ENIT, there has been a marked reduction in unplanned ICU transfers resulting in a net cost savings. Other metrics besides LOS, LOS-I, ventilator days, and mortality may be helpful to further evaluate an early rapid response program. Further exploration of the potential impacts of the ENIT program is needed.

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