Exploring Nursing Cost Using Patient Level Data

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Disclosure-Dr. Peggy Jenkins

• Learning Objective-Understand direct nursing cost per patient.
• I have no conflict of interest.
• Employer-VHA and University of Colorado.
• A grant from Alpha Kappa Chapter of Sigma Theta Tau was used to support this research.
Research Summary

• The purpose of the study was to explore variability of nursing cost per acute care episode for patients with similar DRGs using patient level data and to investigate the relationships among nurse characteristics, patient characteristics, and nursing cost.
Key Findings

• Direct Nursing Cost showed large variability for patients with similar DRGs.
• Nurses with more experience and education do not increase cost substantially.
• Nurses with more experience and education are not consistently assigned sicker patients.
• Average nursing cost per day on the study unit was $96.48 (SD 55.73, range .33-600.81).
Background

• Healthcare policy such as Affordable Care Act impacts hospital business model. Value based purchasing creates an environment in which understanding costs by patient is necessary.

• Nurse scientists have documented the need to measure variability in nursing cost at the patient level for decades. (Chiang, 2009; Diers, Bozzo, & RIMS Acuity Project Group, 1997; Edwardson & Giovannetti, 1987; Naylor, Munro, & Brooten, 1991; Pappas, 2007; Sovie, 1988; Thompson & Diers, 1985; Wilson, Prescott, & Aleksandrowicz, 1988)

• Nursing costs are averaged across all patients (NHPPD, NCPPD). Nursing is charged in room and board.

• Measuring patients as “average” reduces nursing to a commodity.
Design, Setting, Data Source

• Retrospective, exploratory cost study using secondary data.

• Setting was one medical/surgical nursing unit from a large, urban hospital in Central United States.

• Data source was repository collected from three existing databases 1) Clairvia® Care Value Management, 2) Medical Management System, and 3) Human Resources.
Variables

• Patient variables-
  ✧ MSDRG
  ✧ Acuity Score
  ✧ Total hours on unit
  ✧ Age
  ✧ Gender
  ✧ Total LOS
  ✧ Admitted through ER

• Nurse variables-
  ✧ Age
  ✧ Gender
  ✧ Education level
  ✧ Years of service in organization, unit
  ✧ New graduate
  ✧ Skill level
  ✧ Hourly wage
Human Subjects Compliance

• IRB approval
  ✷ COMIRB expedited approval received June, 2011
  ✷ Study site IRB approval November, 2012
  ✷ Continuing review approved June, 2012; June, 2013; April, 2014
Data Merger Architecture

"Patient Age & LOS" $N = 4589$

Merge With "Location & LOS" $N = 4589$

"Patient Age & LOS2" $N = 4589$
Generate Inclusion Criteria

Drop 1051 not on study unit entire LOS

"Inclusion LOS" $N = 3528$

Merge with "Assign Care & RN Intensity" $n = 4200$

"Intensity" $N = 3538$

Drop 185 patients with missing intensity
Drop 242 patients with missing days intensity

"Intensity C" $N = 3353$

"Main Patient File" $N = 3111$
44,842 shift obs

Merge Drop 71 Missing Employee observations

"HR Float" $N = 91$

Append

"HR Unit" $N = 67$

"Main HR File" $N = 154$
Drop 4 duplicates

"Main File" $N = 3111$ patients
$N = 150$ nurses
44,771 shift obs
### Description of Nursing Personnel Sample

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>RN (n = 101)</td>
<td>Non-RN (n = 49)</td>
</tr>
<tr>
<td>Age</td>
<td>41.1 (11.2)</td>
<td>39.6 (13.1)</td>
</tr>
<tr>
<td>Years Service Organization</td>
<td>8.1 (4.6)</td>
<td>6.2 (4.3)</td>
</tr>
<tr>
<td>Years Service Unit</td>
<td>6.1 (4.2)</td>
<td>5.7 (4.2)</td>
</tr>
<tr>
<td>Wage</td>
<td>$31.21 ($7.16)</td>
<td>$14.19 ($4.81)</td>
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</table>

<table>
<thead>
<tr>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>BSN</td>
</tr>
<tr>
<td>Clinical Ladder</td>
</tr>
<tr>
<td>Certification</td>
</tr>
<tr>
<td>Float</td>
</tr>
</tbody>
</table>
Description of Patient Sample

- 3111 patients
- 54% female (n = 1688)
- Mean age 55 years (range 18-89)
- Mean Total days hospital 3.64 (range 0-25)
- Mean hours on unit 84.37 (range 1.12-600.18)
Data Analysis-Research Question 1

• What is the variation in nursing cost per acute care episode for patients with similar DRGs with and without complications?
• Significant difference in cost ANOVA $F(3, 3107) = 340.63, p < .001, \eta^2 = .247$
• Tukey-Kramer post-hoc significant between all groups at $p < .05$
# Variability of Nursing Cost

<table>
<thead>
<tr>
<th>Complication</th>
<th>DRG</th>
<th>n</th>
<th>Range</th>
<th>M</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td>Without CC</td>
<td>192</td>
<td>LOS</td>
<td>.81-14</td>
<td>3.57</td>
<td>2.11</td>
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<tr>
<td></td>
<td></td>
<td>NCACE</td>
<td>$54-1570</td>
<td>$325</td>
<td>$242</td>
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<tr>
<td></td>
<td></td>
<td>DAYNINT</td>
<td>.15-10.48</td>
<td>2.87</td>
<td>1.56</td>
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<tr>
<td></td>
<td></td>
<td>NCDAY</td>
<td>$4.87-322.66</td>
<td>$82.22</td>
<td>$45.76</td>
</tr>
<tr>
<td>With CC</td>
<td>191</td>
<td>LOS</td>
<td>1-26</td>
<td>4.04</td>
<td>2.98</td>
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<tr>
<td></td>
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<td>NCACE</td>
<td>$17-3674</td>
<td>$408</td>
<td>$427</td>
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<tr>
<td></td>
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<td>DAYNINT</td>
<td>.34-9</td>
<td>3.20</td>
<td>1.71</td>
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<tr>
<td></td>
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<td>NCDAY</td>
<td>$4.87-280.48</td>
<td>$92.01</td>
<td>$51.59</td>
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<tr>
<td>With MCC</td>
<td>190</td>
<td>LOS</td>
<td>1-9</td>
<td>4.43</td>
<td>1.99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NCACE</td>
<td>$132-1455</td>
<td>$462</td>
<td>$316</td>
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<td>DAYNINT</td>
<td>.36-13</td>
<td>3.33</td>
<td>1.75</td>
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<tr>
<td></td>
<td></td>
<td>NCDAY</td>
<td>$5.78-428.35</td>
<td>$97.23</td>
<td>$56.03</td>
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</table>
Q4 - What is the average cost per day measured at the patient level?

<table>
<thead>
<tr>
<th></th>
<th>Observations</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost per Day</td>
<td>12,765</td>
<td>$96.48</td>
<td>$55.73</td>
<td>$.33</td>
<td>$600.81</td>
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<td>Intensity per Day</td>
<td>12,765</td>
<td>3.298</td>
<td>1.815</td>
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<td>16</td>
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<td>RN Cost Day</td>
<td>12,321</td>
<td>$88.52</td>
<td>$49.99</td>
<td>$1.76</td>
<td>$572.30</td>
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<td>RN Intensity</td>
<td>12,321</td>
<td>2.65</td>
<td>1.40</td>
<td>.04</td>
<td>14</td>
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</tbody>
</table>

One outlier $600 per day, 60 y/o male, DRG 206 (other respiratory without/major cc), received care from more than one RN during several shifts.
Discussion

• The use of the nurse-patient assignment could provide an alternative costing metric for nursing care.
• The current study found differences in direct nursing cost by shift, day, and acute care episode level of analysis.
• This demonstrates the potential of these data to provide a range of business analytics that have not been available. (Caspers & Pickard, (2010); Eck Birmingham, S. (2010); Welton, J. M., L. Zone-Smith, and D. Bandyopadhyay. (2009) .
Limitations

• Reliability and validity threat due to de-identified data from a secondary source.

• Selection Bias

• Endogeneity

• Results are not generalizable beyond the unit where the data were collected.
References

Research Questions

1. What is the variation in nursing cost per acute care episode for patients with the same DRGs without complications, with complications, and with major complications?

2. What is the relationship among nursing characteristics (years of service, educational degree) on nursing cost per acute care episode?

3. What are the characteristics of nurses assigned to patients with complications and major complications?

4. What is the average direct nursing cost per day measured at the patient level?
Conceptual Framework

(Brewer, Verran, & Stichler, 2008)
Modified Systems Research Organizing Model

Conceptual Framework

Context
Nurse Intensity
Wage
Nurse Age
Years of Service

Client
DRG
Acuity Level
Age
Gender

Outcome
Nursing Cost per Acute Care Episode
Literature Review

• Wide variation exists in nursing literature on definition of nursing cost (Wilson, Prescott, & Aleksandrowicz, 1988; Chiang, 2009).

★ Direct Cost

• Salaries and benefits of all nurses on a unit (Wilson, Prescott, & Aleksandrowicz, 1988; Witzell, Ingersoll, Schultz, & Ryan, 1996).

• Costs that can be traced to a patient accounting system (Chiang, 2009; Pappas, 2007).

• Cost of nursing care while nurses have contact with the patients (Chiang, 2009).

• Assignable nursing time defined in the actual assignment multiplied by average wage (Welton, Zone-Smith, and Bandyopadhyay, 2009).
Literature Review

- Various methods used to derive nursing cost in nursing studies because patient level nursing cost data was not available.
  - Ratio of cost-to-charge (Chiang, 2009).
  - Relative Value Units (Dowless, 2007)
  - Cost per Relative Intensive Measure (Knauf, Ballard, Mossman, & Lichtig, 2006).
  - Case Costing (Pappas, 2007)
Definitions

• Nursing Cost per Acute Care Episode
  ✦ Total nursing assignable time per patient summed for each nurse giving care to the patient during an acute care episode on one nursing unit.

• Nursing Intensity
  ✦ The amount of assignable time per patient.

• Nursing Cost
  ✦ Function of nursing intensity and actual nursing wage.
Data Organization/Analysis

• Merged seven excel files in Stata (V. 12)
• Stata Do-files written to allow replication
• Long’s (2009) Data Management Process used
  ✦ Planning, Organization, Computing, Documentation
• Descriptive and Inferential Analysis
Data Analysis-Research Question 2

- What is the relationship among nursing characteristics on nursing cost per acute episode?
- Right skewed variables log transformed
- Ordinary Least Squares robust regression ncace on nurse characteristic variables significant ($F(1,3088) = 4173.25, p < .001$), $R^2 = .86$
- Postestimation commands assessed heteroskedasticity
## Regression Models

<table>
<thead>
<tr>
<th>Variable</th>
<th>model 1</th>
<th>model 2</th>
<th>model 3</th>
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<tr>
<td>larnyorg</td>
<td>.989***</td>
<td>1.01***</td>
<td>.997***</td>
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<td>.00245***</td>
<td>.00232***</td>
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<td>aflt</td>
<td>.0462***</td>
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<td>_cons</td>
<td>1.137***</td>
<td>1.09***</td>
<td>1.26***</td>
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<tr>
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<td>.855</td>
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<tr>
<td>rmse</td>
<td>.352</td>
<td>.354</td>
<td>.36</td>
</tr>
</tbody>
</table>

**legend:** *** $p<0.001$
Question 3-What are the characteristics of nurses assigned to patients with complications?

Histogram Acuity
## Nurse Characteristics and Acuity Correlations

<table>
<thead>
<tr>
<th></th>
<th>Acuity</th>
<th>Comp Code</th>
<th>Pt Age</th>
<th>Pt Days</th>
<th>Years Org</th>
<th>% BSN</th>
<th>Float</th>
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<tr>
<td>Pt Age</td>
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<td>1.0000</td>
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<tr>
<td>Pt Days</td>
<td>0.3355</td>
<td>0.4163</td>
<td>0.1318</td>
<td>1.0000</td>
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<tr>
<td>Years Org</td>
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<td>-0.0131</td>
<td>-0.0073</td>
<td>-0.0413</td>
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<tr>
<td>% BSN</td>
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<tr>
<td>Float</td>
<td>0.1773</td>
<td>0.1841</td>
<td>0.0557</td>
<td>0.3819</td>
<td>-0.0426</td>
<td>-0.1277</td>
<td>1.0000</td>
</tr>
</tbody>
</table>
Data Analysis-Research Question 3

• Regressed acuity on nursing characteristics, model significant \((F(3,3029 = 87.09), \ p< .001), \ R^2 = 0.124\).

• Nurse years in organization was not significant; BSN and float significant \((p=.001\), 1\% increase in BSN associated with .002\% increase in acuity, increase in 1 float nurse associated with 7\% increase in acuity holding other variables constant.

• Data did not suggest assignment of more complicated patients is based on experience or education level of nurse.
References


• Long, J. S. (2009). The workflow of data analysis. College Station, TX: Stata Press.


