Knowledge Discovery Data Analytics Methods: Potential use in Nurse Credentialing Research

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Or: Developments in Research Methodologies, Health Metrics, and Data Infrastructure to better evaluate the impact of nursing credentialing
The Challenge: Identify critical knowledge gaps and methodological limitations in the field

• “Whether credentialing within nursing actually improves or signals better quality depends a great deal on researchers’ ability to produce convincing evidence that there is an effect on health care outcomes.”


• Knowledge discovery data analytics methods have potential to produce convincing evidence.

“More, Messy, Good Enough”  (p. 12, Mayer-Schonberger & Cukier, 2013)

- ‘Big Data’ changes the scientific paradigm
  - More data means less sampling error
  - Messy means we can try to understand and account for the biases inherent within observational data
  - Good enough means we can let go of our fixation on causation
    - Description
    - Pattern Discovery
- Hypothesis generation
  - Letting the data give voice to nurses and patients


Resources

Nursing Data

Nursing Minimum Data Set

http://www.nursing.umn.edu/prod/groups/nurs/@pub/@nurs/documents/asset/nurs_71413.pdf

- a **minimum set** of elements of information with uniform **definitions** and categories concerning the specific dimensions of **nursing**, which meets the information needs of multiple **data** users in the health care system.

- Client characteristics & outcomes
- Nursing assessments & interventions


Nursing Context Data

Nursing Management Minimum Data Set

http://www.nursing.umn.edu/icnp/usa-nmmds/

- **core essential data** needed to support the administrative and management information needs for the provision of nursing care. The standardized format allows for comparable nursing data collection within and across organizations.

- Nurse and health system characteristics
- Nurse and health system credentials

Recognized Nursing Terminologies
American Nurses Association

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<tr>
<th>Terminology</th>
<th>Nursing Problem</th>
<th>Nursing Intervention</th>
<th>Nursing Outcome</th>
<th>Nursing Intensity</th>
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The above three terminologies must be used together to obtain information about the nursing problem (diagnosis), intervention and outcome. The below terminologies all have terms for the nursing problem, intervention, and outcome.

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<td>Omaha System (1992)</td>
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The Omaha System (Martin, 2005)

Problem Classification Scheme
- Environmental
- Psychosocial
- Physiological
- Health Related Behaviors

Intervention Scheme
- Client Specific Information
- Target
- Category
- Services

Problem Rating Scale for Outcomes
- Assessments and Outcomes
- Knowledge
- Behavior
- Status

Problems
- Used for documenting
- Standardized terms
- Codes

Big Data Laboratory

- 2010: Dean Delaney invited the Omaha System Partnership for Knowledge Discovery and Healthcare Quality within the University of Minnesota Center for Nursing Informatics
  - Scientific teams
  - Affiliate members
  - Data warehouse
Using a Logistical Mixed-effects Model with Nursing Data

• How do nurses and interventions contribute to variability in patient and population health?

• Nurse (17%)
• Client (50%)
• Problem (17%)
• Intervention (17%)

- Client age was significantly positively associated with knowledge benchmark attainment in all models

\[ Y_i \sim \text{Bernoulli}(\theta_i), \text{ where} \]
\[ \log(\theta_i) - \log(1 - \theta_i) = \beta_0 + \beta_1 \text{Age} + U_i \]
\[ U_i \sim N(0, \sigma^2), \]

Using Data Visualization to Detect Client Risk Patterns

Each image (sunburst) was created in d3 from public health nursing assessment data for a single patient. Data were generated by use of the Omaha System signs and symptoms and Problem Rating Scale for Outcomes.

Key:
- Colors = problems
- Shading = risk
- Rings = Knowledge, Behavior, and Status
- Tabs = signs/symptoms

Documentation patterns suggest a comprehensive, holistic nursing assessment.

Kim et al. found that the presence of mental health signs and symptom tends to be associated with more diagnostic problems and worse patient condition.

Using Generalized Estimating Equations for Cohort Comparison

- Mothers with intellectual disabilities have twice as many problems as mothers without intellectual disabilities
- Receive more public health nursing service
  - Twice as many encounters and interventions
- Show improvement in all areas
  - Do not reach the desired health literacy benchmark in Caretaking/parenting

Using Graphing Methods with Multilevel K-way Partitioning to Form Non-Overlapping Intervention Clusters

This research was supported by a Midwest Nursing Research Society New Investigator Seed Grant. Monsen, K. A., Banerjee, A., & Das, P. (2010). Discovering client and intervention patterns in home visiting data. Western Journal of Nursing Research, 32(8), 1031-1054. doi:10.1177/0193945910370970
Using Kaplan-Meier Curves to Depict Problem Stabilization

This research was supported by the National Institute of Nursing Research (Grant #P20 NR008992; Center for Health Trajectory Research). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Nursing Research or the National Institutes of Health. Monsen, K. A., McNaughton, D. B., Savik, K., & Farri, O. (2011). Problem stabilization: A metric for problem improvement in home visiting clients. Applied Clinical Informatics, 2, 437-446 http://dx.doi.org/10.4338/ACI-2011-06-RA-0038
Using Data Visualization to Detect Nursing Intervention Patterns

Each image (streamgraph) was created in d3 from longitudinal public health nursing intervention data for a single patient. Data were generated by use of the Omaha System in clinical documentation.

Key:
- Colors = problems
- Shading = actions (categories)
- Height = frequency
- Point on x-axis = one month

From 403 images, 29 distinct patterns were identified and validated by clinical experts.

Documentation patterns suggest both a unique nurse style and consistent patient-specific intervention tailoring.

Monsen, K. A. et al., 2014

Using Inductive and Deductive Approaches to Create Overlapping Intervention Groups

Relationships between four intervention grouping/clustering methods for wound care.

Using Receiver Operating Curves to Understand Model Fit

- Comparison of Intervention Modeling Approaches and Hospitalization Outcomes for Frail and Non-frail Elderly Home Care Patients

Using Logistic Regression to Associate Home Care Interventions and Hospitalization Outcomes

• Too little care may result in hospitalization when patients have more intensive needs
  • Frail elders are more likely to be hospitalized if they have low frequencies of four skilled nursing intervention clusters

Using Pattern Comparison Pre- and Post-Intervention to Demonstrate Intervention Effectiveness

Knowledge scores across problems over time

- Pre-intervention, patterns by race/ethnicity
- Post-intervention, patterns by problem

Further Research

• Credentialing
  • What is the credentialing effect relative to patient assessment, intervention tailoring, and patient outcomes?
  • What is the value of credentialing?

• Examine associations between intervention patterns and client outcomes
  • Is there differential effectiveness of intervention patterns for similar client profiles?
  • What is optimal intervention tailoring?
  • What is the nurse effect?

• Evaluate patterns across agencies and programs
  • Do patterns persist across agencies?
  • What aspects of nursing interventions are similar across programs and populations?
  • How does individualized care relate to evidence-based practice?

Recommendations

• Expand the development of data analytics methods to incorporate nursing and interprofessional datasets and encompass all standardized terminologies and structured data.
• Continue to develop and test new methods on existing datasets.