The Development and Testing of a Measure for Turbulence in Intensive Care

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Introduction

The purpose of the dissertation was to provide a description of essential variables and relationship patterns that described workarounds performed by nurses when interacting with Health Information Technology (HIT).
Background: Model Development

- Current thinking describes workflow barriers as precursors to workarounds (Carayon & Gurses, 2007)

- But... workarounds were being performed even when blockages were not present and...
- Many nursing work activities could not be ascribed to the variable “workload”
Turbulence

Extraneous work activities took up a great deal of nursing time, but did not meet the definitions and attributes of current workload measures. The concept of turbulence, in nursing literature, did specify these activities.
Based on literature, a turbulence variable was developed: The concept was defined and empiric indicators specified

The essential properties of turbulence require that it be:
(a) random or unpredictable,
(b) disruptive or that it impacts another activity and/or
(c) adds complexity to the nurses’ work.

Turbulence: The degree to which the interaction between a nurse and the pace and disruptiveness of change in the environment affects the nurses’ ability to practice or provide care.
(Browne & Braden, 2016)
### Empiric Indicators for Original Turbulence Variable

<table>
<thead>
<tr>
<th>Pace of Change</th>
<th>Disruptive Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition:</strong> Variation in the frequency, number and kinds of conditions</td>
<td><strong>Definition:</strong> Surprises and unanticipated change</td>
</tr>
<tr>
<td>Acuity, census, discharges, transfers, unit variability, number of patients per day, excessive responsibility, heavy patient loads, patient turnover (ADT), simultaneous demands, new/difficult, unfamiliar work, time pressure.</td>
<td>Leaving the unit, distance travelled on the unit, responsiveness of support system (absence of secretary), interruptions, accessibility of resources, perceived environmental uncertainty, breakdowns, distractions, inadequate handoffs (loss of information), noise, interpersonal relations, information overload (cognitive stacking), equipment and supply issues.</td>
</tr>
</tbody>
</table>
Methodology/ Sample

A **15 item turbulence measure** was administered as part of a national survey interested in assessment of a **Health Information Technology Workaround model**.

Study approved by **UTHSCSA IRB** and website hosted by UTHSCSA.

A voluntary survey was sent to members of **The American Association of Critical Care Nurses** (AACN).

Respondents were asked if any of the **15 listed turbulence activities were present on their unit during their workaround experience**. Activities not specified in the 15 listed items could be written in as “other”.

Responses were on a Yes (1)/ No (0) scale.

Exploratory factor analysis was used to investigate similar response patterns/ attributes specific to turbulence.

Workload was assessed based on acuity, staffing ratio, and the nurse’s perception of their workload (light, moderate and heavy).

Narratives were analyzed prior to quantitative analysis and any mention of turbulence-type activities in the nurses’ story telling were coded as turbulence and sub-codes permitted to emerge.
Demographic Findings

**Number:** 307 Registered Nurses voluntarily responded

**Gender:** 87% female & 13% male.

**Age:** 58% 45 + years old

**Education:** 50% BSN, 20% ADN, 20% Master’s Degree

**Expertise** midway between proficient and expert level.

**ICU Specialties** included adult, pediatric and neonatal.

**Patient Acuity:** 62% critical, 29% guarded and 9% stable.

**Workload reported:** 40% Heavy and 58% Moderate

Software representation included: KBMA (Allscripts), Carefusion, Cerner, Epic, Meditech, McKesson, Soarian, eICU, EndoTool, GlucoStabilizer and Smart Pumps.
## Study Findings: Turbulence

### Distribution Characteristics: Quantitative Variables Associated with Turbulence (N = 296)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of Episodes</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admissions/Discharges</td>
<td>31</td>
<td>2.8</td>
</tr>
<tr>
<td>Transfers in and out of unit</td>
<td>75</td>
<td>6.5</td>
</tr>
<tr>
<td>Communication breakdown</td>
<td>102</td>
<td>8.9</td>
</tr>
<tr>
<td>Information overload</td>
<td>43</td>
<td>3.8</td>
</tr>
<tr>
<td>Equipment and supply issues</td>
<td>19</td>
<td>1.6</td>
</tr>
<tr>
<td>Absence of a secretary</td>
<td>9</td>
<td>0.8</td>
</tr>
<tr>
<td>Staff having to leave unit</td>
<td>50</td>
<td>4.3</td>
</tr>
<tr>
<td>Interpersonal distractions</td>
<td>27</td>
<td>2.3</td>
</tr>
<tr>
<td>Changes in acuity</td>
<td>197</td>
<td>17.1</td>
</tr>
<tr>
<td>Noise</td>
<td>79</td>
<td>6.9</td>
</tr>
<tr>
<td>Administrative Demands</td>
<td>103</td>
<td>9.0</td>
</tr>
<tr>
<td>Preceptee or Student</td>
<td>36</td>
<td>3.1</td>
</tr>
<tr>
<td>Distractions</td>
<td>157</td>
<td>13.6</td>
</tr>
<tr>
<td>Interruptions</td>
<td>185</td>
<td>16.0</td>
</tr>
<tr>
<td>Loss of Information Handoff</td>
<td>37</td>
<td>3.2</td>
</tr>
</tbody>
</table>
Study Findings: Turbulence
Overall Agreement between Quantitative and Qualitative Findings

No descriptions of interpersonal distractions, but a number of narratives describing inadequate training

Turbulence Subcodes

- Admit, DC or Transfer: 4
- Admin/ Regulatory Demands: 11
- Technology Communication: 24
- Communication breakdowns: 16
- Distraction: 19
- Equipment & Supply Issues: 17
- Inadequate Training: 6
- Information Overload: 2
- Interpersonal Distraction: 0
- Interruption: 29
- Loss of Handoff Information: 2
- No Secretary: 0
- Noise: 1
- Staff off Unit: 0
- Student/ Preceptee: 0
- Technology Response Time: 35

Qualitative Descriptions of Turbulence
## Study Findings: Turbulence

*EFA used to identify the underlying factor structure of turbulence measure*

<table>
<thead>
<tr>
<th>Attributes</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distractions</td>
<td>.802</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interruptions</td>
<td>.753</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>.563</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absence of a secretary</td>
<td></td>
<td>.679</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment and supply issues</td>
<td></td>
<td></td>
<td>.589</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff having to leave the unit</td>
<td></td>
<td></td>
<td></td>
<td>.545</td>
<td></td>
</tr>
<tr>
<td>Administrative or Regulatory demands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.530</td>
</tr>
<tr>
<td>Communication breakdowns</td>
<td></td>
<td></td>
<td></td>
<td>.728</td>
<td></td>
</tr>
<tr>
<td>Information overload</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.683</td>
</tr>
<tr>
<td>Loss of information during hand-off</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.590</td>
</tr>
<tr>
<td>Admissions/Discharges</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfers into and out of unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.799</td>
</tr>
<tr>
<td>Responsibility for Preceptee or Student</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.774</td>
</tr>
<tr>
<td>Interpersonal distractions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.636</td>
</tr>
</tbody>
</table>
Study Findings: Turbulence

- Data for analysis was satisfied with a final sample size of 296 (> 12 cases per variable).
- Reliability of the turbulence scale acceptable (α = .751)
- Items had factor loadings > .5 except changes in acuity. (removed)

The Turbulence 5 factor solution (14 items) explained 54% of variance, representing:

1. Attention diversion
2. Resources
3. Lack of Information
4. ADT (admission/discharge/transfer)
5. Interpersonal relationships
Final Turbulence Definition and Specification

The attribute <pace of change> and associated items (admissions, discharges, transfers) were determined to be representative of workload and were removed as empiric indicators for the turbulence definition.

“The degree to which a nurses’ attention to task is diluted or redirected by thought diversions, resource inadequacy, information shortcomings and/or interpersonal relationships”

Turbulence: Empiric Indicators (revised)

<table>
<thead>
<tr>
<th>Thought Diversion</th>
<th>Inadequate Resources</th>
<th>Information Shortcomings</th>
<th>Interpersonal Relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distractions</td>
<td>Absence of a secretary</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supply Issues (to include Meds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equipment Issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Staff off Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Administrative demands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interruptions</td>
<td>Communication breakdown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>Information Overload</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Information Loss</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Education deficit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Additional Duties: Preceptee or Orientee</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interpersonal Distractions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What did we find?

- The methods used to explore turbulence included:
  - Correlation Analysis
  - Logistic Regression
  - Development of Feedback Loops
  - Mediator and Moderator Testing
## Exploratory Findings

Using primarily Spearman Correlation, there were numerous significant relationships found between turbulence and the issues associated with the HIT problems. In other words, as problems with technology increased, so did turbulence.

<table>
<thead>
<tr>
<th>Turbulence X</th>
<th>$V=31, n=294, p=.006$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Complexity</td>
<td>$V=33, n=294, p=.004$</td>
</tr>
<tr>
<td>Administrative Requirements</td>
<td>$V=33, n=296, p=.004$</td>
</tr>
<tr>
<td>Data Retrieval</td>
<td>$V=33, n=296, p=.004$</td>
</tr>
<tr>
<td>Insufficient Staffing</td>
<td>$V=39, n=296, p=.000$</td>
</tr>
<tr>
<td>Equipment Issues</td>
<td>$V=26, n=296, p=.000$</td>
</tr>
<tr>
<td>Total HIT Problems</td>
<td>$V=38, n=296, p=.000$</td>
</tr>
<tr>
<td>Workload</td>
<td>$V=62, n=296, p=.000$</td>
</tr>
</tbody>
</table>
The evidence demonstrated that workload and the HIT problems may be interacting indirectly with patient safety via turbulence.
Findings: Turbulence and Safe Patient Care

The most frequent turbulence items were distractions, interruptions, information overload and loss of information.

In this example, no distractions or interruptions occurred for turbulence scores of 3 or less, scores 5-9 had approximately twice as many occurrences as not. For turbulence scores > 11 distractions and interruptions happened every time.
Exploratory Findings
Turbulence and Patient Safety

Converting qualitative data to causal loop diagrams confirmed reinforcing loops between turbulence and workload, HIT problems, and safety risk

(Browne, 2016)
Exploratory Findings: Turbulence

Logistic regression was conducted to examine if turbulence might be predictive of a workaround.

Logistic Regression and Odds Ratio Calculation of Workaround Variables

<table>
<thead>
<tr>
<th>IV</th>
<th>DV</th>
<th>B</th>
<th>se</th>
<th>Wald</th>
<th>df</th>
<th>Sig</th>
<th>Odds</th>
<th>X^2</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbulence</td>
<td>Informal Communication Workaround</td>
<td>.412</td>
<td>.06</td>
<td>47.4</td>
<td>1</td>
<td>.000</td>
<td>1.5</td>
<td>65.5</td>
<td>.000</td>
</tr>
<tr>
<td>Turbulence</td>
<td>Intuitive Workaround</td>
<td>.120</td>
<td>.045</td>
<td>7.17</td>
<td>1</td>
<td>.007</td>
<td>1.1</td>
<td>7.27</td>
<td>.007</td>
</tr>
</tbody>
</table>

For every one unit increase in turbulence, a nurse is 1.5 times more likely to use a workaround.
Moderation and Mediation Testing:

**Moderation**
Under what conditions of B is A significantly associated with C?
OR
Under what turbulence conditions are Patient safety & HIT Problems Significantly associated?

**Mediation**
What accounts for the impact of A on C?
Or
What accounts for the impact of turbulence on patient safety?
Interaction Plot of Moderation Effect of Turbulence on Number of Problems and Patient Safety Hazard Risk

As problems and turbulence increased, patient hazard risk increased: Visually, the range of influence of the moderating variable turbulence is twice the range with high problems/high turbulence.

Moderation was tested using the Hayes’ Process program
Mediation Testing: Workarounds

The relationship between turbulence and patient safety is being partially mediated by workarounds.

Model Summary of Informal Communication Workaround Mediating Turbulence and Patient Safety

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Sq</th>
<th>Adjusted R Sq</th>
<th>S.E.</th>
<th>R Sq Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.119&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.014</td>
<td>.011</td>
<td>.464</td>
<td>.014</td>
<td>4.243</td>
<td>1</td>
<td>294</td>
<td>.040</td>
</tr>
<tr>
<td>2</td>
<td>.135&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.018</td>
<td>.011</td>
<td>.464</td>
<td>.004</td>
<td>1.163</td>
<td>1</td>
<td>293</td>
<td>.282</td>
</tr>
</tbody>
</table>

Kenny, D. A. (2014)
Discussion

- Insidious growth of turbulence over time
- Nursing’s traditional approach to workflow research relies on linear models. A linear view inhibits our ability to visualize all of the work factors nurses face
- Quantifying workload may lead us to inadvertently ignore the nursing activities that cannot be measured
- This presentation was an example of identifying limitations in an established assumptive base (that workload represents all nursing work) and fully specifying concepts
- Importance of theoretical clarity is imperative! Inconsistency, vague terminology and ambiguity will impede the building of our science
Limitations

- Critical care sample only
- Work on turbulence was unanticipated
- Social desirability
- Some variables put restrictions on analysis
- Self reported questionnaires and inability to follow up
Recommendations for Future Study

More studies specific to turbulence & workflow
a. Patient Safety
b. Nursing Work (i.e., novice vs. expert)
c. Stress and Burnout

Turbulence can anchor future intervention studies
a. This will be the utility of the HITW model: identifying where turbulence appears in nursing workflow and in system level interfaces
b. With established measures, consider turbulence, workload and patient safety simulation
HITW Model

Health Information Technology Workaround (HITW) Model

- Communication (Informal)
- Nurse Characteristics
- Problem Solving Workaround
  - Intuitive Workaround

Context & Time

- Patient/Family Participation
- Standardized HIT Protocols and Resources

Historicist Influence

Nurses Adherence to HIT Protocol

- Barriers (Exceptions)

- Nurse Workload
  - Staffing & Scheduling
  - Patient/Family Expectations

Safe Patient Care Outcomes

= Turbulence
= Micro Level
= Mezzo Level
= Macro Level
Thank You So Much!!!
Questions?

References


