Does systems thinking improve the perception of safety culture and patient safety? A medication administration education intervention.
Grant funding $170,840

Two year study
Research Team

- Principal Investigator: Theresa Tetuan, PhD, RN-BC
- Co-Investigator(s):
  - Ruth Ohm, PhD, RN
  - Lenora Kinzie, MLS
  - Shelly McMaster, RN, BSN, MBA, BC-NE
  - Brenda Moffitt, APRN, CNS-BC
  - Jennifer Dunham, PharmD
  - Michael Mosier PhD (Statistics)
- Education
  - Sue Iverson, MSM, BSN, BS, RN
Explore possible associations between systems thinking, safety attitudes, and voluntary reporting of medication errors.

Identify possible workarounds used during medication administration that may lead to medication errors and affect patient safety.

Test the efficacy of a Systems Thinking Education Program (STEP)
Medication Errors

- Any of the six “Rights” are not met:
  - right patient
  - right medication
  - right dose
  - right route
  - right time
  - right documentation
When medication errors do occur, it is important to identify why nurses acted as they did and the relationship between their behavior and their perceptions of the healthcare system environment, instead of what has gone wrong (Armitage, 2009).
Recognize personal responsibility.

In order to engage nurses in systems thinking, it is important that they view problems as part of a chain of events of a larger system, rather than independent events (Dolansky & Moore, 2013).

May not appreciate how safety culture influences their individual behavior.
Characteristics of a Safety Culture (AHRQ, 2014)

- Acknowledgment of the high-risk nature of an organization's activities
- A blame-free environment without fear of reprimand or punishment
- Encouragement of collaboration across ranks and disciplines to seek solutions to patient safety problems
- Organizational commitment of resources to address safety concerns
Workarounds

- Are observed or described behaviors that may differ from organizationally prescribed or intended procedures.
- Workarounds during medication administration: typically used to increase efficiency.
- Observation studies
  - Bar code medication administration (BCMA)
  - Electronic medication administration records (eMAR)
  - Computerized physician order entry (CPOE)
This study aims to:

1. Identify workarounds nurses employ during the medication administration process.
2. Test the efficacy of a systems thinking education program to reduce workarounds that jeopardize patient safety.
   - H1: The frequency of nurse workarounds during medication administration will decrease after the systems thinking education program.
3. Explore the relationship among perceptions of safety culture, systems thinking and medication errors.

- H2: Nurses perception of safety culture will become more positive after the systems thinking education program.
- H3: Systems thinking will be positively correlated with the perception of safety culture.
- H4: With an increase in perception of safety culture there will be a simultaneous increase in voluntary reporting of medication errors.
Design

- Pre-post comparison study
  - Survey all nurses pre-post
    - Systems thinking
    - Perception of Safety Culture
  - Observation of medication administration pre-post
  - Voluntary reporting of medication errors

- Intervention
  - Systems Thinking Education Program
  - Medication Huddles
Measurements

- **Surveys**
  - Systems Thinking Scale (STS)
  - Safety Attitude Questionnaire (SAQ)

- **Observations**
  - *MedAccuracy AU MEDS®, LLC, Lenexa, Kansas*

- **Reports**
  - Voluntarily reported medication errors
Measure systems thinking
  ◦ System interdependencies

20 item, 5–point Likert scale
Safety Attitude Questionnaire (SAQ) (Sexton et al., 2006)

- Nurses perception of safety culture
- 36 5-point Likert items
  - Teamwork Climate
  - Safety Climate
  - Job Satisfaction
  - Stress Recognition
  - Perceptions of Management (Unit and Hospital level)
  - Working Conditions

- Demographics
  - Professional roles (RN vs. LPN)
  - Years of nursing experience
  - Primary unit of employment
Medication Administration Observations

- Observation Audits - MedAccuracy AU MEDS®, LLC, Lenexa, Kansas
  - Onsite observation reliability training according to their protocol
  - 4-5 RNs trained
  - Workaround rate:
    \[
    \frac{\text{# observed workarounds}}{\text{# observed administered doses}}
    \]
Interventions

- Systems Thinking Education Program (STEP)
- Medication Huddles
Systems Thinking Education Program (STEP)

- Medication Huddle Train-the-Trainer Class
- STEP Kickoff Celebration
  - Steve Peterson, BSN, RN–BC and Diane Glynn, JD, RN
- Systems Thinking and Nursing Practice Seminar featuring:
  - Mary Dolansky, PhD, RN
  - Sorrel King
    - Josie’s Story Traveling Bags
  - Jackie H. Jones, EdD, RN, and Linda Treiber, PhD
- Understanding Peer Review
  - Deb D’Orvilliers, RN and Jana Brown, RN
Journal Club featuring Systems-Thinking Articles

Medication Safety in the Ambulatory Care Setting featuring:
- Pat Iyer, MSN, RN, LNCC

Medication Safety – What Can I Do?
- Jennifer Dunham, PharmD

HLC: Science of Safety (on-line, from John Hopkins Hospital)

HLC: Mindfulness Practice & Medical Errors
- Heidi Pritchard, LMSW
From Actress to Survivor: The Story of Alicia Cole.
Alicia Cole

Exploring Medication Errors: Simulation and Analysis of Real World Situations
Ashley Brock, MSN, RN, Elizabeth Purling, BSN, RN, CEN

Systems Thinking Crossword Puzzle
Big Read
Ruth Ohm, PhD, RN & Libby Rosen, PhD, RN, IBCLC

Swiss Cheese Poster Contest
Fanning the Flames: Bringing Ideas to Life
Terry M. Foster, RN, MSN, FAEN, CCRN, CPEN, CEN
Beth Ulrich, EdD, RN, FACHE, FAAN
Tracy Granzyk MS, CPHQ
Medication Huddles

- Medication Huddle Form developed
- Train the Trainer
- Staff trained on designated units
Sample and Setting

- Units selected for observation:
  - 6 North
  - 7 South
  - Pavilion
  - Critical Care
  - Ambulatory care areas (Treatment Room and Allergy Department)
- Systems Thinking Education Program (STEP) offered organization-wide
- All RNs and LPNs surveyed
Results
Number of medication observations

Observations

Pre
Post
Event Rates

Event Rates

Pre
Post

0 1 2 3 4 5 6 7 8 9 10
Aim 1

Identify workarounds nurses employ during the medication administration process.
Aim 2

To test the efficacy of a systems thinking education program to reduce workarounds that jeopardize patient safety.

- H1: The frequency of nurse workarounds during medication administration will decrease after STEP.
Percent of workarounds associated with events (wrong time, dose or omission)

- I can't wait to graduate
- I look forward to developing workarounds to poorly designed processes
Aim 3

Explore the relationship among perceptions of safety culture, systems thinking and medication errors.
<table>
<thead>
<tr>
<th></th>
<th>Pre–STEP N=585</th>
<th>Post–STEP N=334</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Role (% RN)</strong></td>
<td>432 (78.3%)</td>
<td>235 (73.7%)</td>
</tr>
<tr>
<td><strong>Employment status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full time</td>
<td>493 (86.6%)</td>
<td>272 (83.4%)</td>
</tr>
<tr>
<td>Part time</td>
<td>59 (10.4%)</td>
<td>36 (10.8%)</td>
</tr>
<tr>
<td>PRN</td>
<td>17 (3%)</td>
<td>18 (5.5%)</td>
</tr>
<tr>
<td><strong>Shift worked</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>day</td>
<td>460 (80.7%)</td>
<td>279 (85.3%)</td>
</tr>
<tr>
<td>night</td>
<td>110 (19.3%)</td>
<td>48 (14.7%)</td>
</tr>
<tr>
<td><strong>Current position (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>85 (14.9%)</td>
<td>48 (14.8%)</td>
</tr>
<tr>
<td>1–2</td>
<td>99 (17.4%)</td>
<td>60 (18.5%)</td>
</tr>
<tr>
<td>3–5</td>
<td>132 (23.2%)</td>
<td>72 (22.2%)</td>
</tr>
<tr>
<td>6–10</td>
<td>112 (19.6%)</td>
<td>64 (19.8%)</td>
</tr>
<tr>
<td>&gt;10</td>
<td>142 (24.9%)</td>
<td>80 (24.7%)</td>
</tr>
</tbody>
</table>
## Units Worked

<table>
<thead>
<tr>
<th>Unit Worked</th>
<th>N (%)</th>
<th>Unit Worked</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 North</td>
<td>21 (3.7%)</td>
<td>6 North</td>
<td>9 (2.8%)</td>
</tr>
<tr>
<td>Critical care</td>
<td>59 (10.3%)</td>
<td>Critical care</td>
<td>19 (5.9%)</td>
</tr>
<tr>
<td>Pavilion</td>
<td>25 (4.4%)</td>
<td>Pavilion</td>
<td>17 (5.2%)</td>
</tr>
<tr>
<td>7 South</td>
<td>12 (2.1%)</td>
<td>7 South</td>
<td>11 (3.4%)</td>
</tr>
<tr>
<td>Treatment</td>
<td>7 (1.2%)</td>
<td>Treatment</td>
<td>4 (1.2%)</td>
</tr>
<tr>
<td>Allergy</td>
<td>3 (.5%)</td>
<td>Allergy</td>
<td>2 (.6%)</td>
</tr>
<tr>
<td>Other</td>
<td>447 (77.9%)</td>
<td>Other</td>
<td>262 (80.9%)</td>
</tr>
<tr>
<td>Program</td>
<td>Attendees</td>
<td>Responders who Attended</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------</td>
<td>-------------------------</td>
<td></td>
</tr>
<tr>
<td>Jan 6: Kick–off</td>
<td>131</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Feb 17: Josie’s Story</td>
<td>147</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>March 4: Peer Review</td>
<td>79</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>April 21: Ambulatory</td>
<td>76</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>April/May Journal Clubs</td>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>May 1: Reflection</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>June 17 Med Safety</td>
<td>22</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>July: Science of Safety</td>
<td>998/1289</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Mindfulness &amp; Med Errors (n=1315)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>August 26: Real world situations</td>
<td>35</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>September: Story of Alicia Cole</td>
<td>88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>September: Crossword Puzzle</td>
<td>82</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>October: Big Read</td>
<td>35</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>November: Swiss Cheese Poster</td>
<td>11 posters</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Dec 2: Fanning the Fire</td>
<td>88</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>
114 respondents attended at least one STEP session

<table>
<thead>
<tr>
<th># sessions</th>
<th>frequency</th>
<th>percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>42</td>
<td>36.8</td>
<td>36.8</td>
</tr>
<tr>
<td>2</td>
<td>19</td>
<td>16.7</td>
<td>53.5</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>13.2</td>
<td>66.7</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4.4</td>
<td>71.1</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>7.0</td>
<td>78.1</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>5.3</td>
<td>83.3</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>4.4</td>
<td>87.7</td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>6.1</td>
<td>93.9</td>
</tr>
<tr>
<td>9</td>
<td>3</td>
<td>2.6</td>
<td>96.5</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>2.6</td>
<td>99.1</td>
</tr>
<tr>
<td>11</td>
<td>1</td>
<td>.9</td>
<td>100</td>
</tr>
</tbody>
</table>
H2: Nurses perception of safety culture (SAQ) will become more positive after the systems thinking education program.

<table>
<thead>
<tr>
<th>PRE–POST (n)</th>
<th>Mean SAQ (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE (460)</td>
<td>3.95 (.605)</td>
</tr>
<tr>
<td>POST (250)</td>
<td>4.05 (.547)</td>
</tr>
</tbody>
</table>

- $t(556.906) = -2.193, p = .029^{**}$
- **equal variances not assumed
- Cronbach’s alph .941 and .932
Is there a difference in perception of safety culture among nurses who attended a STEP program and those who did not?

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean SAQ</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NoSTEP</td>
<td>163</td>
<td>4.03</td>
<td>.55</td>
</tr>
<tr>
<td>STEP</td>
<td>87</td>
<td>4.08</td>
<td>.59</td>
</tr>
</tbody>
</table>

- $t(248) = -0.749$, $p = .454$
# SAQ subscale mean scores pre–post STEP

<table>
<thead>
<tr>
<th>subscales</th>
<th>Pre–STEP (N=575–580)</th>
<th>Post–STEP (N=327–332)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork Climate</td>
<td>4.08 (.83)</td>
<td>4.16 (.74)</td>
</tr>
<tr>
<td>Safety Climate</td>
<td>4.21 (.67)</td>
<td>4.24 (.63)</td>
</tr>
<tr>
<td>Job Satisfaction*</td>
<td>4.26 (.80)</td>
<td>4.39 (.68)</td>
</tr>
<tr>
<td>Stress recognition**</td>
<td>3.57 (.98)</td>
<td>3.72 (.94)</td>
</tr>
<tr>
<td>Working conditions</td>
<td>3.92 (.87)</td>
<td>3.98 (.86)</td>
</tr>
<tr>
<td>Perception of unit management</td>
<td>3.76 (1.00)</td>
<td>3.78 (1.01)</td>
</tr>
<tr>
<td>Perception of hospital management</td>
<td>3.697 (.93)</td>
<td>3.75 (.91)</td>
</tr>
<tr>
<td></td>
<td>N=464</td>
<td>N=264</td>
</tr>
</tbody>
</table>
H3: Systems thinking will be positively correlated with the perception of safety culture.

<table>
<thead>
<tr>
<th>PRE–STEP</th>
<th>POST–STEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r \ (n=456) = .297$</td>
<td>$r \ (n=247) = .210$</td>
</tr>
<tr>
<td>$p &lt; .001$</td>
<td>$p = .001$</td>
</tr>
</tbody>
</table>
Is there a difference in Systems Thinking Scores (STS) among nurses who attended a STEP program and those who did not?

<table>
<thead>
<tr>
<th>Attend STEP?</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (112)</td>
<td>68.2 (7.66)</td>
</tr>
<tr>
<td>No (216)</td>
<td>63.2 (8.44)</td>
</tr>
</tbody>
</table>

$t(326) = -5.216, \ p<.001$
Is there a difference in Systems Thinking Scores (STS) after the STEP program?

<table>
<thead>
<tr>
<th>PRE–POST STEP (n)</th>
<th>Mean STS (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE (574)</td>
<td>63.396 (9.36)</td>
</tr>
<tr>
<td>POST (328)</td>
<td>64.9096 (8.50)</td>
</tr>
</tbody>
</table>

$t(735.465) = 12.478, p = .013^{**}$  
**equal variances not assumed
<table>
<thead>
<tr>
<th></th>
<th>PreSTEP</th>
<th>PostSTEP</th>
<th>RWJF (2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample size (n)</td>
<td>515</td>
<td>284</td>
<td>225</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>63.43 (9.12)</td>
<td>64.72 (8.53)</td>
<td>61.1 (7.9)</td>
</tr>
<tr>
<td>Cronbach’s alpha</td>
<td>.902</td>
<td>.89</td>
<td>.82</td>
</tr>
</tbody>
</table>
H4: With an increase in perception of safety culture there will be a simultaneous increase in voluntary reporting of medication errors.

- Because of the changing in our reporting system we were unable to fully test this hypothesis.
Medication Huddles – during STEP education programs

- From February 20 through October 20, 2015, there were 46 medication huddles completed.
- 24 of 46 (52%) were high alert medications
- 5 of high alert errors (20.8%) – no double check
- 2 verbal orders (not high alert meds)
Medication Huddles
Event Factors through a Systems Thinking Lens

- Individual Factors
- Technical Factors
- Systems Factors
Issues that were observed for individual factors

- Experience-related
- Distracted
- Interruptions
- Rushed
- Did not follow policy
Technical Factors

- Too close administration flag/warning not activated (2)
- Look alike/sound alike med
- Computer down–time
- Order not clear, and placed where not very noticeable (hold med)
- Over–ride warning of barcode scan
- Pump syringe
System Factors

- 7 staffing issues; not enough staff or unfamiliar to area
- 8 busier than usual
- Communication
- Wrong dose in Omnicell; expired med
- Previous pts meds still in bin
- Change in order during day
Discussion
There was a decrease in frequency of workarounds post STEP intervention.


- Omission of process steps
- Steps performed out of sequence
- Unauthorized BCMA process steps
Technique Issues Identified by Medication Administration Observations

- Timing of medication with food & vital signs
- IV Push Rates too fast
- Double checks not being completed
- Patient identifiers not completed
- Injections techniques
- Hygiene issues
Efficacy of Step Program

- **STEP program**
  - Variety of presentations
  - Opportunity to hear from national speakers
  - Attendance well over 1,000 (including on-line)

- **PreSTEP and PostSTEP responders**
  - ↑ Systems thinking scores
  - ↑ Safety culture score

- **Attendees vs. non-attendees**
  - ↑ Systems thinking scores
  - No change in safety culture scores
Safety culture

- Overall small increase post intervention
Relatively weak association with safety culture and systems thinking

Unique concepts
Medication huddles

- Only on 6 observation units
- Over half these medications were high-alert
- Lack of system-wide sharing
- Anecdotally, huddles well received
  - Information thorough at the point of discovery
- System-wide implementation in organization?
Limitations

- Presence of an observer may influence the nurses’ behavior.
- Medication administration observers 3/5 both collection times.
- Observation audits from 0800 and 1200 hours; Monday through Friday.
- Turnover of nursing staff.
- Low response rate to surveys
- Intervention did not occur at unit level
- Sharing of medication event stories was limited
- Loss of original research committee members
- Change of medication error reporting system
Implications for clinical practice

- To huddle or not to huddle?
- Enhance medication event transparency
- Evaluate individual practice for workarounds
- Speak out when systems are not working
Implications for future research

- Unit-based systems thinking education
- Nurse as a second victim
- Transparency with events
- Investigation of medication timing with meals for patients with diabetes
- IV push administration techniques
- Medication huddles


Data Analysis – STS & SAQ scales

- Descriptive Analysis: medians, means, sd, ranges
  - Demographic information
  - Total STS and SAQ scale scores
  - Relationship of STS and SAQ scale scores with reported medication errors and observed error/workaround rates
- Pearson correlations: to assess associations among STS and SAQ items, separately at baseline and post-intervention.
- Comparisons between baseline and post-intervention total STS and SAQ scale scores will be performed using independent sample T-tests
- Exploratory analyses: to assess whether there are differences (pre & post) in STS and SAQ scale scores between demographic populations, such as professional role, (physician, RN, LPN, or pharmacist), years in specialty, and primary unit of employment.
Method of Data Analysis

- Koppel et al., 2008: rate of workarounds at about 10%; approximately 1 out of every 10 medication administrations will have a workaround.
- Our goal: Lower this rate to 7% or less would be clinically meaningful.
- 1134 observed administered doses at each phase (baseline and post-intervention) will provide at least 80% power to detect a change of at least 3%.
- Z-test for a difference in two independent sample proportions.
The proportion of observations that resulted in an observed error/workaround will be computed, and compared between pre and post intervention using a Z-test for a difference in two independent sample proportions.

Exploratory analyses will be conducted to assess whether there are differences in the observed error/workaround rates between demographic populations, such as professional role, (physician, RN, LPN, or pharmacist), years in specialty, and primary unit of employment.

Evaluation of STEP program offerings.
Questions?