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Clinical Critically Appraised Topics

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12-2018

### **Lean education strategies: Summary**

Children's Mercy Kansas City

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**Office of Evidence Based Practice (EBP) – Critically Appraised Topic:**  
**What interventions have been used to increase the bedside nurses' knowledge of Lean within a value stream when engaging in a Lean Management System?**

**Specific Care Question**

What interventions have been used to increase the bedside nurses' knowledge of Lean within a value stream\* when engaging in a Lean Management System?

\*Value stream is defined within the context of healthcare as a series of events that takes a customer from the beginning to the end of care (in this case from admission to discharge).

**Question Originator**

Newly Licensed Nurses (NLN) Residency Program

**Literature Summary**

**Background.** Lean thinking has been applied to many industries to improve quality and efficiency by adding value and decreasing redundancy (Jones & Mitchell, 2006). In the early 2000s organizations in the United States (Institute of Healthcare Improvement) and the United Kingdom (National Health Service Confederation and the Institute for Innovation and Improvement) advocated for the integration of Lean thinking into healthcare (Jones & Mitchell, 2006; Westwood, James-Moore, & Cooke, 2007; Womack & Miller, 2015).

**Study characteristics.** The search for suitable studies was completed on November 15, 2018. Dr. Bartlett reviewed the 46 titles and abstracts found in the search and identified zero articles believed to answer the question. Due to the newness of Lean methodology application within the healthcare arena there is a dearth of research studies that analyze how to increase bedside nurses' knowledge of Lean within a value stream (D'Andreamatteo, Ianni, Lega, & Sargiacomo, 2015). However one article (Kaltenbrunner, Bengtsson, Mathiassen & Engstrom, 2017), in this search, provides a measurement instrument in which the staff's perception of Lean adoption within their department can be quantified. Based on the lack of study findings, the Children's Mercy Director of Performance Improvement, Mr. M. Boyd, was sought out to identify any literature sources to answer the question posed. Mr. Boyd shared six articles that should be considered in answering the question. Though none of these articles answered the immediate question, when viewing the literature through the quality improvement lens, two articles provided insights for the NLN residency team (Kim, Hayman, Billi, Lash, & Lawrence, 2007; O'Neill, Jones, Bennett, & Lewis, 2011).

**Key results.**

Based on current evidence, strategies that can be used to increase bedside nurses' knowledge is yet to be measured. However, what has been learned from current literature is that it is imperative that bedside staff are at the table at the beginning of the process (data collection) and when developing potential interventions to improve the process. As the interventions and outcome data were dissimilar between the studies, outcomes cannot be reported in a forest plot. Therefore, the studies will be reported in high level format.

**Summary of studies**

**Kaltenbrunner et al. (2017).** The mixed method study (Kaltenbrunner et al., 2017) was used to transform Liker's four Lean constructs (philosophy, processes, people and partners, and problem solving) into an instrument that measures staff perception of Lean adoption in healthcare. The instrument was identified to have construct validity, internal consistence and stability.

Face validity of the instrument occurred through purposive sample interviews ( $N = 12$ ) of health care staff. The staff interviewed represented hospital and primary care, public non-profit and private for-profit organizations. Interview data was deductively analyzed and changes were made to the instrument entitled Lean in Healthcare Questionnaire (Kaltenbrunner et al., 2017).

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Lean in Healthcare Questionnaire (LiHcQ) was tested for construct validity, internal consistency and stability through the use of a convenience sample of primary care staff ( $N = 481$ ) from public non-profit and private for-profit organizations. Construct validity was acceptable using the statistical tests of relative chi-square = 2.33, root mean square error of approximation = 0.07, 90% CI [.06 – .09], standardized root mean square residual = .048, and the confirmatory fit analysis = .93 (Kaltenbrunner et al., 2017). In measuring internal consistency, construct Cronbach alphas were reported as: philosophy = .75, processes = .86, people and partners = .60, and problem-solving = .81 (Kaltenbrunner et al., 2017). It should be pointed out that the Cronbach alpha of the construct, people and partners, is not within the statistically acceptable range of greater than .70 (Pett, Lackey, Sullivan, 2003) however the entire questionnaire's Cronbach's alpha was acceptable, .93 (Kaltenbrunner et al., 2017). The instrument's stability was acceptable as reported through the intra-class correlations coefficient test for each construct: philosophy = .8, processes = .77, people and partners = .88, and problem-solving = .79 (Kaltenbrunner et al., 2017).

**Kim et al. (2007).** The cohort study (Kim et al., 2007) captured the application of a quality improvement initiative within the Department of Radiation Oncology. Participants included all levels of staff (bedside to administrative). The intent of the initiative was to standardize the process to initiate palliative radiation. Though statistical analysis was not reported, the total number of steps to initiate care were reduced from 27 to 16 when comparing pre-implementation to post-implementation respectively. The authors (Kim et al., 2007) also reported that the number of patients able to undergo treatments the same day increased from 43% to 94%, though the denominator for the two time periods was not disclosed (see the article for the pre- and post-implementation process strategies).

**O'Neill et al. (2011).** The cohort study (O'Neill et al., 2011) reports the rapid process improvement work initiative that occurred in two independent nursing units in the same organization. The time spent delivering direct patient care increased from 35% to 60%, though from the figures provided this appears to have occurred on only one of the two units (see the article Figure 1 for a depiction of the team's findings). The authors also identified that medication rounds decreased between the pre- and post-implementation phases, though the medication rounds were not implicitly delineated in Figure 1. What is clear is having staff nurses present throughout the process provided an avenue for them to buy into the change process (O'Neill et al., 2011).

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**Search Strategy and Results** ([see Figure 1. PRISMA diagram](#))

#	Query	Limiters/Expanders	Last Run Via
S3	S1 AND S2  (MH "Medical-Surgical Nursing+") OR (MH "Nursing Interventions") OR "Nursing Interventions" OR (MH "Saba Clinical Care Nursing Interventions+") OR (MH "Iowa Nursing Interventions Classification+") OR (MH "Nursing Staff, Hospital") OR (MH "Perioperative Nursing") OR (MH "Hand Off (Patient Safety)+") OR (MH "Critical Care Nursing+") OR "frontline" OR (MH "Patient Bedside") OR "bedside" OR (MH "Workflow") OR (MH "Hand Off (Patient Safety)+")	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL
S2	"advanced lean" OR "A3 thinking" OR "value stream thinking" OR "lean principles" OR "lean management" OR "lean strategies" OR "lean systems" OR "Six Sigma"	Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL
S1		Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL

**Studies Included in this Review (in Alphabetical Order)**

- Kaltenbrunner et al. (2017)
- Kim et al. (2007)
- O'Neill et al. (2011)

**Studies Not Included in this Review with Exclusion Rationale (in Alphabetical Order)**

Authors (YYYY)	Reason for exclusion
Austin and Pronovost (2016)	Narrative review article on intrinsic and extrinsic motivators
Vickers (2014)	Narrative review article on Lean principles
Leming-Lee, Crutcher, and Kennedy (2017)	Narrative review article on integrating Lean methodology into a DNP curriculum
Tovar and Warshawsky (2015)	Narrative review article on integrating Lean methodology into a DNP problem based learning curriculum

**Method Used for Appraisal and Synthesis**

The Cochrane Collaborative computer program, Review Manager (Higgins & Green, 2011)<sup>a</sup> was used to synthesize the three included studies.

<sup>a</sup>Higgins, J. P. T., & Green, S. e. (2011). *Cochrane Handbook for Systematic Reviews of Interventions [updated March 2011]* (Version 5.1.0 ed.): The Cochrane Collaboration, 2011.

**Medical Librarian Responsible for the Search Strategy**

Keri Swaggart, MLIS, AHIP

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**EBP Scholar's Responsible for Analyzing the Literature**

Becky Frederick, PharmD  
Nicole Ratliff BS RT(R)

**EBP Team Member Responsible for Reviewing, Synthesizing, and Developing this Document**

J. A. Bartlett, PhD, RN

**Acronyms Used in this Document**

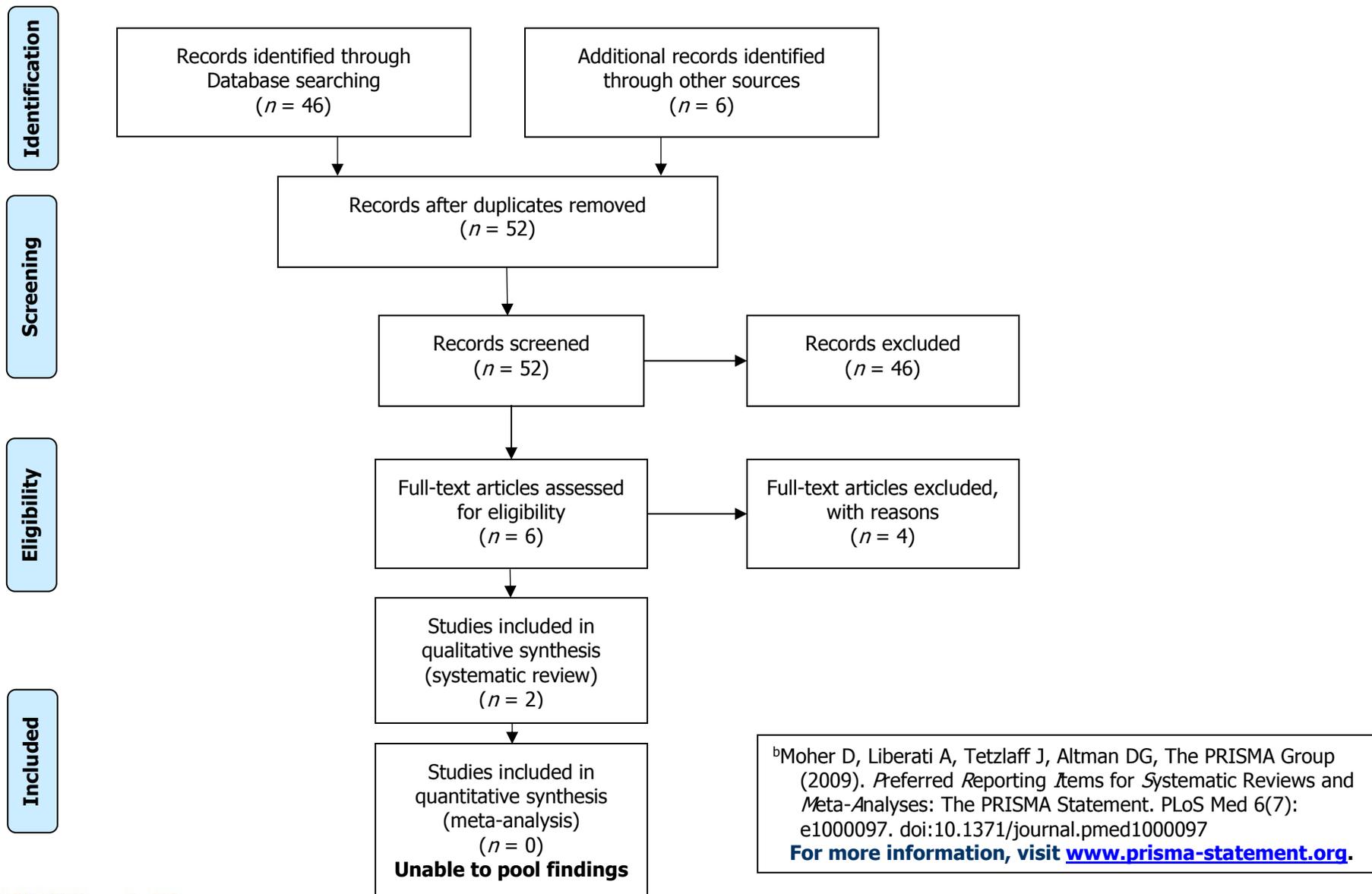
Acronym	Explanation
LiHcQ	Lean in Healthcare Questionnaire
NLN	Newly Licensed Nurses
Relative $\chi^2$	Relative Chi-square
RMSEA	Root Mean Square Error of Approximation
CFI	Comparative Fit index
SRMR	Standardized Root Mean square Residual
ICC	Intra-class correlation coefficient

**Date Developed/Updated**

12.26.18; 1.3.19

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Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)<sup>b</sup>



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**Table 2**  
**Characteristics of Studies**

**Kaltenbrunner et al. (2017)**

<b>Methods</b>	Instrument validation using mixed methods (interviews for face validity, psychometric analysis for construct validity, internal consistency and stability)
<b>Participants</b>	<p><b>Participants for face validity:</b> professional staff  <b>Setting:</b> staff interviewed represented hospital and primary care, public non-profit and private for-profit organizations  <b>Number enrolled:</b> <math>N = 12</math>  <b>Number completed:</b> <math>n = 12</math>  <b>Gender, males:</b> <math>n = 1</math>  <b>Age, mean years (SD):</b> 46 (10)  <b>Inclusion Criteria:</b> purposive sampling of different professions (nurses, managers, physicians, physiotherapists, administrators, secretaries)  <b>Exclusion Criteria:</b> Not described or reported.</p> <p><b>Participants for psychometric analysis:</b> professional staff  <b>Setting:</b> convenience sample of primary care staff from public non-profit and private for-profit organizations  <b>Number enrolled:</b> <math>N = 1040</math>  <b>Number completing at least 50% of the LiHcQ items:</b> <math>n = 386</math>  <b>Number completing all of the LiHcQ items:</b> <math>n = 243</math>  <b>Gender, males:</b> <math>n = 49</math>  <b>Age, mean years (SD):</b> 50 (10)  <b>Inclusion Criteria:</b></p> <ul style="list-style-type: none"> <li>• Staff from primary care units,</li> <li>• the units should have implemented some aspect of Lean</li> <li>• staff should have worked at least three months in their unit prior to data collection</li> </ul> <p><b>Exclusion Criteria:</b></p> <ul style="list-style-type: none"> <li>• specialized units (such as dermatology, nutrition, administration)</li> <li>• units with inpatients or call centers with telenurses</li> </ul>
<b>Interventions</b>	<p>Face validity:</p> <ul style="list-style-type: none"> <li>• First-line managers of the recruited units asked staff with different professions, sex and age about their interest in participating in the interviews</li> <li>• Interviews were held by the first author in a private room</li> <li>• Participants were instructed to “think out loud” while they read the LiHcQ items</li> <li>• When participants hesitated the interviewer asked questions such as “I can see you reacted to the statement, what are your thoughts about it?”</li> <li>• Participants were asked to provide an overall opinion of the instrument</li> </ul>

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	<p>Construct validity, internal consistence and stability of the LiHcQ</p> <ul style="list-style-type: none"> <li>• First-line manager of the recruited units provided study information at regular meetings</li> <li>• All staff received written information from the researchers along with the questionnaire.</li> <li>• Staff was also informed, in writing, that their consent to participate in the study would be assumed if they responded to the questionnaire</li> <li>• The questionnaire was initially web-based</li> <li>• Staff not responding on the web were sent a paper copy of the LiHcQ</li> <li>• Two invitation reminders were sent out to staff</li> </ul>
<p><b>Outcomes</b></p>	<p><b>Primary outcomes:</b></p> <ul style="list-style-type: none"> <li>• Face validity             <ul style="list-style-type: none"> <li>○ Seven participants obtained through purposive sampling were interviewed</li> <li>○ After changes were made to the instrument five additional participants were interviewed</li> </ul> </li> <li>• Construct validity, internal consistency and stability of the LiHcQ             <ul style="list-style-type: none"> <li>○ Construct validity was measured using the following tests with the acceptable parameters:                 <ul style="list-style-type: none"> <li>▪ Relative Chi-square test (<math>\chi^2</math>) less than 3 and the p-value is larger than 0.05</li> <li>▪ Root Mean Square Error of Approximation (RMSEA) below 0.08</li> <li>▪ Comparative Fit index (CFI) value greater than 0.90</li> <li>▪ Standardized Root Mean square Residual (SRMR) less than 0.5</li> </ul> </li> <li>○ Internal consistency                 <ul style="list-style-type: none"> <li>▪ Cronbach’s alpha coefficient values larger than 0.70 indicate acceptable performance</li> </ul> </li> <li>○ Stability (Test-retest reliability)                 <ul style="list-style-type: none"> <li>▪ Intra-class correlation coefficients (ICC) with 95% CI are considered:                     <ul style="list-style-type: none"> <li>▪ poor if &lt;0.40,</li> <li>▪ fair when between 0.40 and 0.59,</li> <li>▪ good between 0.60 and 0.74</li> <li>▪ excellent if the value is <math>\geq 0.75</math></li> </ul> </li> </ul> </li> </ul> </li> </ul>
<p><b>Results</b></p>	<p>Face validity</p> <ul style="list-style-type: none"> <li>• The data from the seven participants were deductively analyzed and changes were made to the instrument</li> <li>• Data from the second set of interviews were deductively analyzed with changes made, resulting in the LiHCQ</li> </ul> <p>Construct validity</p> <ul style="list-style-type: none"> <li>• Number of participants (<math>n = 243</math>) completing the LiHcQ exceeded the needed 160 to perform construct validity</li> <li>• Relative chi-square = 2.33</li> <li>• RMSEA = .07, 90% CI [.06, .09],</li> <li>• SRMR = .048,</li> <li>• CRI = .93</li> </ul>

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	<p>Internal consistency:</p> <ul style="list-style-type: none"> <li>• Cronbach's alpha (for the entire instrument) = .93             <ul style="list-style-type: none"> <li>○ Construct Cronbach alphas:                 <ul style="list-style-type: none"> <li>▪ philosophy = .75</li> <li>▪ processes = .86</li> <li>▪ people and partners = .60</li> <li>▪ problem-solving = .81)</li> </ul> </li> </ul> </li> </ul> <p>Stability:</p> <ul style="list-style-type: none"> <li>• ICC for each construct was acceptable:             <ul style="list-style-type: none"> <li>○ philosophy = .8</li> <li>○ processes = .77</li> <li>○ people and partners = .88</li> <li>○ problem-solving = .79</li> </ul> </li> </ul>
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**Kim et al. (2007)**

<b>Methods</b>	Quality improvement implementation
<b>Participants</b>	<p><b>Participants:</b> Staff caring for patients with bone or brain metastases  <b>Setting:</b> Department of Radiation Oncology Department at the University of Michigan Hospital in July 2005  <b>Number enrolled:</b> <i>N</i> = Not described or reported.  <b>Number completed:</b> <i>N</i> = Not described or reported.  <b>Gender, males:</b> Not described or reported  <b>Age, years/month (mean):</b> Not described or reported  <b>Inclusion Criteria:</b> Radiology Department processes associated with patients with bone or brain metastasis  <b>Exclusion Criteria:</b> Not described or reported.</p>
<b>Interventions</b>	Implement a standardized process to initiate palliative radiation therapy
<b>Outcomes</b>	<p><b>Primary outcomes:</b></p> <ul style="list-style-type: none"> <li>• Number of patients able to undergo evaluation, simulation, and initial radiation treatment within the same work day (regardless of whether these activities occurred on the same day as the initial consultation call or on a different day), %</li> <li>• Number of process steps required to initiate treatment</li> </ul> <p><b>Secondary outcomes:</b></p> <ul style="list-style-type: none"> <li>• Total process time - the actual time it takes to complete an activity</li> <li>• Lead time - the total elapsed time associated with completing an activity; example - waiting for an appointment time</li> <li>• Process cycle efficiency - process time divided by the total lead time, a measure of what percentage of time is spent in value added activity</li> </ul>

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<p><b>Results</b></p>	<p>Pre-implementation of lean process</p> <ul style="list-style-type: none"><li>• Percentage of patients (43%) able to undergo evaluation, simulation, and initial radiation treatment within the same work day (regardless of whether these activities occurred on the same day as the initial consultation call or on a different day)</li><li>• 27 separate steps</li><li>• Total process time average - 290 minutes</li><li>• Lead time of up to 10,000 minutes</li><li>• Process cycle efficiency 3%</li></ul> <p>Post-implementation of lean process</p> <ul style="list-style-type: none"><li>• 94% Number of patients able to undergo evaluation, simulation, and initial radiation treatment within the same work day (regardless of whether these activities occurred on the same day as the initial consultation call or on a different day)</li><li>• 16 separate steps</li><li>• Total process time average - 225 minutes</li><li>• Lead time one day or 1440 minutes</li><li>• Process cycle efficiency 100%</li><li>• The authors provided two process maps that represented what occurred prior to and after the lean implementation process.</li></ul> <p>The total implementation time was not described or reported.</p>
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O'Neill 2011

<b>Methods</b>	Cohort Study to compare pre-and post-implementation of LEAN in two nursing departments.
<b>Participants</b>	<p><b>Participants:</b> A diverse group of clinical and executive staff.  <b>Setting:</b> Flinders Medical Centre (FMC), a 500-bed teaching general hospital in Adelaide, South Australia.  <b>Number enrolled:</b> <i>N</i> = Not reported  <b>Number completed:</b> <i>N</i> = Not reported  <b>Gender, males:</b></p> <ul style="list-style-type: none"> <li>• <b>Group 1:</b> <i>n</i> = Not reported</li> <li>• <b>Group 2:</b> <i>n</i> = Not reported</li> </ul> <p><b>Age, years/month (mean):</b></p> <ul style="list-style-type: none"> <li>• <b>Group 1:</b> <i>n</i> = Not reported</li> <li>• <b>Group 2:</b> <i>n</i> = Not reported</li> </ul> <p><b>Inclusion Criteria:</b></p> <ul style="list-style-type: none"> <li>• Two departments, a surgery department (18-bed rehabilitation, neurology, and neurosurgical wards) and a medicine department (24-bed renal and general medical wards) became the model line departments.</li> <li>• Registered nurses (RNs) from 3 shifts (day/afternoon/night) who provided direct care to 4 patients.</li> <li>• Nurse executives and the nursing leadership team</li> </ul> <p><b>Exclusion Criteria:</b></p> <ul style="list-style-type: none"> <li>• None identified.</li> </ul> <p><b>Covariates identified:</b></p> <ul style="list-style-type: none"> <li>• None identified.</li> </ul>
<b>Interventions</b>	<ul style="list-style-type: none"> <li>• Data collection sheets were developed to record nursing activity detail in 15 second intervals</li> <li>• Observers (clinical and executive staff) were trained in observing and tracking techniques for this inquiry</li> <li>• Nurses from the selected units were observed and tracked for a 24 hour period across three shifts (day/afternoon/night)</li> <li>• Data collected included the primary nursing process, why it was required, length of time for the process, and where the process occurred.</li> <li>• Participants attended a 5 day event to review the data and develop future state vision, plans to achieve the vision, and implementation steps.</li> </ul>
<b>Outcomes</b>	<b>Primary outcome(s):</b> Compare pre-and post-implementation of LEAN

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<b>Results</b>	<ul style="list-style-type: none"><li>• The time nurses spent delivering direct patient care increased from 35% (2.8/8 hour) to up to 60% (4.8/8 hour hours) per shift.</li><li>• The length of medications rounds has been reduced by 50% (from 120 to 64 minutes).<ul style="list-style-type: none"><li>○ Interruptions decreased from the average of 15 to 20 to less than 2 per medication round.</li></ul></li><li>• Time spent communicating patient information was reduced by 40% (from 15 hours of total nursing time across 3 shifts to 7.5 hours). The authors reported the communication quality had increased.</li><li>• Patient surveys upon discharge from the model line units have demonstrated greater than 80% of patients ranked their level of satisfaction with the care as being very good to excellent. Patient surveys prior to the Lean implementation was not reported</li></ul>
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