



Impact of Real-Time Prediction Model-Enhanced Clinical Decision Support Systems on Nursing Sensitive Patient Outcomes: A Review of the Literature

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+ Objectives

- By the end of this session, the learner will be able to:
 - Describe the state of the science for clinical decision support systems that incorporate healthcare predictive analytics.
 - Identify methodological challenges that exist in examining the impact of clinical decision support systems on nurses' behaviors and patient outcomes.



SCHOOL OF NURSING
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+ Introduction



Increased
EHR Use

Large
Datasets
Available

“Big Data”

Applications

- One Application = Healthcare Predictive Analytics (HPA)
- Potential for High Cost Patient, Triage, Deterioration, etc.
- Novel Addition to Clinicians' Toolkit
- Accuracy of Models vs. Action from Providers



Definitions



- Clinical Decision Support (CDS) - computer-based interventions that attempt to influence clinicians' work processes (including decisions and behaviors) by providing them with information intended to be relevant to a particular situation
- Healthcare Predictive Analytics (HPA) - information regarding the likelihood of a future event through risk prediction models that incorporate multiple predictor variables automatically from one or more sources of health-related data beyond what can be simply calculated by most clinicians

+ Background

- Novelty of Topic/Technology
 - Phenomenon not well understood
- Questionable Benefit
 - Simply adding new technology not always beneficial (although CDS research methods improving)
 - Significant time & money spent on new information systems



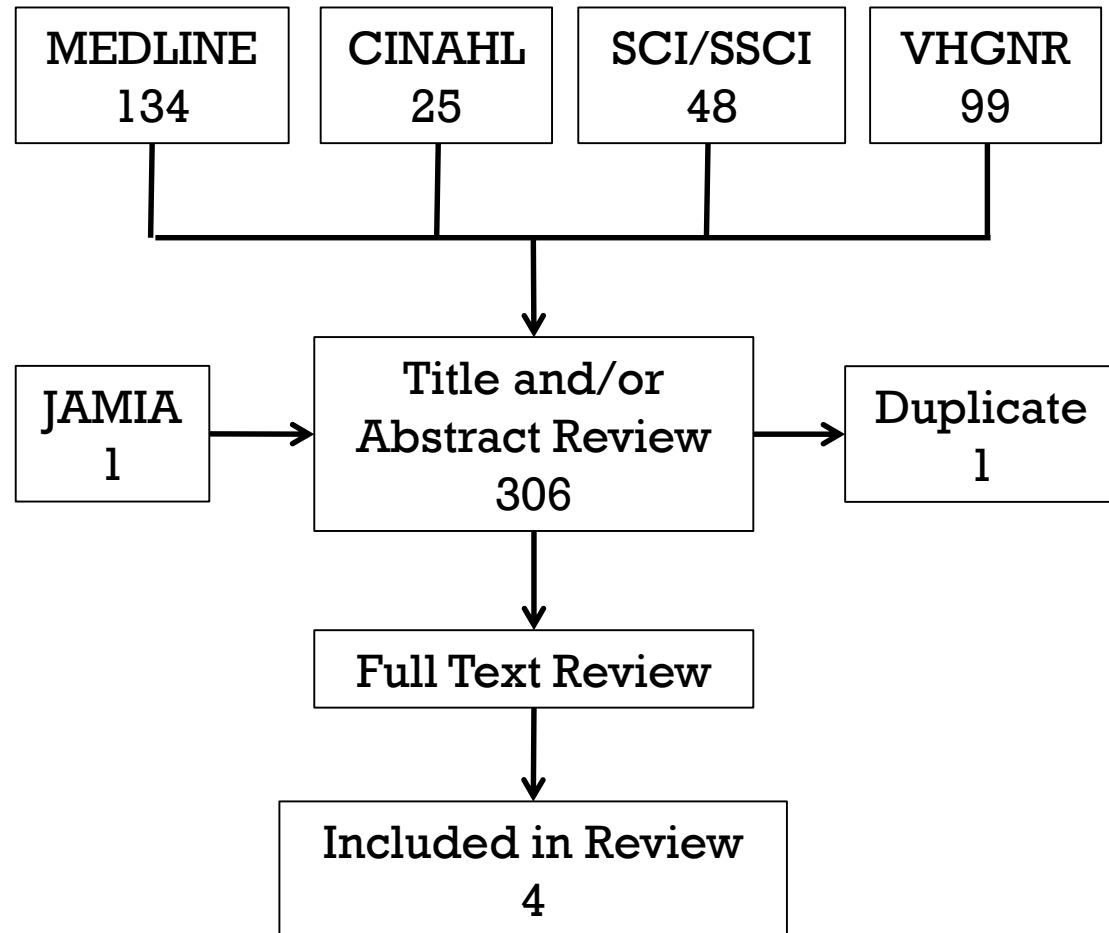
+ Background (cont'd)

- Most CDS studies involve order entry & prescribing
 - Nurses not well studied
- Nurses comprise the largest healthcare profession

Outcome	Cost	Incidence
Pressure Ulcers	\$43,000/stay	Up to 2.5 million/year
Falls	\$13,000/stay	Up to 1 million events/year
Infections	\$14,000/infection	Up to 720,000 infections/year
Failure to Rescue	n/a	3.5-6.9% of post-op patients

+ Objective/Methods

- Summarize primary research studies (and/or reviews) describing the impact of HPA-enhanced CDS on nursing-sensitive patient outcomes.





Basic Results

- 2011-2014 (no limiters set)
- 33 authors – only 1 nurse identified
 - 4 possible from Korea, but no credentials listed
- Outcomes Included:
 - Failure to Rescue (n=3)
 - Pressure Ulcers (n=1)
- All Adult Units
 - 3 med(-surg) wards
 - 1 SICU

INDIVIDUAL STUDY CHARACTERISTICS AND FINDINGS

AUTHOR (YEAR)	OUTCOME	SETTING	STUDY DESIGN	MEASURES	STATISTICALLY SIGNIFICANT RESULTS
Bailey (2013)	FTR (CPA)	Adult Medical-Surgical Wards	Cluster RCT Information Resource Intervention = Charge nurse received pager alert for patients identified by prediction model as having high probability of deterioration	Mortality, Hospital LOS, & ICU Transfer	No change in outcomes.
Cho (2013)	PU	Adult Surgical ICU	Before/After Intervention Information Resource Intervention = Software system provided daily update of pressure ulcer development probability for all patients	Pressure Ulcer Rates, ICU LOS, & User Adoption/Attitudes	Treatment group less likely to develop PU (AOR=0.08, 95%CI: 0.05, 0.15) and had shorter ICU LOS (AOR=0.67, 95%CI: 0.61, 0.73).
Kollef (2014)	FTR (CPA)	Adult Medical Wards	RCT Information Resource Intervention = Rapid response team received a real-time alert on patients identified as high risk for cardiopulmonary arrest	Mortality, Hospital LOS, & ICU Transfer	Hospital LOS reduced by 1 day (p=0.038) for treatment group. No change in other outcomes.
Sawyer (2011)	FTR (Sepsis)	Adult Medical Wards	Cluster RCT (Pilot) Information Resource Intervention = Charge nurse received an alert for patients at risk for sepsis and was instructed to assess patient and notify physician	Mortality, Hospital LOS, ICU Transfer, & Clinician Behaviors	Greater percentage of treatment group (70.8% vs. 55.8%, p=0.018) received at least 1 sepsis intervention. Patient outcomes not impacted.

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Limitations of Critiqued Studies



- Bailey (cardiopulmonary arrest)
 - Did not measure what charge nurses did with alert – treatment fidelity?
- Cho (pressure ulcers)
 - 2 year lag between baseline/control and experiment – historical trends?
- Kollef (cardiopulmonary arrest)
 - Overall increase of RRT use during study – learning effects?
- Sawyer (sepsis)
 - Use of interventions improved but no change in patient outcomes – adequacy of interventions?



Methodological Challenges



Multilevel Nature of Intervention

Treatment Fidelity

**Adequacy of Clinicians' Subsequent
Behavior**



Multilevel Nature of Intervention



- Choice of Level Influences: Randomization & Analysis

- (1 patient exposed to n Clinicians) +

(n patients exposed to 1 Clinician) =

Confounding!

+ The Fork in the Road...



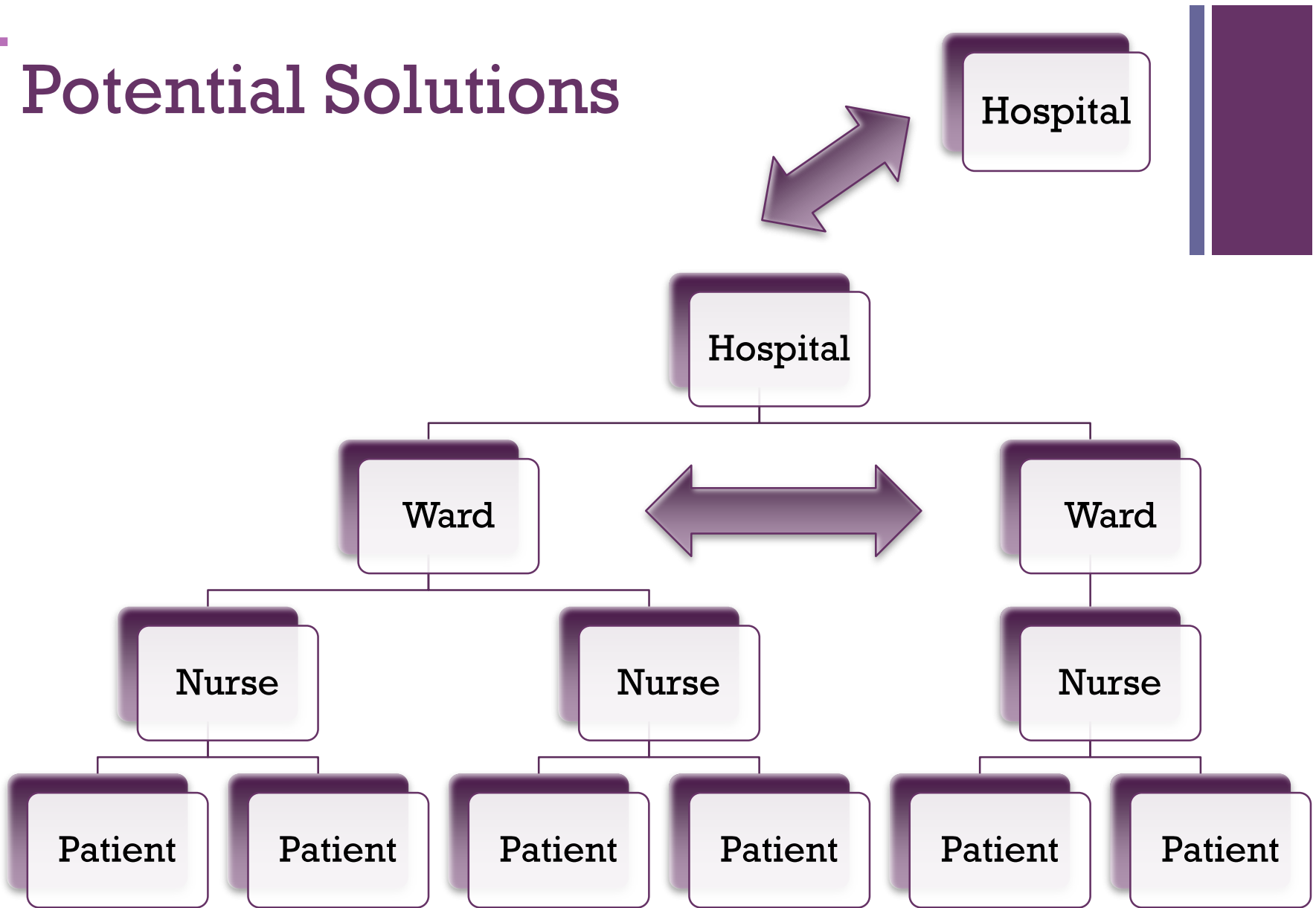
Clinician-Level Randomization

- What if a nurse in the Experimental Group hands off a patient to a nurse in the Control Group?
- Certain events like pressure ulcers don't happen instantaneously – who do you blame?
- Therefore, treatment contamination

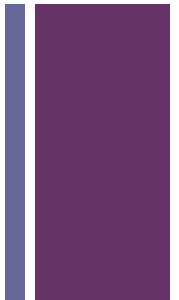
Patient-Level Randomization

- What if a nurse has 6 patients, where 3 are in the Experimental Group and 3 in the Control Group?
- Based on knowledge, experience, current scoring tools, will the nurse not still prioritize if he/she **knows** who the highest priority patient is?
- Therefore, treatment contamination

+ Potential Solutions



+ Treatment Fidelity



		INFORMATION RESOURCE	
		Absent —	Present +
CLINICIAN BEHAVIOR	Unchanged —	Routine/Standard Practice (no change in patient outcomes)	Ineffective Information Resource
	Altered +	Deviation from Standard Practice (potential for change in patient outcomes)	Greatest Potential for Change in Patient Outcomes

+ Treatment Fidelity

Pharmacological	HPA-enhanced CDS
Type	Re-Organization of Work Processes
Dosage	Consider how impactful/influential CDS will be on work processes (e.g., hard stop [forcing function], continuous reminder, single reminder, small pop-up, full screen notification)
Route	Is information given to patient, individual providers, unit leadership, organizational leadership, etc.?
Frequency	How often should the CDS be based on newly available data?
Duration	Likely to be continuously available for all patients but consider (similar to Dosage), how often the output should be displayed.
Onset/Timing	Dependent on targeted unit: if aimed at individual clinicians, one could see quick impacts but if aimed at the organizational level, it could take a substantial period of time to see results.
Technical Aspects & Provider Characteristics	What are we expecting clinicians to do with the information? Can they override information? How do you measure treatment fidelity of both the information resource and clinician behavior?



Adequacy of Subsequent Behavior



- Assuming we have leveled appropriately...
- And assuming we have treatment fidelity...
- What if the recommended action doesn't have a causal influence on the patient outcome?
- For example:
 - Rapid response team implementation doesn't consistently reduce hospital mortality.
 - Most effective pressure ulcer prevention/management strategies are unknown.



Conclusions



- No evidence currently that HPA-enhanced CDS systems have significant impact on patient outcomes
- EHRs & CDS systems aren't likely to go away
- HPA have significant potential to enhance CDS
- Traditional methods of studying healthcare treatment might be inadequate for information resources, especially CDS systems
- Perceptions of information display and risk/uncertainty will also become a focus of research



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+ Thank you!

Questions?