

UNIVERSITY OF TWENTE.



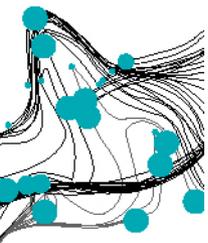
DEVELOPING AND TESTING A COMPUTERIZED DECISION SUPPORT SYSTEM FOR NURSE-TO-PATIENT ASSIGNMENT

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CHOIR



NURSE-TO-PATIENT ASSIGNMENT



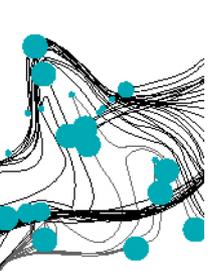
- Takes place at the start of each shift
- Performed by charge nurse or by all nurses together



High-quality, well-balanced assignments are crucial for:

- Quality and safety of patient care
- Nurses' job satisfaction and morale
- Many considerations involved → difficult to perform manually
- Time-consuming: charge nurses spend up to 30 minutes





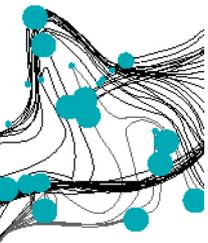
RESEARCH OBJECTIVES



- To develop a CDSS for nurse-to-patient assignment
- To evaluate its overall effect in a clinical setting

CHOIR





PREVIOUS RESEARCH



Rosenberger et al. (2004), Punnakitikashem et al. (2006, 2008), Sundaramoorthi et al. (2009, 2010a, 2010b), Baker et al. (2010)

- Methods: integer programming, stochastic programming, heuristics, Markov decision theory, simulation
- Objective: workload balancing
- Evaluation: training sessions for student nurses



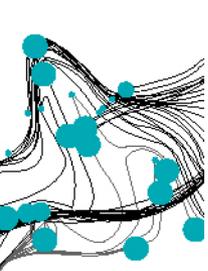
Mullinax et al. (2002), Schaus et al. (2009)

- Methods: integer programming, heuristics, constraint programming
- Objective: workload balancing (patients' locations, max # patients per nurse)
- Evaluation: computer experiments

Donahue (2009)

- Methods: 'pod' design
- Objective: minimizing walking distances (patients' acuity)
- Evaluation: implemented and tested for one month





APPROACH



Mixed methods approach: both qualitative and quantitative



Phase I: Development CDSS



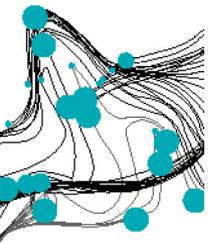
- Literature search
- Focus group sessions
- Consideration importance survey
- Model development



Phase II: Evaluation CDSS

- Before-and-after measurements





PARTICIPANTS



Three nursing wards in the Academic Medical Center (AMC) Amsterdam:

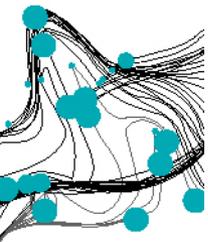
- Neurology 26 beds NEU
- Neurosurgery 20 beds NEC
- Gastro-intestinal surgery 28 beds SURG

Phase I: Development CDSS NEU, NEC

Phase II: Evaluation CDSS NEU, NEC, SURG

AMC practice: nurses make the assignment together





OVERVIEW



Phase I: Development CDSS

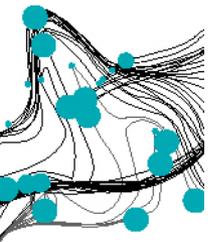
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Phase II: Evaluation CDSS

- Before-and-after measurements





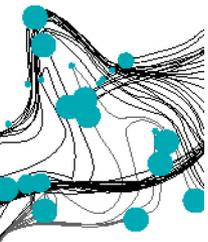
LITERATURE SEARCH

PHASE I: DEVELOPMENT CDSS

Considerations

- Patient acuity information from previous shift
- Patient (or family) preference
- Patient/nurse language match
- Physician preference for particular nurse-patient assignment
- Nurse preference
- Years of nursing experience
- Nurse experience/expertise with this type of patient
- Nurse experience with this patient
- Nurse employment status (regular vs. per diem)
- Nurse level (SNI, etc.)
- Nurse licensure (R.N., L.V.N., etc.)
- Nurse health status (disabilities, etc.)
- Student nurse assignment
- Orientation needs of new nurses
- Other duties of nurses (administrative, orientation)
- Clinical judgment of patient nursing needs
- Amount of time patient is expected to be away from unit
- Location of patient on the unit
- Availability of nonnursing support staff





FOCUS GROUP SESSIONS

PHASE I: DEVELOPMENT CDSS



- 2 sessions: NEC & NEU; per session: 3 nurses, 45 minutes
- Write down considerations
- Considerations from literature were shown
- Write down additional considerations
- Cluster considerations and name clusters
- Researchers matched considerations to those from literature



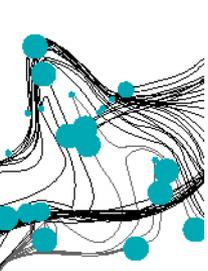
Considerations added

Patient/nurse culture match

Nurse mental health status

Student's year of education



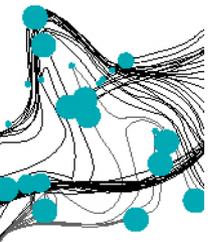


CONSIDERATION IMPORTANCE SURVEY

PHASE I: DEVELOPMENT CDSS



Ranking	Considerations	Ranking in B&S	Average score
1	Patient acuity information from previous shift	1	8.35
2	Patient (or family) preference	8	5.53
3	Nurse experience with this patient	4	4.94
4	Student nurse assignment	NR	4.88
5	Patient/nurse language match	9	4.65
6	Student's year of education	NR	3.53
7	Years of nursing experience	14	3.47
8	Nurse health status (disabilities, etc.)	NR	3.44
9	Location of patient on the unit	10	2.94
10	Nurse mental health status	NR	2.91
11	Nurse experience/expertise with this type of patient	2	2.32
12	Amount of time patient is expected to be away from unit	15	1.47
13	Availability of nonnursing support staff	NR	1.21
14	Nurse preference	5	1.12
15	Clinical judgment of patient nursing needs	3	1.09
16	Orientation needs of new nurses	6	1.06
17	Other duties of nurses (administrative, orientation)	11	0.71
18	Patient/nurse culture match	NR	0.71
19	Nurse employment status (regular vs. per diem)	NR	0.26
20	Nurse level (SNI, etc.)	13	0.26
21	Nurse licensure (R.N., L.V.N., etc.)	12	0.15
22	Physician preference for particular nurse-patient assignment	NR	0.00



OVERVIEW



Phase I: Development CDSS

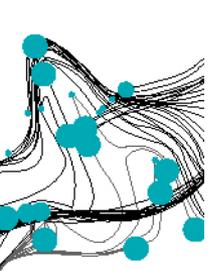
- Literature search
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- Model development



Phase II: Evaluation CDSS

- Before-and-after measurements





OVERVIEW



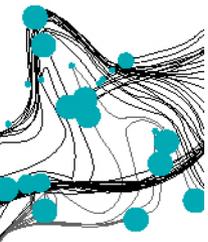
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Phase II: Evaluation CDSS

- Before-and-after measurements



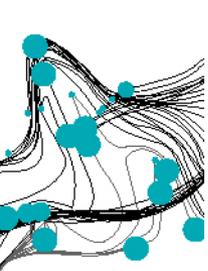


MODEL DEVELOPMENT

PHASE I: DEVELOPMENT CDSS



Ranking	Considerations	Ranking in B&S	Average score
1	Patient acuity information from previous shift	1	8.35
2	Patient (or family) preference	8	5.53
3	Nurse experience with this patient	4	4.94
4	(1) Distribute total amount of care evenly among nurses		
5	(2) Distribute high acuity patients evenly among nurses		
6			
7	Years of nursing experience	14	3.47
8	Nurse health status (disabilities, etc.)	NR	3.44
9	Location of patient on the unit	10	2.94
10	Nurse mental health status	NR	2.91
11	Nurse experience/expertise with this type of patient	2	2.32
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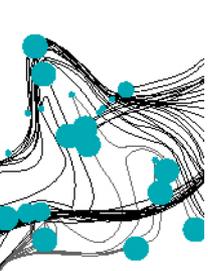
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22			

(3) Assign 'first responsible nurse' to patient
(4) Replicate nurse-to-patient assignment of previous day

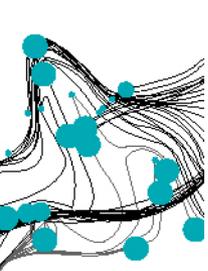


MODEL DEVELOPMENT

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6	Student's year of education	NR	3.53
7	Years of nursing experience	14	3.47
8	Nurse health status (disabilities, etc.)	NR	3.44
9	<p>(5) Assign at most $Q=3$ patients to a student nurse</p> <p>(6) Assign at most $R=6$ patients to a coaching nurse</p>		
10			
11			
12	Amount of time patient is expected to be away from unit	15	1.47
13	Availability of nonnursing support staff	NR	1.21
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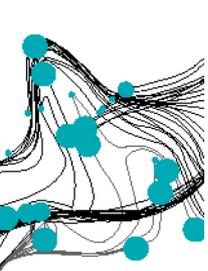


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8	Nurse health status (disabilities, etc.)	NR	3.44
9	Location of patient on the unit	10	2.94
10	Nurse mental health status	NR	2.91
11	Nurse experience/expertise with this type of patient	2	2.22
12	(7) Spread walking distance evenly among nurses		
13	Availability of nonnursing support staff	NR	1.21
14	Nurse preference	5	1.12
15	Clinical judgment of patient nursing needs	3	1.09
16	Orientation needs of new nurses	6	1.06
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MODEL DEVELOPMENT

PHASE I: DEVELOPMENT CDSS



$$\min \quad \{\beta y + \delta w - \theta e - \mu b + \phi a\}$$

$$\text{s.t.} \quad \sum_p A_p x_{np} \leq y \quad \forall n \quad (1)$$

$$\sum_{p|A_p=M} x_{np} \leq w \quad \forall n \quad (2)$$

$$\sum_{n,p} F_{np} x_{np} \geq e \quad (3)$$

$$\sum_{n,p} H_{np} x_{np} \geq b \quad (4)$$

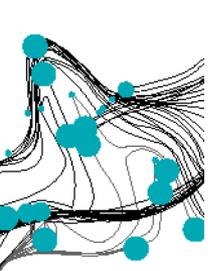
$$\sum_p x_{np} \leq Q \quad \forall n \in N_s \quad (5)$$

$$\sum_p x_{np} + \sum_{\hat{n} \in N_s, p} C_{n\hat{n}} x_{\hat{n}p} \leq R \quad \forall n \in N_c \quad (6)$$

$$x_{np} + x_{n\hat{p}} \leq 1 + r_{n\hat{p}} \quad \forall n, p, \hat{p} \neq p \quad (7)$$

$$\sum_{p, \hat{p} \neq p} D_{p\hat{p}} r_{n\hat{p}} \leq a \quad \forall n \quad (8)$$

$$\sum_n x_{np} = 1 \quad \forall p \quad (9)$$



OVERVIEW



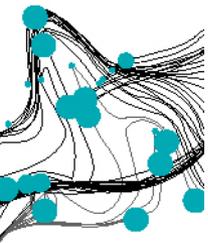
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Phase II: Evaluation CDSS

- Before-and-after measurements





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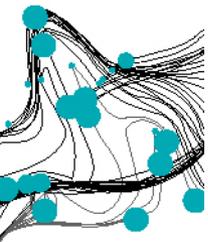
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BEFORE-AND-AFTER MEASUREMENTS

PHASE II: EVALUATION CDSS



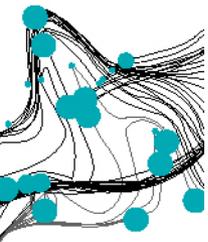
- Measurements during day shifts
- 6 measurements before and 6 after on each ward (NEU, NEC, SURG)



Performance indicators

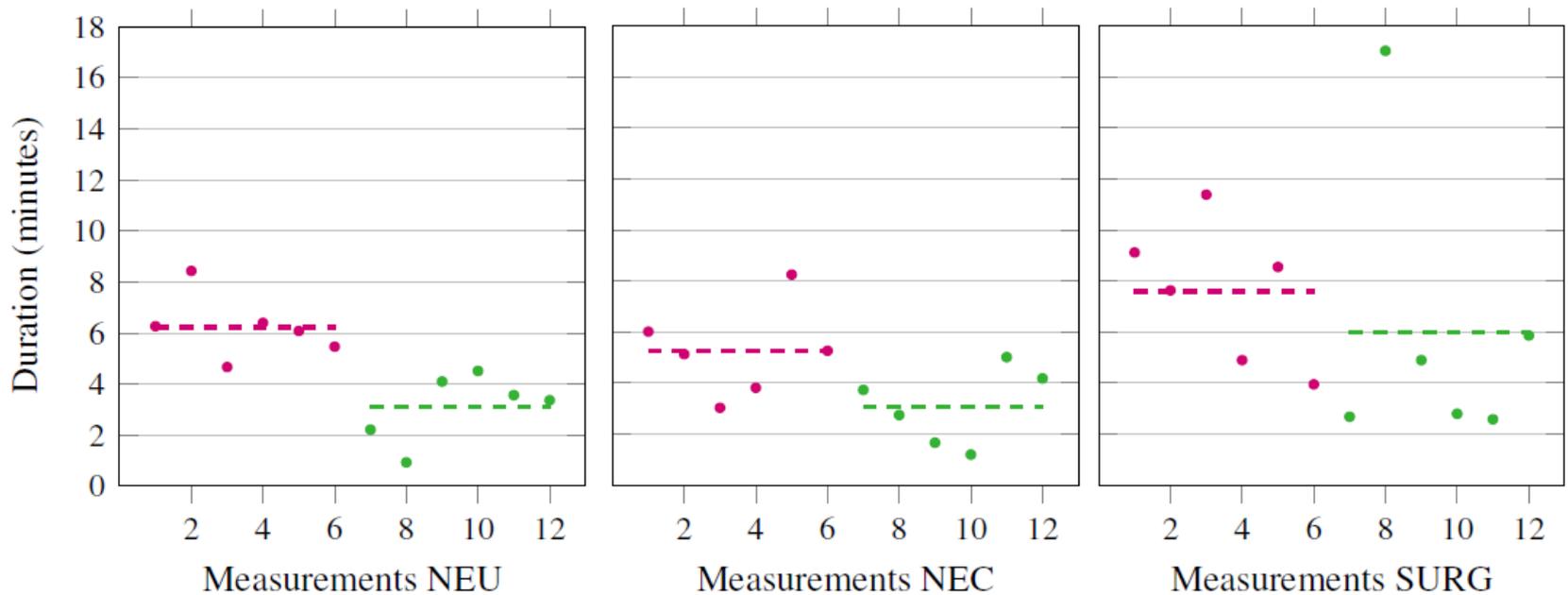
- Duration assignment process
- Charge nurse satisfaction
- Workload satisfaction survey



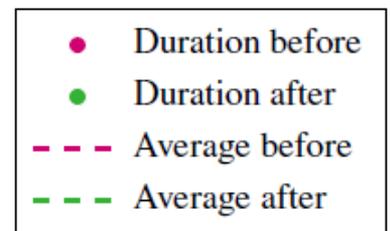


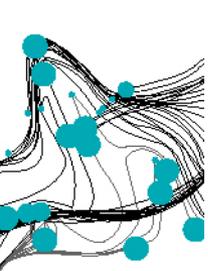
RESULTS – DURATION

PHASE II: EVALUATION CDSS



Total mean duration reduced from 6 (SD 2.0) to 4 (SD 3.5) minutes.





RESULTS – NURSES' PERCEPTIONS

PHASE II: EVALUATION CDSS



Charge nurse satisfaction

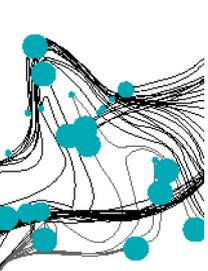
- No changes



Workload satisfaction survey (*n* = 138)

- Nurses experienced lower workload post intervention
- Satisfaction with group of patients decreased





CONCLUSIONS



The developed CDSS can result in:

- Considerable time savings
AMC: 22 wards, 3 shifts per day, average 2 minutes decrease for all nurses
- Improved quality and safety of patient care
- Increased job satisfaction and morale of nurses

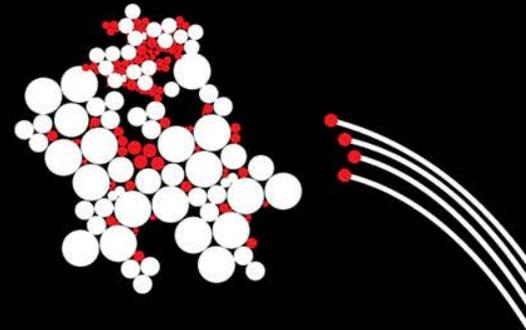
Current trend: creating larger nursing wards and merging nursing teams
→ Potential of CDSS will grow over coming years



UNIVERSITY OF TWENTE.

QUESTIONS?

A.BRAAKSMA@UTWENTE.NL



Symposium & PhD thesis defense

Friday, 25 September 2015

University of Twente

YOU ARE WELCOME!



CHOIR