


**Centre of Research Expertise
for the Prevention of
Musculoskeletal Disorders**

WEBINAR

Predicting Nursing Biomechanical Load, MSD Risk, and Quality of Care During COVID & Non-COVID Scenarios Using Discrete Event Simulation

Dr. Sadeem M. Qureshi & Dr. Patrick Neumann | July 13, 2022


RESEARCH MEETING PRACTICE TO PREVENT MUSCULOSKELETAL DISORDERS (MSD)
The Centre receives funding through a grant provided by the Ontario Ministry of Labour, Training and Skills Development.

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Research Team – Better Work Better Care (BWBC) Coalition

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CHALLENGES IN HEALTHCARE (pre-COVID)

Overtime \$968 million/year	Absenteeism \$989 million/year
Injury Healthcare is #1 in lost-time injuries (including WMSD)	Burnout 71% Nurses experienced burnout once
Missed Care 25-31 tasks (2-2.9 hrs./12 hr. shift)	

Sources: Canadian Federation of Nurses Union (2015, 2017a, 2017b)
 Canadian Nurses Association (2015); Qureshi et al. (2021)




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Nursing work is....

- Complex
- Irregular
- Dynamic
- Physically + Psychosocially demanding
- Difficult to analyze with conventional Human Factors methods

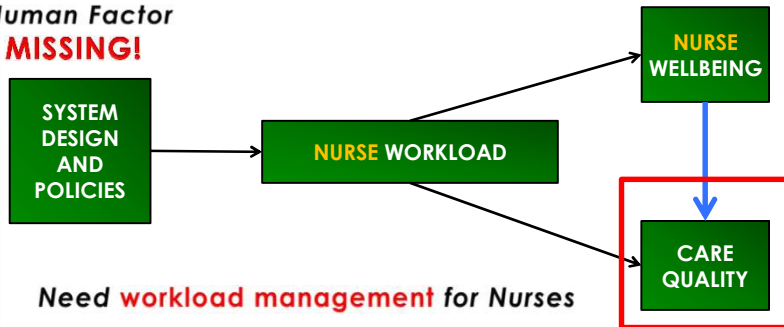
Picture Source: Nursing Times
<https://www.nursingtimes.net/roles/nurse-managers/twelve-hour-shifts-burnout-or-job-satisfaction-21-03-2016/>



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CONCEPTUAL MODEL

Human Factor
MISSING!



Need workload management for Nurses

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DISCRETE EVENT SIMULATION (DES)

- Process of representing complex structures of a system as a sequence of ordered events and stages, in which the variable(s) change at a discrete set of points
- Proven as a successful tool in other fields:
 - Manufacturing
 - Aerospace
 - Service Industries
 - ...

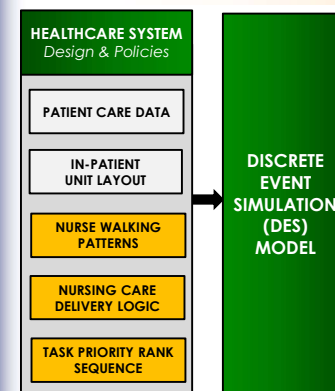
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OBJECTIVE

- Develop an approach to creating “**valid**” computerized simulation model
- **Quantify** the effects of operational decisions on
 - **Nurse Workload**
 - **Biomechanical load and MSD risk**
 - Mental workload and Psychosocial implications
 - Physical workload
 - **Quality of Care**
- Examine **pandemic impacts**

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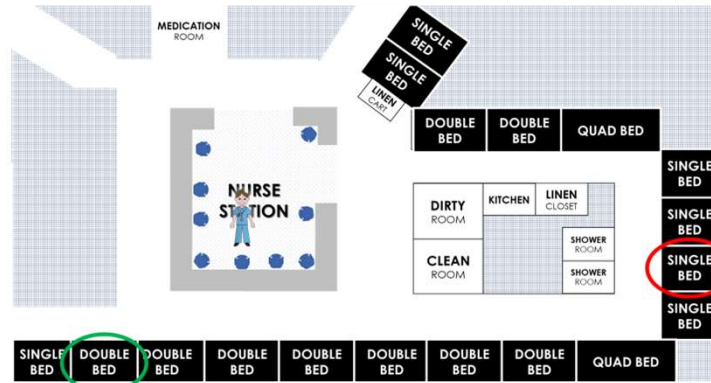
INITIAL MODEL CREATION



- Multiple Focus groups
 - n= 23 RNs
 - Range of experience = 2 to 23 years
 - Two different care delivery logic developed

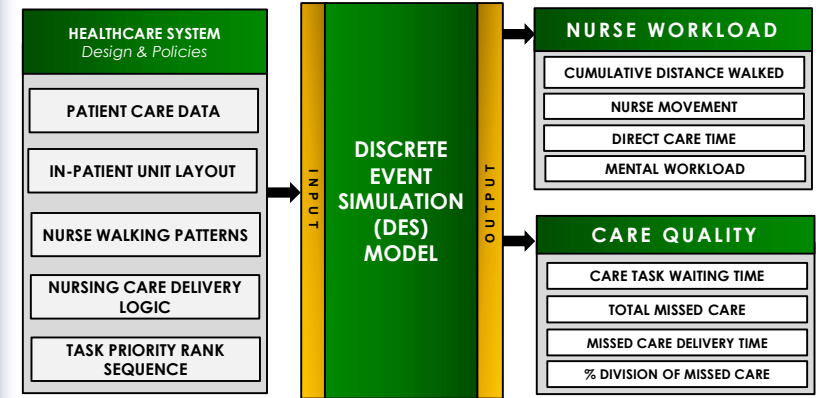
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CARE TASK: Insertion of N/G Tube



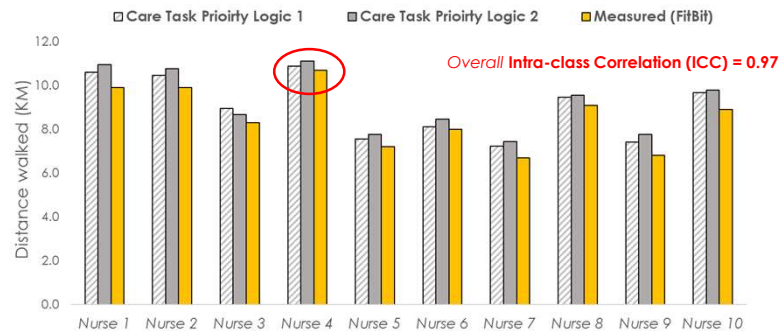
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INITIAL MODEL CREATION (cont.)



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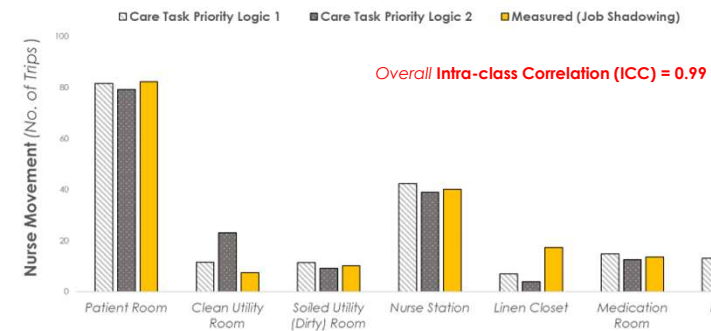
Model Validation (Step Counter Study): DISTANCE WALKED



✓ Validates this indicator

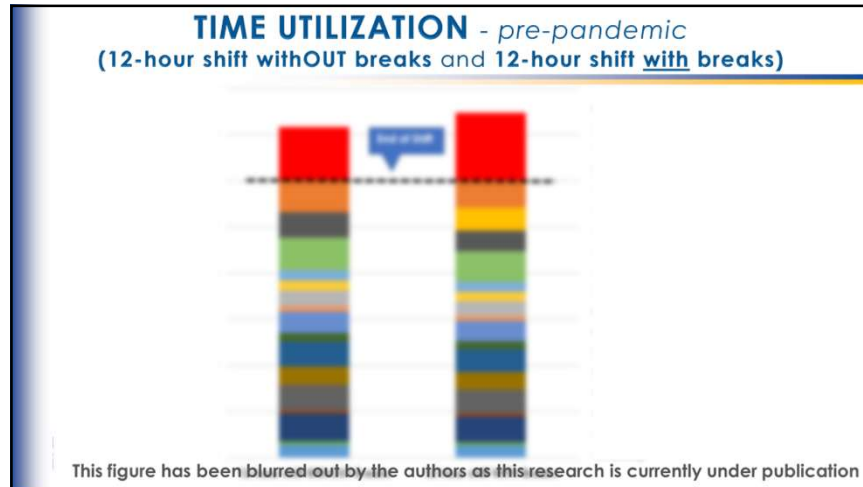
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Model Validation (Job Shadowing Study): NURSE'S MOVEMENT

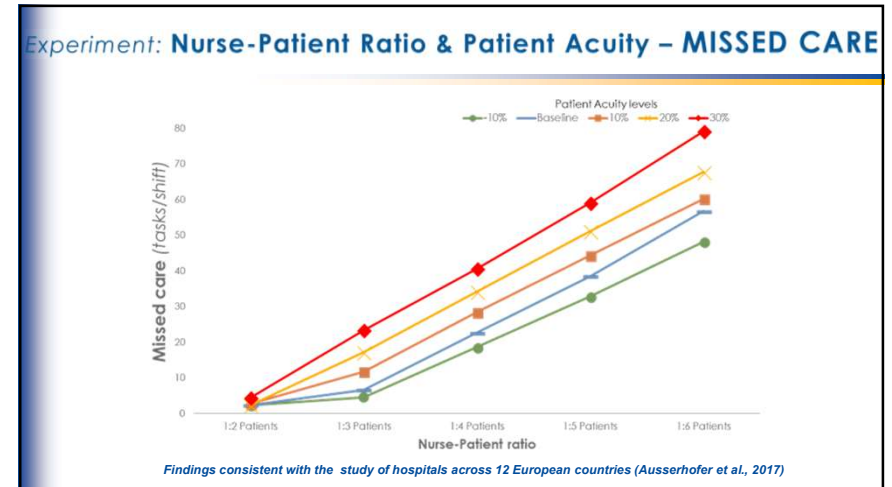


✓ Validates this indicator

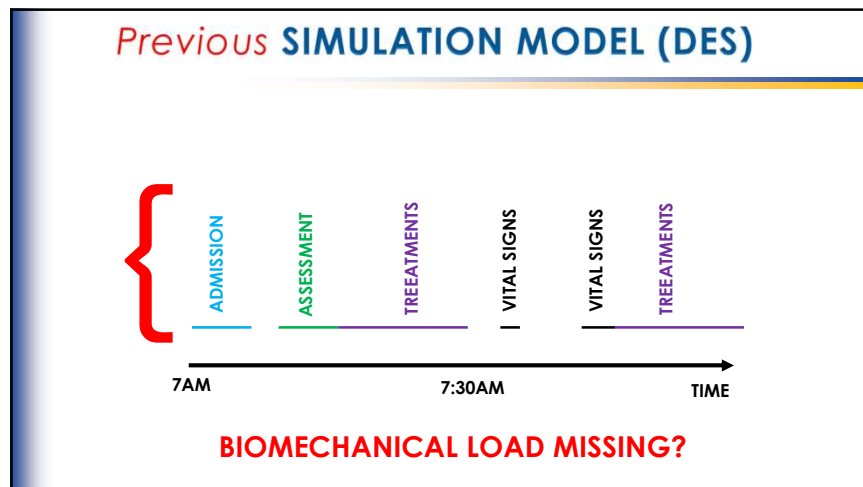
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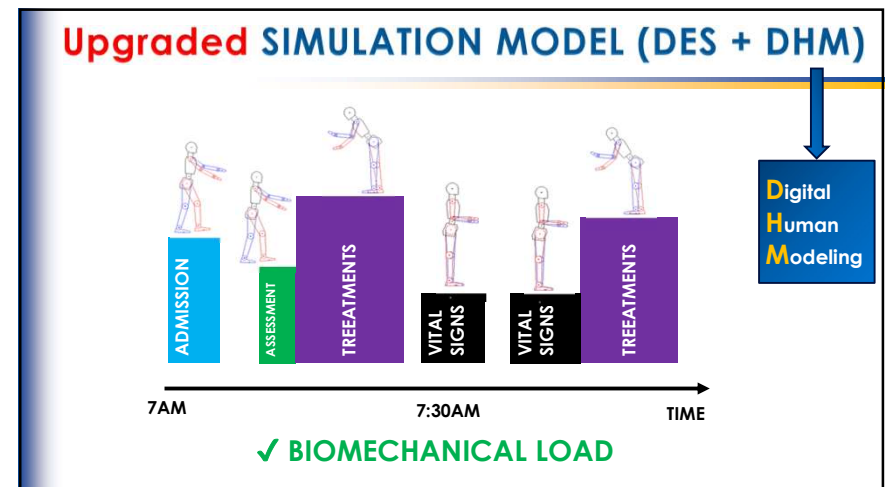
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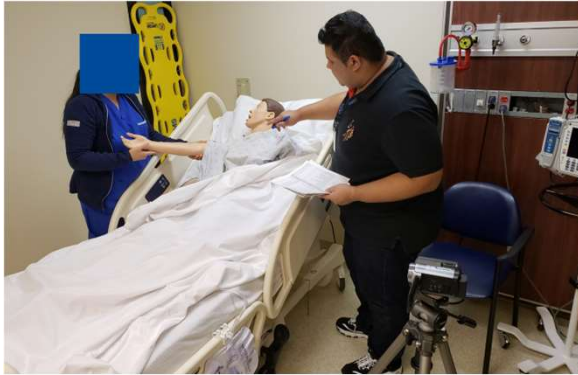


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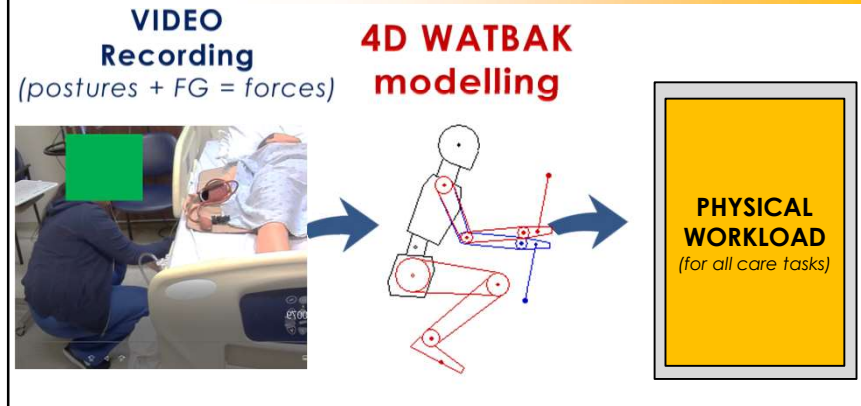
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METHODS: VIDEO RECORDING STUDY



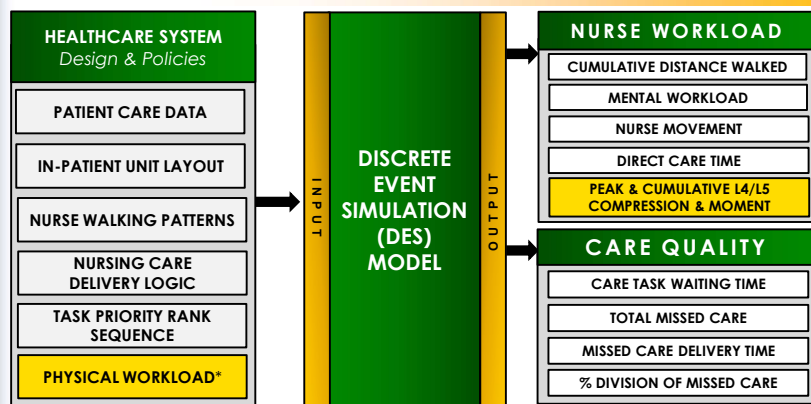
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METHODS: VIDEO RECORDING STUDY



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Integrating Biomechanics to DES



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Results: TIME TRACE – L4/L5 Moment



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Results: PEAK COMPRESSION FORCE

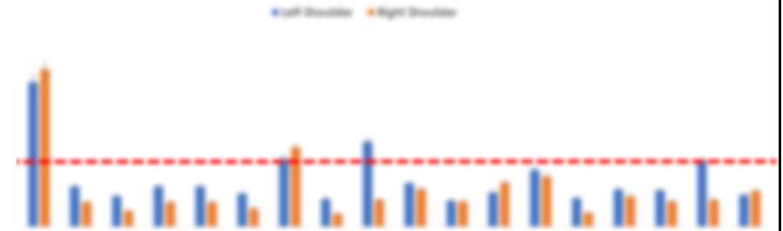
• Top 3 tasks

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Some actions aligns with the work of Holmes et al., (2010)

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SHOULDER MOMENT FOR CARE TASKS



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.... and then COVID-19 happened

Burnout
71% RPNs at breaking point

NEWER CHALLENGES IN HEALTHCARE

HCP Deaths & Suicides

Turnover
8.4% retire

Global Nurse Shortage
13M nurses needed!

Deteriorating Profession
7.2% leave nursing

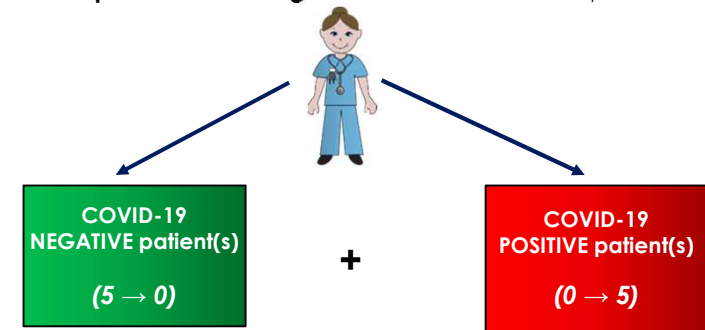
Sources: International Council of Nurses (2021);
WeRPN (2021); RNAO (2021)

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METHODS: MODELLING EXPERIMENT

• COVID-19 patient bed assignment

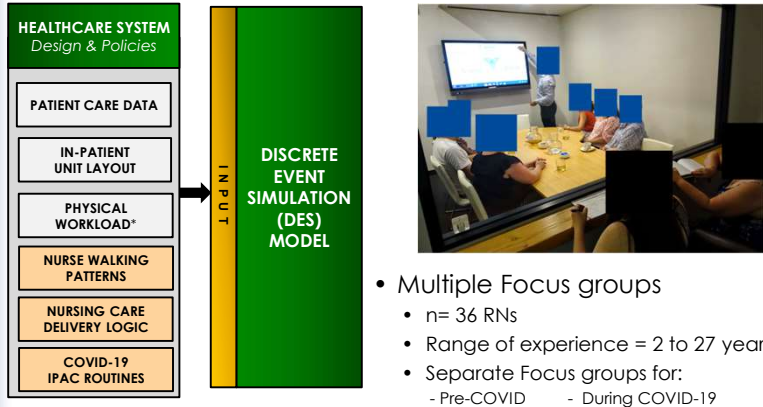
Nurse-patient ratio = 1:5



Example: 1 RN assigned to: 2 COVID- & 3 COVID+ patients

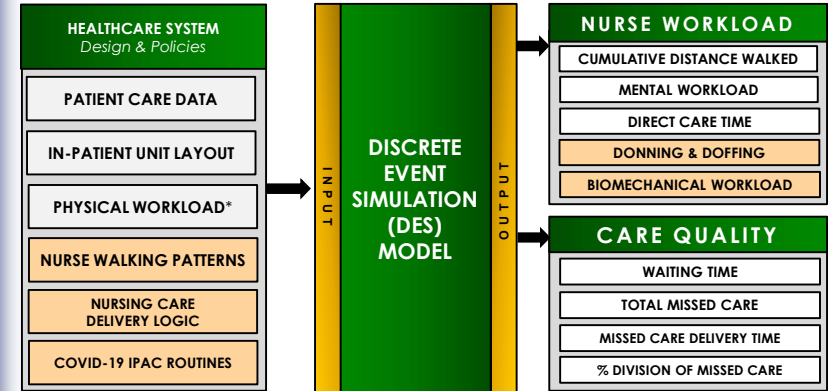
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“upgrading” the model to examine Pandemic impacts



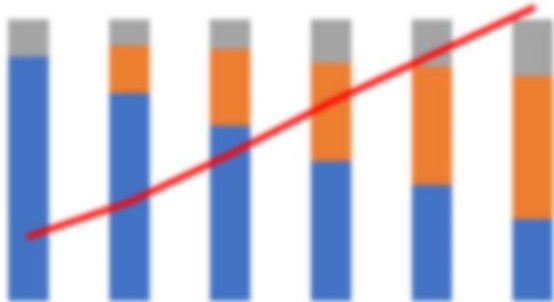
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“upgrading” the model to examine Pandemic impacts



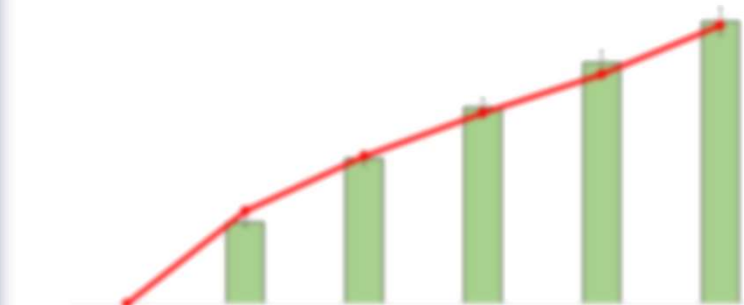
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Time Utilization – during COVID-19 (without breaks)



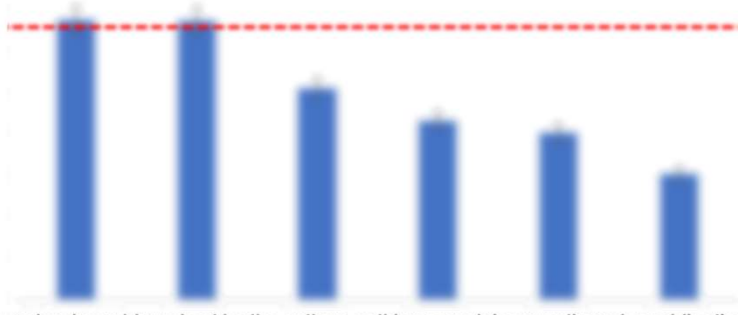
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“Nurses are spending ~6 hours donning & doffing”



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*"IPAC routines decrease **Lumbar load**"*



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Average Lumbar load for "Direct Care work" is HIGHER than IPAC routines



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*"IPAC routines decrease **Cumulative Shoulder Moment**"*



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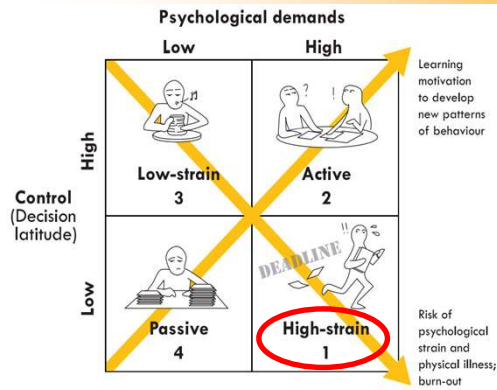
"An already overworked nurse has to do more work!"



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PSYCHOSOCIAL CONSIDERATIONS



Sources: Karasek's (1979) Job-Demand Control Model - Figure illustration by Berlin & Adams (2017)

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IMPLICATIONS (MSD Risk)

- Peak biomechanical load = ~ same
- Cumulative biomechanical load = Decreased
(due to IPAC routines)
- Psychosocial load = increased
- Nurses are spending up to ~6 hours donning and doffing
- Increased Mental Workload

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IMPLICATIONS (cont.)

- Understand drivers of workload and care quality in current systems
- Nurse workload determined by patient assignment
- Nurse workload -> Care Quality
- More COVID+ patient = More Missed Care and increased wait time
- Quantitative Decision-support tool to predict the impact of changes to HC system design
- Avoid 'magical' thinking (policy vs. practice gaps)
- HC leaders interested + Seeing the value of this work

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FUTURE MODEL USERS

- Policy makers
- Hospital managers
- Charge Nurses
- Architects
- Ergonomists
- Product Design / Engineers

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NEXT STEPS

- **New model capability (coming soon!)**
 - Adding fatigue tracking capability inter-shift and intra-shift
- **New contexts and settings:**
 - Test model in Emergency Departments (ED)
 - Continuing Complex Care
 - Economic analysis

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Graduate Student Opportunity

Human Factors in Healthcare Systems Modelling

Human Factors Engineering (HFE) Lab
Department of Mechanical and Industrial Engineering

Interested candidates, please email:
Dr. Patrick Neumann – Pneumann@Ryerson.ca

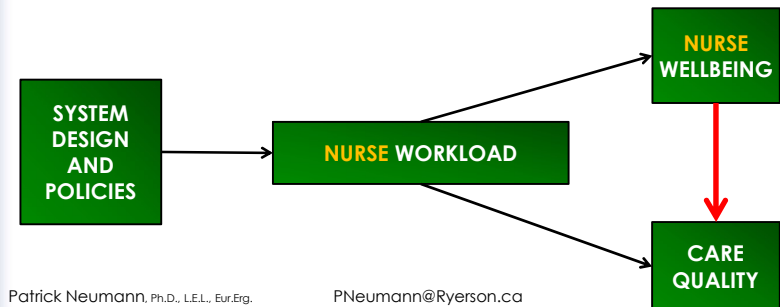
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Funding Partners



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Comments and Questions, please?



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Previous Publications

- Qureshi, S. M., Purdy, N., & Neumann, W. P. (2021). Developing a modelling approach to quantify quality of care and nurse workload — Field validation study. *Operations Research for Health Care*, 29, 100301. <https://doi.org/10.1016/j.orhc.2021.100301>
- Qureshi, S. M., Purdy, N., & Neumann, W. P. (2021). A Computerized Model Quantifying the Impact of Geographical Patient- Bed Assignment on Nurse Workload and Quality Care. *Nursing Economic\$, 39*(1), 23–35.
- Qureshi, S. M., Purdy, N., & Neumann, W. P. (2020). Development of a Methodology for Healthcare System Simulations to Quantify Nurse Workload and Quality of Care. *IIE Transactions on Occupational Ergonomics and Human Factors*, 8(1), 27–41. <https://doi.org/10.1080/24725838.2020.1736692>
- Qureshi, S. M., Purdy, N., Mohani, A., & Neumann, W. P. (2019). Predicting the effect of Nurse-Patient ratio on Nurse Workload and Care Quality using Discrete Event Simulation. *Journal of Nursing Management*, 27(5), 971–980. <https://doi.org/10.1111/jonm.12757>

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Forthcoming Publications

- Qureshi, S. M., Purdy, N., Greig, M. A., Kelly, H., & Neumann, W. P. (In review, 2022). Developing a Simulation Tool to Quantify Biomechanical Load and Quality of Care in Nursing. *Ergonomics*
- Qureshi, S. M., Purdy, N., Bookey-Bassett, S., Greig, M.A., Kelly, H., & Neumann, W. P., (In review, 2022) Modelling the Impacts of COVID-19 on Nurse Workload and Quality of Care Using Process Simulation. *PLOS One*
- Qureshi, S. M., Greig, M.A., Bookey-Bassett, S., Purdy, N., Kelly, H., vanDeursen, A. & Neumann, W. P., (Submitted). Modeling Nurse Workload during the COVID 19 Pandemic with Emphasis on Biomechanical Loading and Injury Risk.

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Thank you

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