# *2021 NCSBN Scientific Symposium* - Keeping Patients Safe: Examining Predictors of Nurses' Fatigue and the Moderating Effect of Inter-shift Recovery on Patient Safety Outcomes Video Transcript

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**Presenter**
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- [Woman] Dr. Farag is a tenured associate professor at UI College of Nursing. She completed her Ph.D. and postdoctoral fellowship at Case Western Reserve University. Dr. Farag's research goals focus on understanding reactive and proactive approaches to enhance patient safety with an emphasis on safe medication administration practices across the care continuum. To achieve her research goals, Dr.

Farag is currently collaborating with different interdisciplinary teams, and using machine learning and artificial intelligence to pursue novel approaches to studying measures to contain medication errors and enhance nurses' wellness.

- [Dr. Farag] Hello, everyone. Thank you so much for being with me today. Today I will be presenting a study that was funded by the National Council State Board of Nursing. The title of my study is "Keeping Patients Safe: Evaluating Predictors of Nurse Fatigue and the Moderating Effects of Inter-shift Recovery."

A little bit of a background. About 38% of working population in the United States suffer from occupational fatigue. Occupational fatigue is a multi-casual, multidimensional phenomenon that is intensified by excessive work demand and inadequate recovery.

In fields outside the healthcare industry, employers and researchers try to put a quantifying amount or dollar amount to fatigue. So what we have in the literature so far, that employers base up to $136 billion annually in health-related loss to productive time and $45 billion annually in loss to productivity.

Fatigued workers are subject to a lot of negative consequences such as musculoskeletal disorders, needlestick injuries, drowsy driving, accidents and near accidents, slow reaction time, altered cognitive function, and medication errors.

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Speaking of nurse fatigue, nurses are the largest professional group in healthcare setting. And this is not a new information for any of us. About 60% of nurses work in hospitals. According to some of the available national and international studies, 75% to 95% of nurses experience fatigue.

Fatigue is more prevalent among females than male nurses. And in a study that monitored nurses and evaluated them for drowsy driving, this study reported that nurses in the study had 92 episodes of drowsy driving and 5 accidents or near accidents when they were monitored for a two-week period.

Reviewing the literature reveals the following gaps. Whereas multiple studies were conducted to evaluate predictors of nurse fatigue, there are limited studies that proposed a comprehensive model to evaluate fatigue and fatigue predictors. There is also limited understanding of fatigue patterns within and between shifts or how the fatigue varies among nurses within the same shift or when they transition from one shift to the other.

And there is also limited understanding of the relationship between nurse fatigue, medication error, and near miss and the moderating effect of inter-shift recovery. Finally, fatigue recovery measures. We have some evidence about some of the available measures for recovery, but we do not have a full understanding of recovery measures used by nurses while at work and during their off shifts.

So guided by the System Engineering Initiative for Patient Safety, I conceptualized and operationalized my variables. And as you can see with the red titles, these is the variables that are used in my study. And this is the study model with all the variables that were measured.

And this is the proposed model that I will be testing. So, about the method of the study. This is a multi-phased mixed method design. I used a quantitative and qualitative approach as well as ecological momentary assessment. The setting, I recruited nurses working in eight hospitals across one Midwestern state.

For my sample, all nurses regardless of their age, experience, shifts, because most of the studies, and a lot of the studies focus on nurses working 12-hour shift or working specifically in night shift. But in my study, I invited all the nurses. My only exclusion criteria was for nurses who are in administrative position, agency and travel nurses, and nurses who do not provide direct patient care.

I distributed 2029 survey. I received 1137 survey back. For my measures, I used already developed and standardized measures. I, of course, developed my personal and demographic questions. For the work environment, I included or I used the Practice Environment Scale and the revised Nursing Work Index to measure variables of the work environment such as leadership support, nurse/physician relationship, and staffing and resource adequacy.

Sleep was measured by two scales, one is the Pittsburgh Sleep Quality and the other one was Epworth Daytime Sleepiness, and these are standardized and known measures used to evaluate sleep quality among nurses in prior studies. Similar to the previous studies, I used measures that has been used by prior researchers to evaluate fatigue.

In addition to the standardized survey measures, I used ecological momentary assessment to evaluate the pattern of fatigue. So in this method, each nurse received four text every day, work and nonwork day, to

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rate their fatigue in a scale from 0 to 10. In the workdays, they were also asked to indicate if they have a medication error or a near miss and this was just yes-no question.

My outcome variable of medication error and near miss, as I mentioned earlier, it was measured with the text messaging and also was measured as a single item question in the survey. So each nurse asked a question, if she had a medication error or near miss over the past months, and it was a dichotomous answer, yes, no.

And nurses who said yes, they were asked to indicate whether it was the beginning, the middle, or the end of the shift. For the study procedure, as I mentioned earlier, this is a multi-phased study. So the first phase included the study survey. So the study IRB approval, it took eight months because IRB reviewers were not happy about asking the nurses to rate their fatigue and if they have a medication error or near miss.

And the hospital leadership group considered this might be a liability issue for the hospitals. Anyway, after eight months of IRB review, I obtained the IRB approval. After obtaining the IRB approval, I attended all the nurses' staff meeting and I introduced the study.

After the introduction of the study, I distributed the study survey to the nurses' mailboxes. Along with the study survey, I included an invitation for the second and third phase of the study. To improve the response rate, I distributed weekly reminder flyers and a last call flyer for over a three-week period.

Each nurse received a $20 compensation upon receiving the completed survey. The second phase of the study, which is the text messaging or the ecological momentary assessment. Once I received the study survey back, I reviewed their individual invitation. Nurses who indicated their interest to be in the second phase of the study, I entered their cell phone number into a platform that was designed specifically for the study, then I called nurses to have their 14-day schedule, and then the 14-day schedule was entered into the texting platform.

To avoid the disturbance of the workflow, I timed the texting. So the first text was 15 minutes before the beginning of the shift and the second and the last text was 15 minutes at the end of the shift. So nurses had to reply to only two texts within the shift to rate their fatigue level.

To improve a response rate for the text messaging, because nurses were monitored for 14-day period, which is a long period of time, participant were compensated $90 for completing the text and they received a $10 bonus if they answered at least 75% of their text back.

And this approach was very successful. I only have 10 participant who didn't have a complete set of response. Initially, I had 1031 nurses indicated their interest to be in the second phase. However, 675 nurses were successfully enrolled, and as I mentioned, 10 of those didn't have a complete set of replies.

That's why they were not included in the study. The third phase of the study included the qualitative interview. Before I did my qualitative interview, I had to do the analysis of the quantitative survey. And guided by their scores, I divided the participants into four quadrants of high fatigue and had medication error or a near miss, high fatigue with no medication error and a near miss, and then low fatigue and had medication error or a near miss, and low fatigue with no error or a near miss.

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This is maximum variation method to maximize the understanding of fatigue recovery and if nurses who recover better, they have lower chances of making medication error, and to see if there are any variation in the fatigue recovery measures used across nurses in the four quadrants.

After I did these quadrants, I selected a random sample of nurses. I mailed…a total of 120 invitation were mailed to the nurses. Forty-two nurses replied back and were enrolled in the interview. Participants received a $40 compensation upon completing the qualitative interview.

About the study result, for the sake of time, I will go over the descriptives. I'm not going to address the results of the regression analysis. Some of the results, I will share with you later on in the conclusion. Regarding the age, so the mean age of my sample was 35 which is a young age cohort.

But when we look at the minimum and the maximum, you will notice that I have a wide range of participants. I range it between 20 to 72. Similar pattern was with the user experience and in the unit and with the nurse manager. I would like to direct your attention to the working hours.

Although the mean was 35, but nurses, in my sample, worked between 3 to 73 hours per week. The one-way commute time ranged between 5 minute to 120 minute, and this is one-way commute per day. For social support, nurses perceive that they have some social support to some extent.

Their mean score was 5.2 in a scale from 0 to 10. Regarding the other demographic variables, the majority of more than half of participant were married, has a PSN, work in critical care units, and 70% were full-time. And almost 60% of them had no children.

For nurses who had children, I had to categorize their age, and I categorized their age based on the age of the youngest child. So almost one-quarter of the participant had a toddler living with them. And the majority of participant didn't have a secondary appointment. So they didn't work a second job.

For the sleep, nurses had poor sleep quality and they had extensive daytime sleepiness. They suffered more acute fatigue than chronic, and mental fatigue than physical fatigue because a lot of nurses sometime complain, and some of the literature talk about how physically and mentally demanding is the nursing profession.

I thought it would be equal, but here in my study, it was evident that they are more mentally than physically fatigued. And there are other study reported similar finding. For the inter-shift recovery, in a scale from 0 to 100, my participants reported 48, almost 49, which they are in the middle.

They need to do a better job to recover. For the work environment, they were in the middle, so they evaluated leadership support, nurse/physician relationship, staffing and resource adequacy around the midpoint in a scale from 0 to 3. One of the study or of the strengths of this study was to evaluate pattern of nurse fatigue.

And for this type of analysis, I collaborated with an engineer in the industrial engineering department in the University of Iowa. And we used one of the machine learning approaches, which is a Hidden Markov Model or Hidden Markov Modeling.

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To have a small clarification about what this model mean, or what this approach mean, or the use of this approach, this is a specific or a special case of cluster analysis, but it takes into consideration longitudinal data. So instead of clustering individual based on a specific construct or a variable, it cluster participant based on pattern or change, in my case, based on change in their fatigue pattern.

The top level, as you can see here, has a smaller number of nurses and this is just accident. And the lower-three clusters has more participation. For the first top level, participant in Cluster 1, 2, and 3, they have close to a consistent state of fatigue.

So Cluster 1 were at a low level of fatigue, and they remained low throughout the observation period. The second level were in the middle fatigue level. And they remained in the middle throughout the study period. And the third cluster had a high fatigue, and they remained high throughout the study period. However, this should be interpreted with caution because of the small number.

The interesting three clusters, the ones that I am currently working on and doing some more analysis are Clusters 4, and 5, and 6, where there are some variation or the nurses fluctuate across three stages of fatigue, low, middle, and high levels of fatigue. To take a deeper dive into this pattern, and to make a small clarification, nurses in Cluster 4, they didn't reach a full recovery.

So they were in the middle fatigue level and remained in the middle or moved to the high fatigue level. So they had a 40% chances of moving from middle to a high fatigue, and they have 27% chances of recovery. After adding the scheduling, because the scheduling is one of the possible intervention to manage fatigue and faster inter-shift recovery.

So nurses in the middle level of fatigue, if they're going to work night shift the following day. They have 47%, almost 48% chances of building of fatigue and to move to a high fatigue level. Once they are at the high fatigue level, if they worked a second day, they need to work the second day off because if they're going to take an off the second day, they have 27% chances of recovery.

Following the same logic, I'm sharing some data for nurses in Cluster 5 and 6. And what I would like to highlight here, that fatigue builds over time. So nurses do not move from first stage to high stage instantly, and this is where we need to tailor intervention to prevent the buildup of fatigue.

So we would like to break the cycle to prevent nurses from moving the first stage to the second stage. Looking at the fatigue clusters in relation to medication error and near miss. Based on this result here, you can see that nurses in Cluster 3 and Cluster 4 had reported more medication error compared to the other, and had reported more near miss than the other clusters.

If you recall nurses in Cluster 3 are the nurses who are at the high fatigue level and remained high throughout the observation period. And nurses in the Cluster Number 4 who stayed in second stage and third stage, they didn't have a chance to recover or they didn't recover throughout the 14-day observation period. So in conclusion, and this is where I will present a little bit of information about my regression analysis.

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Sleep quality and daytime sleepiness, caffeine consumption before work, staffing and resource adequacy were among the strongest predictor of various types of fatigue. I was surprised to have the caffeine consumption before work.

I thought that during work will improve fatigue or decrease fatigue, but it turned to be that consuming it before work was more effective and significant predictor. Nurses are more mentally than physically fatigued and more acute than chronically fatigued. Surprisingly, day shift nurses were more fatigued than night shift nurses.

But night shift delayed the nurse recovery. So night shift, it is not totally helpful for nurses' recovery. Caregiving responsibility and secondary job or having a second appointment was not associated with fatigue. And then finally, based on my qualitative analysis, the prevailing work culture of nurses prevented them from taking the necessary break during their work.

So nurses shared with me that they know that they are tired, they are so fatigued, they're not able to keep their eyes open, but they didn't allow themselves to go to the breakroom to take a small break or even to think about taking a nap. This finding, I believe, it calls for the importance of teaching nurses, especially at the undergraduate level, the importance of well-being and how to take care of themself before taking care of their patients.

And that's it. Thank you, and I'm open for any questions. Thank you, everyone, for joining me today in my presentation, and I am more than happy to entertain all your questions.

A small update is since I finished the study, I submitted it now under review for... to the National Science Foundation, a grant proposal where I'll continue with my work with my industrial engineer collaborator, Dr. Yong Chen. And we are trying to develop a predictive model taking into consideration the shiftwork and the assignment of the nurses to predict their fatigue level.

So, we'll see how the NSF will evaluate the application. So I'm looking here at the chatbox to see any questions. So far, nothing. So I will hold on tight.

The other update other than the NSF foundation application, I'm still in the process of evaluating the clusters. So I will be meeting with the engineering team within like a month or so to start introducing all the different socio-demographic variables and some of the unit variable to see how this affect the pattern and the inter-shift recovery for nurses.

So it is work in progress. So I have a question. How did they report the home duties? I am surprised those were not an the issue and unless the job was overwhelming. So I didn't ask them about the home duties, I just asked them if they have an older adult or a parent at home that they care of.

And it was a yes-no question. And then I have the question about their children, and I categorized it by the age of the youngest child. But I didn't go in details about the home duties. Thank you so much for the question. It is a very valid one. So one interesting finding is, and it is in a manuscript that is currently in progress.

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Hopefully, it is so close to go out for review. Nurses who provide a caregiving responsibilities or assume caregiving responsibilities were not as more fatigued than the other nurses. Actually, in fact, they had a lower mental fatigue. So I was surprised by this finding.

So I sent it back, sitting with my statistician, revising our codes, and reverse coding, and everything. And so far, everything sounds good and perfect. And it is a surprise to me. Another question, to see the 12-hour versus the 8-hour shift. Yes, this is another thing that I am looking at.

With this machine learning approach, it is like so nice that it gives you a very deep and detailed understanding to what is going on there. So my next step is I'm going to split the 8 and the 12 and see. However, I may not be able to have a full understanding because I didn't have sufficient number of nurses who worked 8-hour shifts.

The majority were 12-hour shifts. And I have some work 10-hour shifts. I have the ICU as one of the units and as… They showed a little bit higher acuity in the fatigue, the ICUs and the general units, but it didn't reach the significance level.

And again, I will be introducing the ICU work into my pattern of fatigue to see if it will make any difference. So this is still ongoing, but in the general traditional analysis, the ICU didn't differ significantly from the other units.

And then, great presentation, what data-specific…? Okay, so I have one more question. So there is one question about the specific, about the sleep pattern and the sleep problems like insomnia.

No, the Pittsburgh and the Epworth will not help to identify insomnia, but it is in terms of the duration. It was evident that they have fewer hours of sleep and they have a high daytime sleepiness. So it is not necessarily insomnia per se. Fatigue level, of course, it can be related to job satisfaction but I didn't examine job satisfaction in this particular study.

The hospitals that I worked with, they do not have any nap policy because the question was about having nap policies. The hospitals I collected data from, they do not have any. Oh, the nursing culture, it is very interesting one.

And I address this in the qualitative manuscript that it is currently already published in the "Journal of Nursing Regulation." A small talk about the culture that nurses shared with me. They know that they are fatigued. They are not able to open their eye, but because of the workload or because they will feel guilty if they went to the breakroom, decided they do not want to go to the breakroom and ended up continuing working while they are fatigued.

Thank you so much. Please feel free to contact me and to reach at amany-farag@uiowa.edu if you have any further question. And thank you so much for being here with me in my presentation. I greatly appreciate all your questions and feedback.

Thank you, and have a wonderful day.

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