

## Effect of Nurses' Work Hours and Fatigue on Occurrence of Medication Errors in ICU and Medical Oncology Unit –Cairo University

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**Abstract:** Nurses are responsible for the safety of their patients. So, preventing error and maximizing quality of care for patients requires that those in health care be open to a variety of strategies for modifying work schedules and preventing fatigue that may require changes in long standing behaviors and preferences. **Aim:** To examine the effect of nurses' work hours and fatigue on occurrence of medication errors. **Subject and methods:** An exploratory, descriptive design was utilized to accomplish this study. The sample included all available nurses (n=29) were work in the two medical oncology units and (n=20) nurses work in ICU and conducted at the National Cancer Institute (NCI), Cairo- University. Tools for Data Collection were five included Socio demographic data, working hours data sheet, (CIS) chronic fatigue instrument, Need for recovery instrument and Medication errors observational sheet. **Results:** indicated that there was correlation between working hours and fatigue related to physical activity items in both units. There was correlation between medication errors and concentration fatigue subscale, motivation subscale at the ICU unit. Medication preparation errors and concentration fatigue subscale in the medical unit were also correlated. **Conclusion:** This study concluded that there was no statistical significant correlation between working hours and medication errors with both wings of errors preparation and administration. Also, the study concluded that correlation between medication preparation and administration errors and concentration fatigue subscale.

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### 1. Introduction

Healthcare providers are not expected to make errors, mistakes do occur, and some mistakes have resulted in serious injury or death. Each year, approximately 1.3 million patients are injured because of error during their hospitalization and more than 100000 deaths due to preventable adverse events occur. The effects of human error may be more significant for patients in critical care units (Scott *et al.* 2006). Nurses are responsible for the safety of their patients. Preventing error and maximizing quality of care for patients requires that nurses be open to a variety of strategies for modifying work schedules and preventing fatigue that may require changes in long standing behaviors and preferences (Bellebaum, 2008 and The Joint Commission, 2008).

Improving quality of medication administration process considered number-one of all nurses' priorities and the heart of health strategy to provide safe and error-free medication therapy. Medication errors are an important cause of patient morbidity and mortality, 44,000 to 98,000 patients die each year as a result of medication related problems (Mohamed and Gabr, 2010).

American Society of health – System Pharmacist (ASHP) has defined medication errors as “any preventable event that may cause or lead to inappropriate medication use or patient harm while the

medication is in the control of the health care professional, patient, or consumer”. (National coordinating council for medication error reporting and prevention, 2008). Medication administration is a complex multi-step process that encompasses prescribing, transcribing, dispensing, and administering drugs and monitoring patient response. An error can happen at any step. Administration errors account for 26% to 32% of total medication errors— and nurses administer most medications (Anderson and Townsend, 2010).

It has been reported that 78% of serious errors in the hospital are due to medications and among all serious errors, 11% are potentially life threatening (Wise, 2007). Intensive care unit (ICU) patients are at a high risk for medication errors due to the substantial quantity of medications administered, tenuous nature of the patient and complexity of the environment (Woodward, 2004). Medication administration errors in the ICU have been documented at rates ranging from 3.3 to 44.6% (Kazaoka *et al.* 2007 and Kelly, 2008). In ICU, patients experience 1.7 errors per day and nearly all suffer a potentially life threatening error at some point during their stay (Hussain and Kao, 2005).

Medication errors do occur and are a persistent problem associated with nursing practice. Reducing error rate affects overall institutional risk assessment, and this can decrease costs in institutional insurance

money (Straight, 2008). Clearly, medication errors are a significant and growing problem in health care. Enhanced understanding of some associated factors, such as the hospital unit and nursing shift, on which the error occurred, might assist nursing administrators to identify common patterns and improve nursing care, ensure patient safety, and contain hospital costs. Better organizational systems then could be designed and implemented to reduce potential medication errors (Moyen *et al.* 2008).

Also, Hodgkinson *et al.* (2007) and Kazaoka *et al.* (2007) identified contributing factors to medication errors as: personal, system and managerial problems. Others (Clancy, 2004 and Madegowda, 2007) revealed that these events may be related to professional practice, health care products, or procedures and systems, including prescribing, ordering, communication, product labeling, packaging, and nomenclature. Thirty-two percent of nurses attributed contextual factors to medication errors: short staffing, large numbers of assigned patients, frequency of change in patient assignments, distractions during preparation of medications, high acuity, and lack of knowledge of the patient (Bellebaum, 2008).

A study considered the effect of nurses' work hours on medication errors done by Scott *et al.* (2006) found that 38% of the nurses making at least one error during the two month study period. When nurses worked greater than 12.5 consecutive hours, the risk of that nurse making an error almost doubled compared to nurses who worked 8.5 consecutive hours or less. Another study done by (Rogers *et al.* 2004) used log books to gather error data from nurses in order to consider the effect of work hours on patient safety, nurses worked more than 40 hours per week, and 39% of the shifts were 12 hours or more in length. Fifty-eight percent of the errors captured through the log books were related to medication administration.

Ellis (2008) stated that shift work can result in fatigue, irritability, reduced performance, and decreased mental agility. Because human beings developed for a life style of wakefulness in daylight hours and sleep during hours of darkness, changing this pattern of wakefulness and activity creates the potential for increased fatigue and sleepiness. (Lockley *et al.* 2007) added that 300% more fatigue-related medical errors that led to patient death than those working shorter shift. Fatigue has deleterious effects on all types of performance and has negative effects on alertness, vigilance, concentration, judgment, mood, and performance. Fatigue is defined as "a condition characterized by a lessened capacity for work and reduced efficiency of accomplishment, usually accompanied by a feeling of weariness and tiredness." (Medicine, 2008).

Finally, this study is significant as it will observe nurses who work in both an ICU and medical oncology units. These two areas of nursing have the greatest proportion of nurses working long hours. Few studies have been published investigating the associations with nurses' work hours or fatigue and incidence of medication errors. The medication administration process is an everyday part of nursing practice and is so much more than a simple psychomotor task. Because nurses play a key role in the process of medication administration, namely administering the medication to the patient, so, it is important to examine correlates of medication errors (Maurer, 2010).

The framework for this research is based on the work of Donabedian, in which he categorized medical care in terms of structure, process, and outcome in order to determine indicators of quality (Aday *et al.* 2004). Medication administration errors can serve as quality indicators, but more importantly, they are a proxy measure for patient safety in an institutional setting.

STRUCTURE → PROCESS → OUTCOME

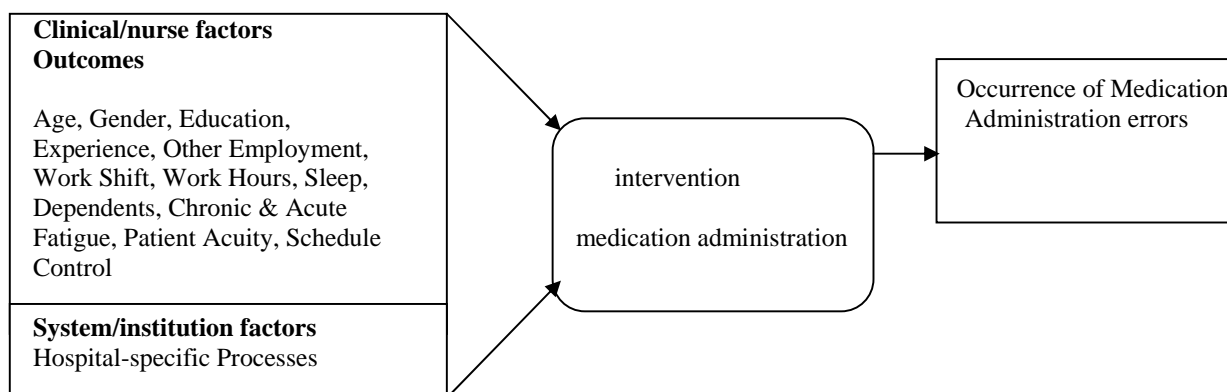


Figure 1.1: Conceptual framework for this study

## 2. Methodology

### The aim of the study:

This study aim to examine the effect of nurses' work hours and fatigue on occurrence of medication errors.

### Research design:

An exploratory, descriptive design was utilized to accomplish the study.

### Sample:

The sample included all available nurses (n=29) were assigned to work in the two medical oncology units and (n=20) nurses from intensive care unit who met the criteria of inclusion which were willing to participate in the study and responsible to give medication were recruited.

### Setting of the study

The study was conducted at the National Cancer Institute (NCI), Cairo- University, in the two medical oncology units and the intensive care unit.

### Tools for Data Collection:

#### Tool I: Socio demographic data:

It was contain information related to demographic characteristics of the studied nurses and it is consisted of 7 items.

#### Tool II: working hours data sheet:

It was used to gather information about the working hours of the nurses during the week and the schedule of work.

#### Tool III: Checklist individual strength (CIS) chronic fatigue instrument:

It contains 20 items, each item is scored on a seven-point scale. There were four subscales which were subjective experience of fatigue (8 items), concentration (5 items), motivation (4 items), and physical activity level (3 items). Cronbach's alpha for reliability of the entire instrument was 0.90 and subscale Cronbach's alphas were 0.88, 0.92, 0.83, and 0.87, respectively. Validity also was proved (Beurskens *et al.*, 2000).

#### Tool IV: Need for recovery instrument:

It was used to assess acute fatigue, it contains 11 items and is scored dichotomously as "yes" with (1) score or "no" with (0) score. Cronbach's alpha was 0.88 (Van Veldhoven and Broersen, 2003).

#### Tool V: Medication administration errors observational sheet:

It contains 40 items, it was used to gather information about the medication administration process. It was divided into 2 parts (a) medication preparation errors, that contains 23 items & medication administration errors which contains 17 items. Content validity was done by four panel of experts from medical surgical and administration staff members. Each item is scored as (1) for error occurred and (0) for no error.

### Methods of Data collection:

#### Ethical consideration

Human rights and ethical permission were obtained to conduct the study. An official permission was obtained from Cairo faculty of nursing dean and then the official permission was obtained from the National Cancer Institute (NCI), Cairo- University director. Nurses were fully informed of the study. The voluntary nature of participation was stressed as well as confidentiality. Consent was obtained from each nurse.

#### Pilot study

A pilot study was conducted on 3 nurses at medical oncology unit and 2 nurses in the intensive care unit, and these nurses were excluded from the study sample. The objectives of the pilot study were: (a) estimate the time necessary for nurses to fill out the entire questionnaire; (b) test the clarity of the questions (whether any question was unclear or ambiguous); (c) identify the most appropriate response categories for specific questions; and (d) Test whether there was any question that might frustrate nurses.

#### Data collection procedures:

Data were collected in two ways:

##### 1. Observation checklist :

During observation, the medication administration errors observational sheet was filled out. Each nurse was observed for 3 times during 3 different days. Nurses were observed during the routine medication administration at both units. The day of observation was divided into 2 observation periods at first during medication given at 10 o'clock second, during medication given at 2 pm o'clock. These periods were selected because the majority of medications ordered were taken during these periods. So that, adequate numbers of medications for observation were feasible at the 2 proposed time periods of observation.

##### 2. Interview questionnaires:

Each nurse was individually filling four questionnaires:

Demographic data sheet, working hours data sheet, checklist individual strength (CIS) Chronic Fatigue Instrument & need for recovery instrument to measure acute fatigue. The checklist individual strength (CIS) and the need for recovery instruments:

- It was collected by all the nurses while they are on duty, purpose of the study was explained prior to get the questionnaire sheet, and it distributed to be answered within (45- 60 minutes) then collected.
- The questionnaire was filling from 1-2 nurses per day started from November 2011 to January 2012, over a period of 3 months starting according to nurses' schedule for attendance to the hospital and availability of time for both nurses and their units.

**Limitation of the study:**

1. Night nurses shift were excluded from the sample because none of the observers can be available during night shifts.
2. Hawthorne effect, which is an improvement in a subject's performance when being observed may also affect the results.
3. Nurses did not had the same numbers of medication which my seem unfair among the nurses work.

**Data Analysis Plan:**

Descriptive statistics were used to summarize demographic characteristics of ICU and medical oncology nurses to give an overview results for the instruments. Data were revised, coded, analyzed and tabulated using the number and percentage distribution and carried out using SPSS version 16. The statistical tests used are chi square test. A value of  $p < 0.05$  was considered to be statistically significant.

**3. Results**

Table (1) shows that most of nurses had age less than 30 years and about (65% ) of them were females in both units. (80% & 69%) of nurses were technician with less than 5 years of experience in (70% & 65.5%) in ICU & medical oncology units respectively. Also, there was no statistical significant difference between ICU and medical oncology unit in relation to socio-demographic variables.

Table (2) illustrates that total means of working hours per week were (52 & 51.4 hours) at ICU and medical oncology units respectively. Also, all nurses suffer from chronic and acute fatigue with mean scores of (79.2, 76.5 & 6.2, 6.1) at ICU and medical oncology units respectively. In addition, there was statistical significant difference between ICU and medical oncology unit in relation to fatigue related to physical activities.

Table (3) says that there was no significant correlation between working hours, both medication preparation and administration errors in both units.

Table (4) shows that there was statistical correlation between working hours and fatigue related to physical activity items in both units. In addition there was correlation between concentration chronic fatigue subscale & working hours in ICU unit.

Table (5) reflects that there was correlation between medication errors and both concentration & motivation fatigue subscale in the ICU unit. Medication preparation errors and concentration fatigue subscale in the medical oncology units were also correlated.

Table (6) says that there was correlation between years of experience and medication preparation errors in medical oncology unit.

Table (7) shows that there was statistical significant difference between level of education and medication preparation errors in medical oncology unit.

**Table 1:** Socio-demographic variables among nurses in both ICU and medical oncology units

Items	ICU (n= 20)		Medical Oncology units (n=29)		p-value
	N	%	N	%	
Age					
20 – <30	15	75	24	82.8	NS
30 – 40	5	25	5	17.2	
X ± SD	26.5 ± 4.1		25.3 ± 3.5		
Gender					
Male	7	35	10	34.5	NS
Female	13	65	19	65.5	
Level of education					
Diploma	2	10	4	13.8	NS
Technician	16	80	20	69	
Bachelor	2	10	5	17.2	
Years of experience					
1 –	14	70	19	65.5	NS
5 –	3	15	6	20.7	
10 –	3	15	2	6.9	
15 – 20 years	0	0	2	6.9	
X ± SD	4.7 ± 3.2		4.8 ± 5.1		

NS: no significant difference

**Table (2):** Compare of means between ICU and medical oncology units nurses regarding working hours per week, fatigue & medication errors

Variables	ICU		Medical Oncology units		t-test	p-value
	X	SD	X	± SD		
Working hours	52	9.9	51.4	11.2	0.167	.869
CIS subscale (chronic fatigue)						
-Subjective fatigue feeling	32.9	6.8	31.3	7.1	0.833	.415
-Concentration	20.4	3.2	20.8	3.2	0.470	.644
-Motivation	14.4	3.2	12.8	4.7	1.35	.190
-Physical activity	12	1.8	10.4	3.3	2.120	.040
Total mean scores	79.2	12.4	76.5	12.8	.900	.384
Need for recovery (acute fatigue)	6.2	1.5	6.1	2.3	0.160	.874
Medication errors						
- Medication preparation errors	3.3	2.8	2	2.4	1.406	.176
- Medication administration errors	0.5	1.2	0.2	0.7	1.07	.297

**Table (3):** Relationship between working hours & medication errors among nurses in both ICU and medical oncology units

Medication errors	Working hours			
	ICU		Medical Oncology units	
	r-test	p-value	r-test	p-value
Medication preparation errors	-.233	.323	.175	.363
Medication administration errors	-.256	.275	-.070	.719

**Table (4):** Relationship between working hours and fatigue among nurses in both ICU and medical oncology units

Fatigue	Working hours			
	ICU		Medical oncology units	
	r-test	p-value	r-test	p-value
CIS subscale (chronic fatigue)				
-Subjective fatigue feeling	-.131	.583	.117	.545
-Concentration	.442	.051*	-.010	.958
-Motivation	-.351	.129	.029	.880
-Physical activity	.534	.015*	.471	.048*
Total mean scores	-.218	.434	.297	.282
Need for recovery (acute fatigue)	-.370	.109	.243	.205

**Table (5):** Relationship between medication errors and fatigue among nurses in both ICU and medical oncology units

Fatigue	Medication errors			
	ICU		Medical Oncology units	
	Preparation	Administration	Preparation	Administration
CIS subscale				
-Subjective fatigue feeling	.250	.283	-.200	.334
-Concentration	.656*	.662*	.601*	-.264
-Motivation	.274	.455*	-.158	-.009
-Physical activity	-.254	-.176	.140	.058
Total mean scores	.321	.386	-.412	.141
Need for recovery (acute fatigue)	.240	.193	.142	.334

**Table (6):** Correlation between years of experience and medication errors among nurses in both ICU and medical oncology units

Medication errors	Years of experiences			
	ICU		Medical Oncology units	
	r-test	p-value	r-test	p-value
Medication preparation errors	.058	.807	-.395*	.034
Medication administration errors	-.043	.856	-.206	.283

**Table (7):** Compare of means, ANOVA test, between levels of education and medication errors among nurses in both ICU and medical oncology units

Medication errors	Level of education			
	ICU		Medical Oncology units	
	F	p-value	F	p-value
Medication preparation errors	.926	.415	3.188*	.058
Medication administration errors	.078	.925	.377	.689

#### 4. Discussion

The aim of the current study was to examine the effect of nurses' work hours & fatigue on occurrence of medication errors. In this study, medication error means not only a deviation from the physicians' medication order as written on the patients' chart, but also, any variation from safe medication practice such as washing hands, wrong preparation of medication and wrong administration.

Regarding socio- demographic profile, the study concluded that the nurses' age in both units were in the middle adult hood, the majority of them were females and technician with years of experience less than five years. In addition there were no statistical significant difference in relation to socio-demographic characteristics between ICU and medical oncology nurses. These results were disagreed by (BHP, 2006 and Scott *et al.* 2006 ) created that 73.7% of nurses had an average age of 41 years, had worked in their current position for over eight years, and all of them were females.

In relation to working hours, most of the nurses had 12 hours working a day and all of them suffered from both acute and chronic fatigue. The result of the current study come into the same line with a study done by Landrigan *et al.* (2004) who reported that higher work hours per day and greater work hours per week generally lead to fatigue and more need for recovery from work.

In addition, ICU nurses perceived more fatigue regarding physical activity than medical oncology unit. The study done by Ruggiero (2003) consistent with the results of the current one whereas she found that ICU nurses are most likely suffer from fatigue, and she added that work hours, anxiety, depression and shift work are likely contributors to fatigue in critical care nurses.

As regards to medication errors the study concluded that about one third of the nurses had medication preparation errors, most of these errors

were: no hand washing and no wearing gloves. In addition, less than one fifth had administration error with most common error is not observing the patient after giving drugs. The result of the study was congruent with Bellebaum (2008) who concluded that thirteen percent of medication errors were administration without hand washing. Also, Mohamed & Gabr (2010) found that nurses work in surgical ICU not follow aseptic technique in preparing medication by making hand washing and nurses did not read medication label, also, they were depending on color and shape of medication packaging when preparing the medication and they did not follow the basic safety measures that require nurse to check the medication product for expiry date.

The study results also concluded that there was no statistical significant difference between ICU and medical oncology units in relation to medication preparation or administration errors. This result was contradicted with what was mentioned by Woodward (2004) who said that intensive care unit patients are high risk for medication errors than other patients. In addition, Bellebaum (2008) reported that a comparative study on medication error in ICUs and medical-surgical units at two hospitals was done and found that medication errors were more likely to be severe in the ICUs than the other wards.

Although the study reported that there was medication errors occurred, but it concluded that there was no statistical significant correlation between working hours and medication errors with both wings of errors preparation and administration. This result was incongruent with two studies done by Maurer (2010) who found that nurses who had worked over 12 hours had a greater mean number for medication errors compared with those who had not worked over 12 hours. The next one done by (Rogers *et al.* 2004 ; Dorrian *et al.* 2006 and Hewitt, 2010) said that the chance of making medication errors were three times higher when nurses worked 12 hours or more in a shift

than those who worked 8 hours or less. **Scott et al. (2006)** found that working more than 40 hours per week increased nurses' errors. While **Bellebaum (2008)** support the result of the current study and found that there was no statistical relationship existed between nurses' total work hours and occurrence of medication errors.

With reference to working hours & fatigue, the study revealed that when working hours increased, fatigue related to concentration and physical activity also increased. The result was contradicted with a study done by **Berger and Hobbs (2006)** which reported that there was no significant correlation between fatigue measured by CIS and the average work hours, however the study added that there was significant correlation between average working hours and need for recovery. However, **Jansen et al. (2003)** support the result of the current study, whereas she found that women who working six or fewer hours per day had significantly lower levels of need for recovery time in comparison with women who work eight hours per day.

As regards to medication errors and fatigue, the study concluded that correlation between medication preparation and administration errors and concentration fatigue subscale. A study done by **Bellebaum (2008)** come on the same vein with the current study and said that twenty – five percent of nurses responded that drug errors occur when they are tired and exhausted. **Shen et al. (2006)** and **Eills (2008)** added that fatigue has deleterious effects on all types of performance manifested in decreased alertness, vigilance, concentration, mood and judgment. However studies done by **Ayas et al. (2006)**; **Barger et al. (2006)**; **Gander et al. (2007)** and **Lockley et al. (2007)** concluded that there was no relationship found between nurses' level of fatigue and occurrence of medication errors.

Also, the study reflected a correlation between years of experience and medication preparation errors in medical oncology unit, indicating that medication preparation errors decrease when years of experience increase. **Maurer (2010)** concluded that nurses over the age of 35 years reported making fewer errors than those under age 35, though this result was not statistically significant, in addition, the researcher found fewer medication errors were reported by nurses who had been in nursing over one year or employed in the same hospital for more than one year. Nursing experience may have an important influence on patient safety. Experienced nurses are more likely to intercept errors compared with less experienced nurses. Physician inexperience and new staff are particular risk factor for medication errors (**Straight, 2008**). However, study done by (**Biron, 2009**) contradicting the current research finding and concluded that the odds of a medication administration errors were

significantly higher among nurses with more than five years of professional experience compared to nurses with less than five years of professional experience.

Finally, the study result found a statistical significant difference between level of education and medication preparation errors in medical oncology units. This result disagreed by (**Hewitt, 2010**) reported that there was no statistics regarding nurses' level of education, specific practice setting were mentioned. However, **Maurer (2010)** found that 61% (n = 208) of nurses had a masters or doctoral degree identifying themselves as advanced nurse practitioners. The majority of these advanced practice nurses would not currently be working as staff nurses in the hospital setting. The respondents' level of education was not analyzed in relation to the number of medication errors. **Joanna Briggs Institute (2006)** recommended that education and training of nurses could improve nurse competence to prevent errors beyond the skills they had already accrued.

#### Conclusions:

The study done on (49) nurses in the ICU and medical oncology units at National Cancer Institute, Cairo university to examine the effect of nurses' work hours and fatigue on occurrence medication errors concluded that there was statistical significant difference between ICU and medical oncology units in relation to fatigue related to physical activities, moreover, there was no significant correlation between working hours both medication preparation and administration errors in both units. There was statistical correlation between working hours and fatigue related to physical activity items in both units. Finally, there was correlation between medication errors and concentration fatigue subscale, motivation subscale at the ICU unit. Medication preparation errors and concentration fatigue subscale in the medical unit were also correlated.

#### Recommendation

- Preventing errors and maximizing quality of care for patients requires that those in health care be open to a variety of strategies for modifying work schedules and preventing fatigue that may require changes in long standing behaviors and preferences.
- Nurses must be encouraged to use standard protocols in drug preparation and administration.
- Continues in serves education and training specially for new nurses regarding medication administration was recommended.
- Further researches are needed to study the other correlates of medication errors  
Further researches are needed to conduct in other departments in all nurses' shifts.

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**References**

1. **Aday, L. A., Begley, C. E., Lairson, D. R., & Balkrishnan, R. (2004):** Evaluating the healthcare system: Effectiveness, efficiency, and equity (3rd ed.). Chicago: Health Administration Press.
2. **Anderson P. and Townsend T. (2010):** Medication errors: Don't let them happen to you. Mistakes can occur in any setting, at any step of the drug administration continuum. Here's how to prevent them. March American Nurse Today. 5, (3):23-28. ([www.AmericanNurseToday.com](http://www.AmericanNurseToday.com)).
3. **Ayas, N. T., Barger, L. K., Cade, B. E., Hashimoto, D. M., Rosner, B., Cronin, J. W., Speizer, F. E., Czeisler, C.A. (2006):** Extended work duration and the risk of self-reported percutaneous injuries in Interns. JAMA. 296:1055-1062. <http://jama.amaassn.org/cgi/content/abstract/296/9/1055>.
4. **Barger, L.K., Ayas, N.T., Cade, B.E., Cronin, J. W., Rosner, B., Speizer, F. E., & Czeisler, C. A. (2006):** Impact of extended-duration shifts on medical errors, adverse events, and attentional failures. PLoS Med. 3(12): 2440-2448.
5. **Bellebaum, K. L., (2008):** The Relationship Between Nurses' Work Hours, Fatigue, and Occurrence of Medication Administration Errors. the Degree Doctor of Philosophy in the Graduate School of The Ohio State University .
6. **Berger, A. M., & Hobbs, B. B. (2006):** Impact of shift work on the health and safety of nurses and patients. *Clinical Journal of Oncology Nursing*, 10(4): 465-471.
7. **Beurskens, Anna J H M., Bultmann, U., Kant, I., Vercoulen, Jan H M M., Bleijenberg, G., & Swaen, G. M. H. (2000):** Fatigue among working people: Validity of a questionnaire measure. *Occupational and Environmental Medicine*, 57(5): 353-357.
8. **Biron A., (2009):** Medication Administration Complexity, Work Interruptions, and Nurses' Workload as predictors of Medication Administration Errors. School of Nursing, Faculty of Medicine McGill University Montreal, Quebec, Canada June.
9. **Bureau of Health Professions. (2006):** The Registered Nurse Population: Findings from the 2004 National Sample Survey of Registered Nurses. Dept. of Health and Human Services. Retrieved March 23, 2008 from <ftp://ftp.hrsa.gov/bhpr/workforce/0306rnss.pdf>.
10. **Clancy. T.R. (2004):** Medication Error Prevention Progress of Initiatives, JONA'S Healthcare Law, Ethics, and Regulation. 6( 1): 3-12.
11. **Dorrian, J., Lamond, N., van den Heuvel, C., Pincombe, J., Rogers, A., & Dawson, D. (2006):** A pilot study of the safety implications of Australian nurses' sleep and work hours. *Chronobiology International: The Journal of Biological*, 23(6): 1149-1163.
12. **Ellis R. J., (2008):** Quality of Care, Nurses' Work Schedules, and Fatigue. White Paper Washington State Nurses Association, 1-21.
13. **Gander, P., Purnell, H., Garden, A., & Woodward, A. (2007):** Work patterns and fatigue-related risk among junior doctors. *Occupational & Environmental Medicine*. 64 (11): 733-738.
14. **Hewitt P., (2010):** Nurses' Perceptions of the Causes of Medication Errors: An Integrative Literature Review *MEDSURG Nursing*, 19(5,6):3.
15. **Hodgkinson. B. Koch. S. and Nay. R. (2007):** Strategies to reduce medication errors with reference to older adults. *International Journal of Evidence-Based Healthcare*. 4,1: 2-41.
16. **Hussain E., and Kao E., (2005):** Medication safety and transfusion errors in the ICU and beyond. *Crit Care Clin.*, 21:91-110.
17. **Jansen, N., Kant, I., van Amelsvoort, L., Nijhuis, F., & van den Brandt, P. (2003):** Need for recovery from work: Evaluating short-term effects of working hours, patterns and schedules. *Ergonomics*, 46(7): 664-680.
18. **Joanna Briggs Institute (2006):** Strategies to reduce medication errors with reference to older adults. *Nursing Standard*. 20(41): 53-57.
19. **Kazaoka T., Ohtsuka K., Ueno K. and Mori. M. (2007):** Why nurses make medication errors: A simulation study. *Nurse Education Today*. 27: 312-317.
20. **Kelly P. (2008):** Nursing leadership and management, 2nd ed., Thomson, United State, pp 437-447.
21. **Landrigan, C. P., Rothschild, J. M., Cronin, J. W., Kaushal, R., Burdick, E., Katz, J. T., et al. (2004):** Effect of reducing interns' work hours on serious medical errors in intensive care units. *The New England Journal of Medicine*, 351(18): 1838-1848.
22. **Lockley, S.W., Barger, L.K., Ayas, N.T., Rothschild, J.M., Czeisler, C.A., and Landrigan, C.P., (2007):** Effects of health care provider work hours and sleep deprivation on safety and performance. *Joint Commission Journal of Quality & Patient Safety*. 33,(11 Supp 1):7-18.
23. **Madegowda B. Hill. P.D. and Anderson. M.A. (2007):** Medication Errors in a Rural Hospital. *MEDSURG Nursing*, 16( 3):175- 180.



24. **Maurer M.J., ( 2010):** Nurses' Perceptions of and Experiences with Medication Errors. Doctor of Philosophy in Health Education. The University of Toledo
25. **Medicine.net. (n.d.) (2008):** Definition of fatigue. Retrieved March 22, from <http://www.medterms.com/script/main/art.asp?articlekey=9879>.
26. **Mohamed N., and Gabr H., (2010):** Quality improvement techniques to control medication errors in surgical intensive care units at emergency hospital. *Journal of Medicine and Biomedical Sciences*,(5): 24 -35.
27. **Moyen. E. , Camiré. E. and H. Stelfox. (2008):** Review Clinical review: Medication errors in critical care. *Critical Care*. 12(2)1-7:208.
28. **National coordinating council for medication error reporting and prevention. (2008):** Retrieved 8/7, 2008, from <http://www.nccmerp.org/aboutMedErrors.html>
29. **Rogers, A. E., Hwang, W. T., Scott, L. D., Aiken, L. H., & Dinges, D. F. (2004):** The working hours of hospital staff nurses and patient safety. *Health Affairs. (Millwood)*, 23(4), 202-212.
30. **Ruggiero J. S. (2003):** Correlates of fatigue in critical care nurses. *Research in Nursing & Health* 26, (6): 434-444.
31. **Scott, L. D., Rogers, A. E., Hwang, W., & Zhang, Y. (2006):** Effects of critical care nurses' work hours on vigilance and patients' safety. *American Journal of Critical Care*, 15(1): 30-37.
32. **Shen, J., Botly, L.C.P., Chung, S.A., Gibbs, A. L., Sabanadzovic, S., & Shapiro, C.M. (2006):** Fatigue and shift work. *Journal of Sleep Research*. 15(1): 1-5.
33. **The Joint Commission (2008):** Potential national patient safety goals. Retrieved April 4, 2007, from [http://www.jointcommission.org/NR/rdonlyres/24E03413-852F-4546-A944-667DADC9AAF6/0/08\\_potential\\_DSC\\_NPSG.pdf](http://www.jointcommission.org/NR/rdonlyres/24E03413-852F-4546-A944-667DADC9AAF6/0/08_potential_DSC_NPSG.pdf)
34. **Van Veldhoven, M., & Broersen, S. (2003):** Measurement quality and validity of the "need for recovery scale". *Occupational and Environmental Medicine*, 60: i3-i9 doi:10.1136/oem.60.suppl\_1.i3
35. **Wise Y. (2007):** Leading and managing in nursing. 4th ed., Mosby Compy. Texas, , pp 389-399.
36. **Woodward S., (2004):** Achieving a safer health service. Part 2: Reporting requirements, *Professional Nurse*.19 (6):328-332.

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