Day Shift Nurses vs. Night Shift Nurses: Sleep Deprivation and Circadian Rhythm Affecting Night Shift Nurses to Commit More Medication Errors

By

Kayce E. Moore

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Abstract

Hospitalized patients receive multiple medications both during the day and the night. Since nurses administer many medications throughout their workday, there is a possibility that a medication error could occur. These medication errors cost hospitals billions of dollars. (Flynn, Liang, Dickson, Minge & Dong-Churi, 2012). Moreover, medication errors have been shown to lead to the death of multiple patients per year (Flynn et al., 2012). This quantitative descriptive study examined if night shift nurses commit more errors than day shift nurses. The hypothesis of this study is that night shift nurses commit more medication errors because of sleep deprivation, fatigue, or their circadian rhythm. The statistical analysis that was used in this study is a two-sample t-test. After the analysis was completed, it was shown that there was no significance when comparing day shift versus night shift, nor the sleep cycle versus the wake cycle.

Key words: Medication Error, Sleep Deprivation, Circadian Rhythm, Shift Work

Introduction

Medication errors have been established as one of the most common medical errors in the health care field (Muñoz et al., 2010). The Institute of Medicine reported that in 2006 there were 1.5 million medication errors that occurred in the United States (Partin, 2006). Not only can medication errors cause harm to patients who are seeking care, but these errors also have the potential of costing the United States more than $2 billion a year (Flynn et al., 2012). According to Flynn et al. (2012), it is the nurse's responsibility to intercept these medication errors, and prevent the misuse of the medication. Nurses who are sleep deprived, such as night nurses, have shown an increase in the incidence of medical errors (Caruso & Hitchcock, 2010). The issue of medication errors is complicated even further by factoring in each human's circadian rhythm which affects the wake and sleep cycle throughout the twenty-four hours of the day (Phyllis & Brandon, 2008). Night nurses work through the night, and could be affected by the sleep cycle of the circadian rhythm, as well as other employees who work while the rest of the world sleeps (Dees, 2012). Medication errors are harmful to patients, and nurses could be held responsible by administering the medication while affected by fatigue due to sleep deprivation, or their circadian rhythm (Moyen, Camiré & Stelfox, 2008).

Nurses Role in Preventing Medication Errors

Nurses play the primary role of intercepting and preventing medication errors (Flynn et al., 2012). The National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) defines a medication error as any preventable event that could possibly lead to patient harm or the medication being used inappropriately (NCCMERP, 2005). In order to prevent these medication errors, nurses are taught the five rights of giving medications. These

five rights include ensuring that the medication is given at the right time, to the right patient, at the right dose, by the right route, and it is the right medication (Perry & Potter, 2010).

The nurse's role in preventing medication errors learned in school is also carried out in practice (Choo, Hutchinson & Bucknall, 2010). There are multiple ways to avoid medication errors, and nurses have reportedly stated that critical thinking is the one skill that is used the most when giving medications (Eisenhauer, Hurley & Dolan, 2007). Learning how to intercept medication errors begins in nursing school. For example, at Thomas Jefferson University the instructors include in their curriculum the critical thinking skills that are involved in preventing medication errors and an emphasis on their importance (Papastrat & Wallace, 2003). Beginning with the first semester, students are taught about situations in which medication errors often happen, and they brainstorm and learn ways to prevent them (Papastrat & Wallace, 2003).

Other ways to prevent medication errors are being studied. One particular method is the bar code method. This method helps to ensure patient safety when nurses are administering medications to the patient (Fowler, Sohler & Zarillo, 2009). The bar codes located on the patient's bracelet and on the medication contain information. When the nurse is administering the medication they scan the patient's hospital bracelet in order to confirm that it is the right patient. After receiving patient confirmation, the nurse scans the bar code located on the medication. If the medication does not belong to the patient, then the nurse will be notified, and she will double-check the patient information and the medication for verification. This technology helps the nurse to ensure that the five rights of administering a medication are completed properly (Fowler et al., 2009).

Consequences of Medication Errors

Medical errors, including medication errors, have been reported to be the seventh leading cause of death in the world (Moyen et al., 2008). Medication errors are responsible for patient morbidity and mortality, the two most severe consequences of a medication error. 44,000 to 98,000 patients die a year due to medical errors, with a large number of those errors being medication errors. These deaths are the most important consequences and should not be ignored. When thinking of medication errors, patient morbidity is what comes to mind (Moyen et al., 2008).

In critically ill patients there is a higher prevalence of medication errors. The critically ill patient is receiving twice as many medications as other patients, and there is potential for a large amount of harm when the wrong medication is given. If the medication errors causes the patient harm, then the nurse will notice the medication error, and he or she will be able to report it (Moyen et al., 2008).

Medication errors are not only costly to the hospital, but also to the patients. On average, a patient is exposed to one medication error a day (Flynn et al., 2012). It is very possible that a patient could suffer due to the negligent act of a medication error. This harm can even be a result of medication omission. Nurses who commit medication errors have the possibility of facing criminal charges. Specifically, a registered nurse was found guilty on two charges of criminal negligence by administering 300 mg of MS Contin to the wrong patient, and not doing anything to counteract the medication that was causing the patient harm (Starr, 2011). Not only does this cause the patient to pay more in medical bills, but the hospital now has to pay for legal representation of their employee. This is how these medication errors can end up costing hospitals more than $2 billion a year (Flynn et al., 2012).

Lastly, there is a psychological consequence. Nurses begin practicing nursing in order to take care of patients. When a nurse commits a medication error it can affect their confidence in being a nurse (Moyen et al., 2008). Not only does it decrease the nurse's confidence in herself, but it can also decrease the patient's confidence in patient care, and the public's confidence in the hospital. A medication error with a bad outcome can haunt the nurse for the rest of her career (Moyen et al., 2008).

Medication Errors Related to Sleep Deprivation

Since medical care must be provided around the clock, some nurses must work the night shift. When working the night shift, there is an increased possibility that nurses are deprived of sleep. According to Johnson, Brown, and Weaver, (2010) sleep deprivation greatly affects the night shift nurse's psychomotor skills. As a result, there is more of a chance for error during patient care. Sleep deprivation has even been compared to working while under the influence of alcohol (Johnson, Brown & Weaver, 2010).

Registered nurses (RN) who are sleep deprived are not the only healthcare providers to commit medical errors. For example, medical student residents have been studied during their 72 and 96 hour shifts. It has been cited that these long work hours are not beneficial to the residents and can cause more complications with the patients due to the residents' lack of sleep (MacDonald, Hébert, Flegel & Stanbrook, 2011). The responsibilities of health care professionals do not come to an end once the sun sets, but the health care providers need rest in order to give appropriate patient care (MacDonald et al., 2011).

Circadian Rhythm Affecting Shift Workers

The effect of the circadian rhythm is a topic of recent research (Dees, 2012). Circadian rhythm is also referred to as the body's biological clock. It is found in mammals to occur over a

slightly longer than twenty-four hour period. The circadian rhythm is controlled by the suprachiasmatic nucleus (SCN) of the hypothalamus located in the brain (Phyllis & Brandon, 2008). Being exposed to light also affects this sleep-wake cycle being described. In the hospital, nurses who are working shift work are exposed to artificial light. This light can delay the circadian rhythm. When it is dark, the body has a sleeping tendency (Phyllis & Brandon, 2008).

There are different times during the day that the body endures the sleep cycle. The first time the body has a sleeping tendency is from 1:00 p.m. to 4:00 p.m. (Your guide to, 2011). Then the body undergoes a surge of energy and remains in the wake cycle until the mid- and late evening hours (Phyllis & Brandon, 2008). Lastly, the body then becomes sleepy once again from midnight to 7:00 a.m. (Your guide to, 2011).

There is a documented sleeping disorder, accredited with research studies, known as shift work disorder (SWD) (Dees, 2012). It occurs in the employees who are working while most of the population sleeps. This disorder not only affects how the nurse treats the patient, but it also affects the health of the nurse. SWD can lead to multiple comorbidities including depression, breast cancer, impaired memory, and myocardial infarction (Dees, 2012). This disorder can also be found in people who have to fly multiple times in their life, and is associated with jet lag (Phyllis & Brandon, 2008).

The U.S. Department of Health and Human Services in collaboration with National Institutes of Health and the National Heart Lung and Blood Institute (2011) has created a catalog that informs the public on how to promote healthy sleep. In this catalog the authors state that "night shift workers often find themselves drowsy at work, and they have difficulty falling or staying asleep during the daylight hours" (Your guide to, 2011, 8). As previously stated, light plays a large role in affecting the circadian rhythm; therefore, a person is more awake during the

daylight hours and sleepy during the early morning hours. This particular characteristic of the circadian rhythm makes a person's best working hours to be during the daylight hours (Your guide to, 2011).

Previous Studies

The first step in researching medication errors, is finding out the nurses role in the process (Choo, Hutchinson & Bucknall, 2010). According to Flynn et al., (2012) the nurse plays a large role in intercepting medication errors. There are multiple causes that affect the nurse from intercepting the medication errors. The majority of medication errors occur when nurses are careless or working in an environment that is not comfortable for them (Flynn et al., 2012). However, nurses who are sleep deprived have psychomotor skills that are greatly affected compared to nurses who are not sleep deprived. These decreased psychomotor skills can lead to medication errors that aren't related to the nurse's working environment (Johnson et al., 2010). The more medication errors that are intercepted by the nurses, the higher patient safety is for that hospital. Furthermore, a supportive environment is needed for the nurses to intercept more medication errors. A supportive environment includes many characteristics. These characteristics are things such as good communication, the nurses having input on the way tasks are performed, teamwork, adequate staffing levels, education and training, and a supervisor who is competent. Hospitals and other practices that have the previously stated characteristics have a better chance at having less medication errors (Flynn et al., 2012). Also, night shift nurses who receive enough sleep during the day will have a better chance of having good psychomotor skills and will be able to intercept the medication errors (Johnson et al., 2010).

Mrayyan (2012) argues that the most common medication error was a wrong-programmed rate for total parenteral nutrition (TPN) in the Intensive Care Unit. She stated that in

this case the error was reported and an incidence report was filled out. The most popular reason to not report medication errors was because the nurses were scared of the repercussions. This is a problem because if the medication errors are not reported then the patient could suffer without treatment (Mrayyan, 2012). This also causes a problem for further research. If the nurse is not reporting the medication error, then the researcher is not able to receive an accurate number of medication errors that have occurred (Mrayyan, 2012).

Wehrens, Hampton, & Skeene (2012) proved that sleep deprivation not only affects psychomotor skills and judgment, but it also increases the risk for cardiovascular disease, as does working the night shift due to the circadian rhythm (Johnson et al., 2010; Dees, 2012). These three studies give credit to the accusations that not only is sleep deprivation and working at night potentially harmful to the patient, but it also can harm the nurse. Working under these conditions are not desired, and the human body does not always adapt to the conditions well (Wehrens et al., 2012).

Jasper, HÄußler, Marquardt, and HermsdÖrfer (2009) studied how circadian rhythm affects the handwriting of healthy males, in order to determine how it affects the fine motor skills. These subjects had to undergo 40 hours of sleep deprivation and write every three hours. They state that at the onset of melatonin, which is controlled by the SCN, which controls the circadian rhythm, the handwriting began to slow down. The handwriting was at its slowest during the early hours of the morning, specifically at 3:30 A.M. They argue that a circadian rhythm does exist and it does affect the fine motor skills that are involved in handwriting (Jasper et al., 2009). This study reiterates what was stated previously, about the specific times the human body experiences the sleep cycle (Your guide to, 2011). According to the research, predictably,

the nurse should have more medication errors around 4:00 a.m. when your body is being influenced by the sleep cycle of the circadian rhythm (Jasper et al., 2009; Your guide to, 2011).

Soni et al. (2008) studied the affects of circadian rhythm in permanent night shift workers. These night shift workers worked eight-hour shifts at a local newspaper printing office. They compared these permanent night shift workers to the day shift workers. After working nights for six days, the permanent night shift workers received one day of rest. This day of rest was studied to find a difference in the circadian rhythm rest cycle. They argue that there is a difference between the night shift workers and the day shift workers. They also argue that working the night shift has the potential to be dangerous to the worker (Soni et al., 2008). Once again the multiple authors agree that working during the night shift is harmful on the human body, which can lead to night shift workers to make more mistakes during their shift (Soni et al., 2008; Johnson et al., 2010; Wehrens et al., 2012; Dees, 2012).

There are no previous studies that directly related sleep deprivation and the affects of the circadian rhythm with medication errors.

Ways to Prevent the Affects from Sleep Deprivation and Circadian Rhythm

Sleep deprivation while working has become such a problem in the health care setting that more research is being conducted to explore this issue. Allowing for naps during work is one strategy that has been implemented to prevent sleep deprivation. Nurses have claimed that napping during work decreases their fatigue and increases their alertness. Nevertheless, a nap is not always accessible when considering the work environment, and the time management that is needed to be able to do so (Fallis, McMillan & Edwards, 2011).

Recently administrators found nurses sleeping on the job in the Neonatal Intensive Care Unit (NICU). These nurses were fired immediately. However, Clavreul (2004) believes that

taking short naps on the job, also referred to as power naps, can help increase the attentiveness of the employees. She claims that studies show that a short nap can be more useful than an energy aid such as coffee or energy drinks. A nap helps the nurse become more focused, and enhances learning. Sleep deprivation is not only dangerous (Johnson et al., 2010), but it can also cost the hospital up to $18 billion a year due to slowed productivity, which is why these short power naps are needed (Clavreul, 2004).

As stated before sleep deprivation and the circadian rhythm can increase harm for the human body. There are many risks that are associated with shift workers (Dees, 2012; Johnson et al., 2010; Wehrens et al., 2012). These risks can include premature labor, low birth weight babies, loss or change in appetite, increased gastric motility, ulcer and bowel disease, and cardiovascular problems. In order to attempt to prevent these risks the nurse needs to consider his or her sleep environment and habits. The goal of the nurse is to fall asleep within ten minutes of going to bed, and to stay asleep for the full eight hours of being in bed. A change in the sleep environment could be to reduce all noise, and to make the room as dark as possible (Blachowicz & Letizia, 2006). As stated before light keeps the body attentive, and when it is dark it helps the body to relax and fall asleep (Phyllis & Brandon, 2008). Other sleeping habits that could be used include having a regular sleeping schedule. This is difficult for night shift nurses, but whenever it is possible to have a consistent sleeping schedule, it is best. (Blachowicz & Letizia, 2006).

Methodology

This quantitative descriptive study examined data from Freeman Health System, a hospital in a Midwestern Community in order to prove that the study's hypothesis, night shift nurses commit more medication errors because of sleep deprivation, fatigue, or their circadian rhythm, is correct. Nominal data was collected from documents called Customer Safety Reports

(CSR). An RN fills out these reports when he or she makes a medication error. Once the form is completed it is submitted to the Freeman Health System risk management department. After IRB approval was obtained from both Freeman Health System and Missouri Southern State University, the Paula Finskey, RN was contacted to obtain permission to review the CSR reports. The reports were reviewed on site at Freeman Health System in the risk management office in order to keep the documents confidential. The reports were analyzed to examine if more medication errors occurred during the night shift compared to the day shift. CSR's covering a five-month period were examined, from January 1, 2012 to May 31, 2012. This five-month span gave a wide enough sample size for a two-sample t-test to be completed. This statistical analysis compared the two populations, night shift and day shift as well as two other populations, sleep cycle and wake cycle. The CSR reports were time stamped to make it easier to separate the medication errors between the four different populations. Lastly, each medication error that was collected was divided into the types of medication errors. These types included wrong dose, wrong route, wrong time, wrong patient, wrong medication, and omission. The data received was put into a computer program, Predictive Analytic Software (PASW) that is used at Missouri Southern State University in order to make the correlation between the four populations and a higher number of medication errors. The data was then analyzed with the help of Dr. Casey Cole, a statistics professor at Missouri Southern State University.

When the CSR's were first obtained, there was a sample size of 1400 medication errors. The only medication errors that were included in the data were the errors that occurred during the previously specified time frame. Also, the description of the error was included in the CSR. After reading the description, only the medication errors that were at the fault of the nurse were included. Medication errors that were excluded from the sample were errors that were classified

as controlled substance abuse, errors that were committed by respiratory therapists, errors that didn't occur during the specified time frame, and errors that were just close calls. Controlled substance abuse was reported in a CSR, but they were times when nurses did not lock up narcotics well, or the wrong number of narcotics was in the medicine dispenser. Close calls were also not included, because they were medication errors that were actually intercepted by the nurse before the error was actually made. In the end, the sample size was 417 total medication errors over 152 days.

Results

Just looking at the numbers without running the statistical analysis there were 2.74 medication errors on average per day. There were 199 errors that occurred between the hours of 0700 and 1800, day shift. 218 errors occurred between 1900 and 0600, night shift. The sleep cycle hours of mammal's circadian rhythm include the hours 1300 to 1600, and 0000 to 0700 (Your guide to, 2011). There were more medication errors at the hours of 0900, 1600, 2100, and 0000. There were 23, 24, 22, and 97 errors that occurred at these hours respectively. There are a number of reasons these hours showed the most number of errors, which will be discussed later.

Day Shift vs. Night Shift

Once the data was collected it was placed into the PASW computer software. A two-sample t-test was performed. The results showed no significance. No significance refers to a p-value for each type of medication error that was above 0.05. However, some of the averages showed a slight higher occurrence during the night shift. Since the p-value showed that there was

no significance, no conclusion can be derived from this data.

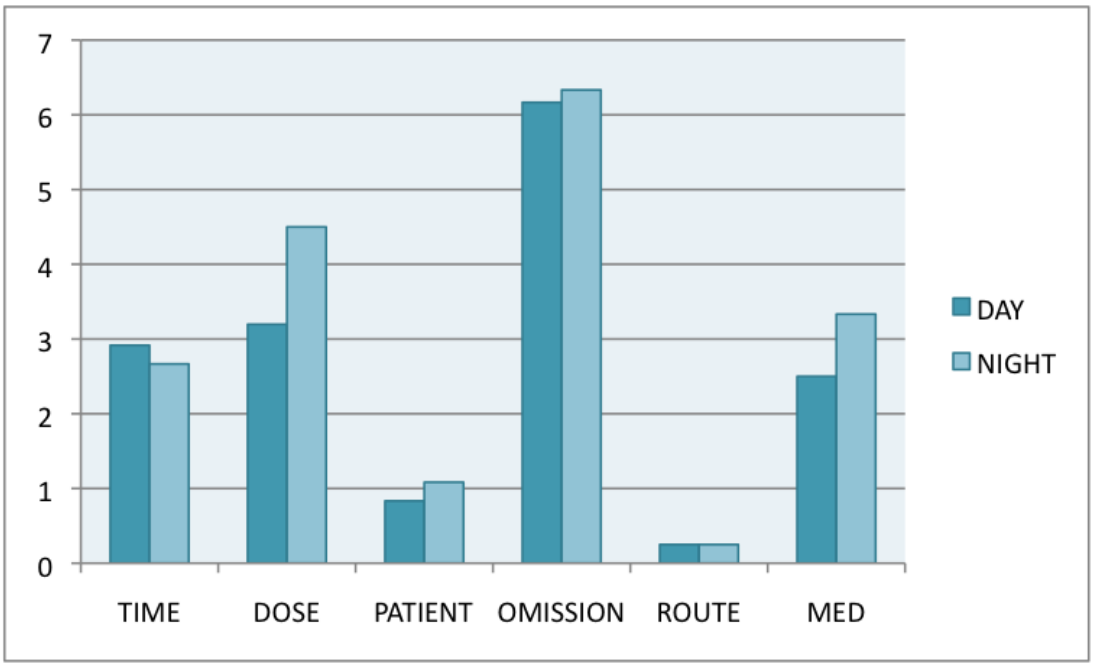

Figure 1 This figure shows the averages of the medication errors that were committed of each type between the day shift and night shift.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TIME	Equal variances assumed	.074	.788	.235	22	.816	.25000	1.06452	-1.95768	2.45768
	Equal variances not assumed			.235	20.266	.817	.25000	1.06452	-1.96868	2.46868
DOSE	Equal variances assumed	1.879	.184	-.294	22	.771	-.58333	1.98081	-4.69128	3.52462
	Equal variances not assumed			-.294	13.675	.773	-.58333	1.98081	-4.84123	3.67456
PATIENT	Equal variances assumed	1.222	.281	-.352	22	.728	-.25000	.71022	-1.72292	1.22292
	Equal variances not assumed			-.352	14.632	.730	-.25000	.71022	-1.76713	1.26713
OMISSION	Equal variances assumed	3.859	.062	-.074	22	.942	-.16667	2.25350	-4.84015	4.50682
	Equal variances not assumed			-.074	12.600	.942	-.16667	2.25350	-5.05083	4.71750
ROUTE	Equal variances assumed	.146	.706	0.000	22	1.000	0.00000	.28204	-.58491	.58491
	Equal variances not assumed			0.000	16.585	1.000	0.00000	.28204	-.59619	.59619
MED	Equal variances assumed	1.982	.173	-.445	22	.661	-.83333	1.87420	-4.72019	3.05352
	Equal variances not assumed			-.445	11.938	.665	-.83333	1.87420	-4.91921	3.25254

Figure 2 This chart shows the results from the two-sample t-test. This graph shows the p-value of each type of medicaiton error. All p-values are above 0.05.

A second t-test was performed on two different populations. The populations were the wake cycle and the sleep cycle. The results that were discovered for the populations, day shift and night shift, are the same results for this population. Although the means show some of a difference, all of the p-values are above 0.05, which shows no significance. This means that the null hypothesis cannot be proven to be false.

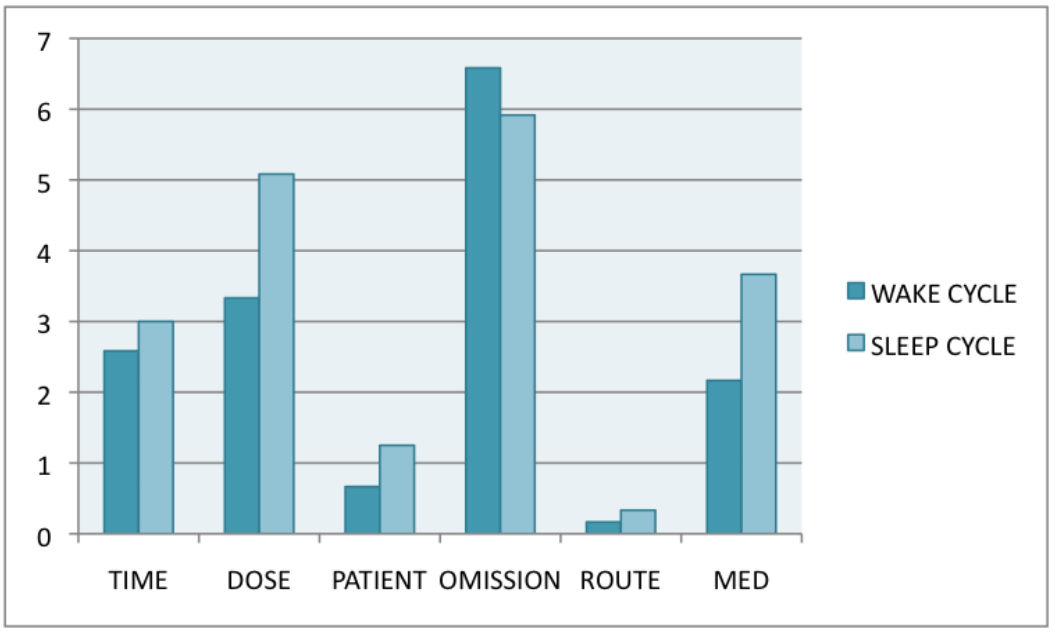

Figure 3 This chart shows the averages compared between the wake cycle and the sleep cycle for each type of medication error.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TIME	Equal variances assumed	.719	.406	-.392	22	.699	-.41667	1.06215	-2.61943	1.78609
	Equal variances not assumed			-.392	19.352	.699	-.41667	1.06215	-2.63703	1.80370
DOSE	Equal variances assumed	3.196	.088	-.898	22	.379	-1.75000	1.94933	-5.79266	2.29266
	Equal variances not assumed			-.898	13.233	.385	-1.75000	1.94933	-5.95373	2.45373
PATIENT	Equal variances assumed	.757	.394	-.832	22	.414	-.58333	.70128	-2.03770	.87103
	Equal variances not assumed			-.832	15.165	.418	-.58333	.70128	-2.07666	.91000
OMISSION	Equal variances assumed	3.340	.081	.296	22	.770	.66667	2.24930	-3.99809	5.33143
	Equal variances not assumed			.296	12.879	.772	.66667	2.24930	-4.19728	5.53061
ROUTE	Equal variances assumed	1.786	.195	-.596	22	.557	-.16667	.27979	-.74692	.41358
	Equal variances not assumed			-.596	15.080	.560	-.16667	.27979	-.76275	.42942
MED	Equal variances assumed	2.317	.142	-.809	22	.427	-1.50000	1.85524	-5.34753	2.34753
	Equal variances not assumed			-.809	12.099	.434	-1.50000	1.85524	-5.53856	2.53856

Figure 4 This chart shows the significance of the wake cycle and the sleep cycle for each type of medication error. The p-values are all above 0.05.

Discussion

When collecting the data, there were two categories of medication errors listed on the CSR that were not included in the plan to collect the data. These two categories were "allergy overlook," and "wrong rate". Allergy overlook was included under the category "wrong medication," and wrong rate was included under the category "wrong dose" for this particular study. These were categorized this way because of the definitions that are found in Perry and Potter (2010) for "wrong medication" and "wrong rate" (Perry & Potter, 2010).

These results are not concurrent with the previous studies. Johnson, Brown, and Weaver (2010), claimed that sleep deprivation greatly affects the psychomotor skills of nurses. The psychomotor skills that are needed to give medications were not affected in this study. There is

no reason to claim that the null hypothesis is false. Night shift nurses do not commit more medication errors than day shift nurses due to sleep deprivation or circadian rhythm.

These results support hospitals that are operating at this moment. Nursing schools are teaching their students how to prevent medication errors, and it is being completed (Papastrat & Wallace, 2003). In this case, patient who are in the hospital over night do not have to worry that they are not receiving the standard of care that day shift nurses give. This should give comfort to the patients that they are being treated well throughout the 24 hours of the day.

There were a few problems with the data. In the case that the nurse did not put a time on the CSR, the medication error was automatically time stamped with the time 0000. The researcher was not able to decipher if the medication error actually occurred at the time 0000 or not without bias. Also, as stated in the literature review, nurses have the tendency to not report the medication errors they commit (Mrayyan, 2012).

More errors could have been committed at 0900 because that is when medications are mostly given in the hospital setting. If there are more medications given, then there is more of a chance for error to occur. Also, the other times that were mentioned to have more medication errors were either considered to be during the sleep cycle or during the night shift. Even though there were more errors at these times, the analysis showed that there was no significance at these times.

Medication errors are still commonly occurring in hospitals all over the world (Muñoz et al., 2010). These errors have numerous consequences on the patient, the nurse, and the hospitals (Moyen et al., 2008). The errors can happen for numerous reasons that involve giving the medication at the wrong time, to the wrong patient, by the wrong route, the wrong does, or by giving the wrong drug (Perry & Potter, 2010). It is the nurse's responsibility to ensure that the

patient is getting the proper medication administration (Flynn et al., 2012). The affect of sleep deprivation and the circadian rhythm did not prove to have an affect on the shift-working nurse to commit these medication errors. Further research should still be completed in order to find ways to keep these medication errors from happening, as well as to find ways to make the nurse document the medication error that he or she committed.

Limitations

This study was limited to only the nurses at Freeman Health System. More results, and a larger sample size, could be obtained when comparing multiple hospitals to one another. The study was also limited to the dates January 1, 2012 to May 31, 2012. If the data were collected concurrently for a full year, there would be a larger sample size as well. Also, the data was not limited to one floor. This could cause a problem, because most patients do not receive medications while they are sleeping. If the study were limited to the emergency department, there would be more of a chance that the night shift is giving just as many medications as the day shift due to the constant influx of patients being received throughout the day. Lastly, the study was limited to only the number of medication errors. There is the possibility that day shift nurses are sleep deprived as well. A survey asking how much sleep the nurse received that would be included with the CSR could keep this limitation from occurring.

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