

Nurse Staffing and Adverse Patient Outcomes

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ABSTRACT

Knowledge regarding the influence of nurse staffing on patient outcomes provides information to nurse administrators for determining numbers of nursing personnel in each units in order to promote a quality of care in nursing care. The purposes of this study is to identify the relationships between nurse staffing and adverse patient outcomes. Data were received from the documentation of 98 medical and surgical nursing units of 15 hospitals located in the northern region of Thailand. The results revealed that nursing working hours per patient day were positively related to patient falls, pressure ulcers, and urinary tract infections (UTIs), while the proportion of professional nurses was negatively associated with patient falls. The proportion of expert position professional nurses was negatively correlated to patient falls, pressure ulcers, and UTIs. The model for predicting patient fall incidence included nursing working hours per patient day and the proportion of expert position professional nurses. The model for predicting pressure ulcer incidence included the proportion of expert position professional nurses, nursing unit types, and gender of patients admitted in nursing units. The model for predicting UTI incidence included nursing working hours per patient day, the proportion of expert position professional nurses, and nursing unit types. The results of this study revealed the significant influence of the expert position professional nurses on patient outcomes, which reflect nursing care quality.

Key words: Nurse staffing, Patient outcomes, Patient falls, Pressure ulcers, Pressure sores, Urinary tract infection

INTRODUCTION

For more than five decades, the quality of health care has been a concern. Presently, the quality of health care is a global concern of both health care providers and consumers. To access the quality of health care, Donabedian (1980) recommended that structures, processes, and outcomes of care should be evaluated. Especially, outcome assessment can be used to ascertain what matters most; the effect of care on the patients' health and well being (Donabedian, 2003). Patient outcomes that are identified as sensitive to nursing are the most that are relevant, based on nurses'

scope and domain of practice, and for which there is empirical evidence linking nursing inputs and intervention to the outcomes (Doran, 2003).

Nurse-sensitive patient outcomes for acute care setting, according to Kunaviktikul et al., (2001; 2002; 2005) include urinary tract infection (UTIs), patient falls, skin integrity, satisfaction with health education information, satisfaction with pain management, and satisfaction with general nursing care. Furthermore, in 2004, the Bureau of Nursing proposed ten nursing quality indicators and six of them were patient outcome indicators, including pressure ulcers, nosocomial infection, UTIs, readmission rate, patient satisfaction, and length of stay (Bureau of Nursing, Department of Medical Science, Ministry of Public Health, Thailand, 2004). Additionally, nosocomial UTIs and patient satisfaction were consistently found to be hospital quality indicators in Thailand.

While patient outcomes are a major concern of health care services, nursing personnel are the significant variables influencing patient outcomes because they are the major group of health care providers with the responsibility to provide nursing care 24 hours a day. They share the common attributes of caring for, supporting and encouraging clients while constantly assessing, intervening, and monitoring the health needs of their clients. They also play the role of patient advocates, provide educational assistance, and coordinate the various services offered to the clients (World Health Organization, 2002). Specifically, nurses have a significant influence on preventable adverse incidences and complications such as patient falls, pressure ulcers, and UTIs. This is because nurses respond to assess risk factors and perform prevention for these patient outcomes. Besides adverse incidences, nurses also influence patient satisfaction because nurses are the majority of healthcare personnel and are constantly found at the bedside in nursing units providing healthcare services that consequently satisfy patients' needs. In order to promote decreasing adverse incidences and complications, nurse administrators have to carefully consider both the quantity and qualifications of nurses when staffing nursing personnel in each nursing unit.

A number of studies regarding relationships between nurse staffing and nurse-sensitive patient outcomes including patient falls, pressure ulcers, and UTIs were reviewed but the results of the influence of nurse staffing levels and skill mix on these patient outcomes were varied. Three studies found that a higher proportion of registered nurses and licensed nurses lowered the rate of patient falls (Blegen and Vaughn, 1998; Blegen et al., 1998; Sovie and Jawad, 2001) but only one study showed an inverse association between nursing hours per patient day and patient falls (Sovie and Jawad, 2001). While pressure ulcers were inversely related to nursing hours per patient day (American Nurses Association, 1997; Lichtig et al., 1999; Sovie and Jawad, 2001) and the proportion of registered nurses (American Nurses Association, 1997; American Nurses Association, 2000; Blegen et al., 1998; Lichtig et al., 1999), one study found a positive relationship between pressure ulcers and hours of care per patient day (Cho et al., 2003). For UTIs, the last adverse outcome selected for this study, six studies found negative an association between this variable and proportion of registered nurses/licensed nurses (American Nurses

Association, 1997; American Nurses Association, 2000; Kovner and Gergen, 1998; Lichtig et al., 1999; Needleman and Buerhaus, 2003; Unruh, 2003) whereas only two studies reported an inverse relationship between UTIs and nursing hours per patient day (Sovie and Jawad, 2001; Sujjantararat, 2001). Additionally, two studies found no relationship between nurse staffing and UTIs (Cho et al., 2003; Kovner et al., 2002).

In Thailand, only four studies regarding correlation between nurse staffing variables and some patient outcomes were conducted and three of them were performed in only one hospital. Two studies identified the association between nurse staffing and patient satisfaction (Jumpamool, 2003; Khumyu, 2002) including nurses' job satisfaction (Khumyu, 2002), while the other two studied the influence of nurse staffing on mortality (Sasichay-Akkadechanunt et al., 2003) and nosocomial UTIs (Sujjantararat, 2001).

Inconsistency between the relationships of nurse staffing and patient outcome indicated the need for a replication study in this area, especially in Thailand, where only a few studies were conducted. Particularly significant was the issue of nursing staff's educational levels and experience; where less was known about their effect on patient outcomes (Kaestner, 2005). Thus, to enhance the knowledge of the association among nursing care indicators as well as to understand the influences of nurse staffing on patient outcomes in Thai health care organizations, the relationships between nurse staffing and patient outcomes of patient falls, pressure ulcers, and UTIs were selected to be studied in this research. The results of this study can benefit healthcare policymakers and especially, nurse administrators who need evidence-based information for making decisions about staffing nursing personnel in each nursing unit and developing policy regarding nursing personnel in the future. Furthermore, the result of this study could provide basic data for conducting future research in other health care settings.

OBJECTIVES

The objectives of this study are to identify the relationships between nurse staffing, including nursing working hours per patient day; the proportion of professional nurses to all nursing personnel; the proportion of Masters prepared professional nurses to all professional nurses; and the proportion of expert position professional nurses to all professional nurses, and patient outcomes of patient falls, pressure ulcers, and UTIs.

MATERIALS AND METHODS

Design and Sample

A descriptive correlational design was used and stratified random sampling was applied to identify 98 medical/surgical nursing unit samples from a university hospital, four regional hospitals and 10 general hospitals located in the northern region of Thailand.

Instruments

Three recording forms were used to collect data. The details of each recording form and questionnaire were as follows:

1. *Daily Working Record Form* was developed for the purpose of collecting daily nurse staffing data and daily patient census in each unit.

2. *Unit Nurse Staffing Record Form* is a monthly record of each type of nursing personnel and their numbers, numbers of Masters or higher prepared nurses, and the number of expert position professional nurses (position classification [PC] level 7-9) working on each nursing unit.

3. *Selected Patient Outcomes Record Form* was created to record the number of patient fall, pressure ulcer, and UTI incidences for each nursing unit.

Protection of Human Subject

The research proposal was reviewed and approved by the Research Ethical Committee of Faculty of Nursing, Chiang Mai University; of the Faculty of Medicine, Chiang Mai University; and of the Budhachinaraj hospital. The permissions to collect data from the hospital directors were granted.

Procedure

Data collection was between August 1, 2004 and January 31, 2005. The methods used to acquire data to be studied were as follows:

1. The head nurse of each nursing unit or her representative recorded the Daily Working Record Form each day. Head nurses monthly recorded unit nurse staffing, patient falls, pressure ulcers, UTIs as well as the number of catheterized patient data in the Unit Nurse Staffing Record Form and the Selected Patient Outcomes Record Form.

2. Patient ages were retrieved from the medical record files of each hospital with the cooperation of the medical informatics staff after the end of the data collecting period.

Risk Adjustment

Risk adjustment is a statistical method used to identify and adjust for variation in patient outcomes that originate from dissimilarities in patient characteristics (or risk factors) across health organizations (Joint Committee on Accreditation of Healthcare Organizations, n.d.). Risk factors can directly influence an outcome or may possibly interact with aspects of treatment to produce their effect (Kane, 1997). Thus, comparing patient outcomes across organizations without appropriate risk adjustment can be misleading. As the purpose of this research was to study patient outcomes at different levels of hospitals and in different types of nursing units, risk adjustment was a concern for the investigator. Thus, hospital types, nursing unit types, percentage of aging patients, and sexes of patients admitted in each unit were selected to be included in the multivariate regression models to facilitate a more fair and accurate inter-organization and inter-unit comparison.

Data Analysis

Data analysis was conducted by using the SPSS version 11.5 and the STATA 7.0 for Windows software packages. Descriptive statistics — frequency, percentage, mean, and standard deviation — were used to summarize and describe the characteristics of studied variables. Pearson's correlation and Spearman's rho, were used to analyze the association among variables. Univariate and multivariate negative binomial regression analysis were addressed to identify the model for predicting patient falls, pressure ulcers and UTIs because data collected for these variables are the counting of events emerging in each patient unit during the study period and the variances of variables exceeded their means (Hoffman, 2004; Long, 1997; Long and Freese, 2001). The stepwise technique was used to identify the best predicting models (Tabachnick and Fidell, 2001).

RESULTS

There were 98 nursing units of 15 public hospitals located in the northern region of Thailand that participated in this study. The number of hospital beds ranged from 320 to 1,800 beds with 709.39 average beds ($SD = 448.95$). Fifty-three nursing units (54.1%) were units from general hospitals while another 45 units (45.9%) were in university and regional hospitals. The participating nursing units in the study included 52 medical units (53.1%) and 46 surgical units (46.9%). Nursing unit beds ranged between 17 and 64 beds per units ($M = 31.02$ and $SD = 6.18$). The occupancy rates of unit beds were between 55.31 and 150.54 percent. Forty-five nursing units (45.9%) provided care to only male patients, 41 nursing units (41.8%) were for female patients, and the other 12 units admitted both sexes. The average age of patient admitted in the studied nursing units was 51.53 years ($SD = 6.19$). The percentage of aged patients (over or equal to 60 years of age) in each unit ranged between 0.0 and 67.7 percent.

The average working hours of the nursing personnel was 4.25 hours per patient day. Percentages of professional nurses to all nursing personnel in the studied unit ranged from 39.08 – 90.60 percent, with a mean of 59.29. None of the professional nurses graduated with a doctorate degree. Percentages of Masters prepared professionals ranged from 0.00 – 50.0 percent ($M = 6.80$, $SD = 8.53$). Percentages of expert position professional nurses ranged from 0.00 – 71.43 percent, with a mean of 23.51.

The patient fall rate ranged from 0.00–1.31 percent, with a mean of 0.16. The pressure ulcer rate ranged from 0.00–10.88 percent, with a mean of 1.11 percent. The percentage of UTI in catheterized patient rate ranged from 0.00–14.51 percent, with a mean of 2.20.

Correlation among Study Variables

Spearman's rho correlation coefficients of nurse staffing scores and percentage of patient falls, pressure ulcers and UTIs are presented in Table 1. The results show that:

1. Nursing working hours per patient day were related significantly positively to all of the studied patient outcome variables.

2. A negative relationship between the proportion of professional nurses to all nursing personnel and patient outcome variables was found but only the association with patient falls was statistically significant.

3. There was no statistically significant relationship between proportion of Masters prepared professional nurses to all professional nurses and all of the studied patient outcome variables.

4. Negative relationships between the proportion of expert position professional nurses to all professional nurses and patient falls, pressure ulcer, and UTIs per 100 catheterized patients were found.

5. The result of multivariate negative binomial regression revealed that:

5.1 Nursing working hours and the proportion of expert position professional nurses were statistically significant predictors of patient falls. Overall the model can explain 3.5% of the variance in patient falls (McFadden's Adjusted $R^2 = .035$) (see Table 2).

5.2 Three dependent variables including proportion of expert position professional nurses, nursing unit types and sex of patient admitted in the nursing unit were statistically significant predictors of pressure ulcers. Overall the model can explain 3.8% of the variance in pressure ulcers (McFadden's Adjusted $R^2 = .038$) (see Table 3).

5.3 Nursing working hour per patient day, the proportion of expert position professional nurses, and nursing unit types were statistically significant predictors of UTIs. Overall the model can explain 3.7 % of the variance in UTIs (McFadden's Adjusted $R^2 = .037$) (see Table 4).

DISCUSSION

1. Nursing working hours per patient day and patient outcomes.

The finding of this study show statistically positive relations between nursing working hours per patient day and three adverse patient outcomes – patient falls, pressure ulcers and UTIs. Although the positive correlations between nursing working hours per patient day and these patient outcomes were unexpected results, these findings may provide an important clue; that staffing only number of nursing personnel without appropriate skill mix for providing care in itself alone, may not guarantee quality of nursing care. When there are not enough professional nurses in the nursing units, they may not have enough time to provide direct nursing care and to do patient rounds frequently. Therefore, they delegate some of the direct nursing care such as doing patient rounds and responding to the call light to non-professional nurses. As results of this study found that more than 75 percent of nursing units participating in this study had a bed occupancy rate higher than 80 percent and 35.7 percent of all nursing units had a rate higher than 100 percent, there may have not enough nursing personnel for care in these units. When there were high patient loads in the nursing units, nurses may have had time for doing only routine nursing care and not time for doing incident preventions, which are their direct responsibili-

ties. An additional reason for the positive relationship between nursing working hours per patient day and adverse patient outcomes in this study may be that nursing units that had high nursing working hours per patient day tend to use high hours of overtime personnel ($r_s = .45, p < .01$). Using high numbers of overtime personnel may cause high patient incidents as the result of a study indicated that when nurses had to extend hours of work, they felt oppressed, lacked concentration and could make errors (Silen-Lipponen et al., 2005).

2. Proportion of professional nurses to all nursing personnel and patient outcomes

The finding of this study showed a statistically significant negative relationship between the proportion of professional nurses to all nursing personnel and patient falls. For pressure ulcers and UTIs, it found that they were negatively associated to this staffing variable but the relationships were not statistically significant.

The finding that the proportion of professional nurses to all nursing personnel was negatively related to patient falls indicated that nursing units that were staffed with a high number of professional nurses tended to have a lower number of patient falls. This result confirmed the significance of qualified nursing personnel to patient fall prevention. As professional nurses are responsible to assess the patients' risk of falling and are the ones well trained in fall prevention, they may have the ability to prevent patient falls better than nursing assistive personnel do. Thus, nursing units that had enough professional nurses, may have had more time for performing fall prevention than the understaffed nursing units. Additionally, this result is consistent with the previous research outcomes revealing that registered nurse proportions were inversely associated with patient falls (Blegen et al., 1998; Blegen et al., 2001).

Even though pressure ulcers and UTIs were not statistically associated to the proportion of professional nurses to all nursing personnel, the outcome of analysis showed a negative relationship. The negative relationships between the proportion of professional nurses to all nursing personnel and these patient outcomes have implications about the influence of professional nurses on decreasing pressure ulcers and UTIs. However, it may be because 98 nursing units may not be a large enough sample size to make the relationship between these variables negatively statistically significant. Additionally, more than 80 percent of the nursing units participating in this study had less than 70 percent of professional nurses working on each day. These amounts of professional nurses may have not been enough to cover all of the care, which needed professional nursing skills. If there were not enough professional nurses for care, these nurses may have had to do indirect care such as complete patient charts rather than tend to do bedside nursing care, as Cheung (2002) found that when the proportion of registered nurse increased 1 percent, these registered nurses spent 31 percent more time in direct care. Furthermore, even though pressure ulcer assessment and prevention as well as retaining urethral catheter, are the responsibility of professional nurses in Thai hospitals, these activities may be delegated to technical nurses or practical nurses for some nursing units or shifts that do not have

enough professional nurses to cover all of the nursing care.

3. Proportion of expert position professional nurses to all professional nurses and patient outcomes

The proportion of expert position professional nurses to all professional nurses was inversely correlated to patient falls, pressure ulcers, and UTIs and this variable was a good predictor of the three patient outcomes. Nevertheless, there was no a previous study regarding the influence of expert position professional nurses on patient outcomes in Thailand. The results of a study by Wheeler (2000) that reported shorter length of stay ($F = 20.62, p < .001$) and fewer complications (9 % compare to 26%) of total knee replacement patients admitted in nursing units using clinical nurse specialists compared to those patients who stayed in the nursing unit without a clinical nurse specialist may confirm the outcomes of this study. Another study that provided evidence that clinical nurse specialists influenced patient outcomes was that of Ryan et al., (2006). Ryan's study reported that patients consulting with expert rheumatology clinical nurse specialists could improve their perceived ability to cope with their arthritis compared to patients who were managed by outpatient clinical nurses.

The result of the present study indicates that professional nurses, having more experience and competency, can provide high quality nursing care and consequently influence patient falls, pressure ulcers, and the prevention of UTIs. Since professional nurses in expert positions must perform research and write scholarly papers before applying for promotion to these positions, as well as have clinical nursing experience of at least five years for Masters prepared nurses and 10 years for bachelor's degree prepared nurses, they should be highly capable in practical and theoretical skills. Thus, nursing units that have more expert nurses may provide better nursing care in terms of incident assessment and prevention.

4. Proportions of Masters prepared professional nurses to all professional nurses and patient outcomes

The present study found that the proportions of Masters prepared professional nurses to all professional nurses were not statistically significant related to all patient outcome variables. The explanation for no association between this staffing variable and the selected patient outcomes in this study may be that there was not much variation in numbers of Masters prepared professional nurses among the participating units. For this study, there were 44 nursing units, equal to 44.90 percent which had no Masters prepared professional nurses and of 54 nursing units that had Masters prepared nurses, 37 nursing units or 37.75 percent that had only one Masters prepared professional nurse, which included the head nurse. This proportion may not be a significant enough number to make a comprehensible influence on unit patient outcomes. Moreover, these nurses may not be available to provide full time bedside nursing care. Since most of the Masters prepared professional nurses were usually included in either the hospital or nursing department committees, they generally worked on the day shift and delegated a certain amount of working time to

doing the out of nursing unit jobs which are indirect nursing cares. Moreover, the educational majors that each Masters prepared professional nurse graduated with were not identified in this study. Some of the Masters prepared professional nurses may not have graduated with a the clinical nursing major. Thus, the result of this study cannot absolutely ascertain that Masters prepared nurses were not involved in patient outcomes.

5. Predicting models of selected patient outcomes derived from nurse staffing

It is noteworthy that overall models can explain only 3.5 – 3.8 percent in the variance of patient outcomes of this study. The explanation for this evidence is that there were several risk factors such as the patient condition, diseases, and severity of illness as well as other organizational variables such as prevention policy regarding patient incidences, nursing unit environment and equipment, which may have influenced patient outcomes. Additionally, the nursing unit sample size of this study may be slightly small. By using power analysis to identify the sample size for this study, 98 nursing units seems to be the appropriate amount of sample. However, the number of patient falls, pressure ulcers, and UTI incidences in several nursing units in this study, which were zero, was an unexpected situation. According to Long and Freese (2001), if there is modest variation in the dependent variable or a lot of zero count of dependent variables, a larger sample is required. According to this study, there were 45, 13, and, 32 nursing units that had no patient falls, pressure ulcers, and UTI incidences during the study period. This condition may reflect that the pre-calculated sample size of this study may not have been large enough to be a good representative of population and consequently, decrease the ability of predicting of models.

LIMITATIONS OF THE STUDY

This study calculated a sample size for the study based on the multiple correlation squared (R^2) of previous studies but almost all of those studies used the multiple regression and hierarchical regression. This study mainly used the negative binomial regression to identify the predictors of patient falls, pressure ulcers, and UTIs and it did not find suggestions regarding the sample size for the negative binomial regression. Thus, 98 nursing units may not have been a large enough sample size for this study. Consequently, the predictabilities of overall models on patient falls, pressure ulcers, and UTIs were quite low for this study. Additionally, most of the previous studies regarding adverse events used at least a one year dataset for analyses but because of the limitation of time and budget, this study collected data for only a six-month period. Thus, the number of patient falls, pressure ulcers, and UTI incidences may not be a good representative as compared to an entire year of data. Moreover, since this study retrieved patient falls, pressure ulcer and UTI data from nursing units incident reports of each nursing unit, the under reporting of these incidences may have to be considered. Consequently, under reporting may influence the validity of the result this study.

RECOMMENDATIONS FOR FURTHER RESEARCH

Replication of this study with a larger sample size and an expansion of the study setting, which would include other nursing unit types such as orthopedic, gynecology, and intensive care units as well as including private hospitals in the study would be an advantage in increasing sample size and generalization of the research outcomes. Additionally, studying the relationship between direct nursing care times, adequacy of nurse staffing and patient outcomes for each patient may provide a clearer indicator of the influences of nursing on patient outcomes.

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Table 1. Correlation of nurse staffing variables and patient outcomes (n = 98).

Variables	1.	2.	3.	4.	5.	6.	7.
1. Nursing working hours per patient day ^a	1.00	-.27**	-.11	-.39**	.33**	.23*	.42**
2. Proportion of professional nurses to all nursing personnel ^a		1.00	.04	-.01	-.23**	-.01	-.14
3. Proportion of Masters prepared professional nurses to all professional nurses ^b			1.00	.18	.03	.16	-.08
4. Proportion of expert position professional nurses to all professional nurses ^a				1.00	-.37**	-.34**	-.43**
5. Patient falls ^b					1.00	.38**	.43**
6. Pressure ulcers ^b						1.00	.36**
7. UTIs ^b							1.00

Note. a = Pearson's correlation

b = Spearman's rho

* $p < .05$

** $p < .01$

Table 2. Multivariate negative binomial regression of patient falls and studied variables.

Variable	Coef	SE	Z	P value	Adjusted IRR
Nursing working hours per patient day	.46	.16	2.86	.004	1.59
Proportion of expert position professional nurses	-.02	.01	-2.11	.034	.98
Constant	-8.25	.81	-10.07	.000	

n = 98

Likelihood ratio test of alpha = 0; $\chi^2(01) = 39.47$ Prob \geq $\chi^2 = 0.000$

Overall model $\chi^2 = 19.10$ p = .0001 Pseudo $R^2 = 0.0599$

McFadden's Adjust $R^2 = 0.035$

Table 3. Multivariate negative binomial regression of pressure ulcers and studied variables.

Variable	Coef	SE	Z	P value	Adjusted IRR
Proportion of expert position professional nurses	-.02	.01	-3.38	.001	.98
Unit types					
- Medical	1.00				
- Surgical	-.84	.21	-4.01	.000	.44
Sex of patients in nursing unit					
- Male	1.00				
- Female	-.68	.21	-3.23	.001	.51
Constant	-3.57	.20	-17.86	.000	

n = 98

Likelihood ratio test of alpha=0; $\chi^2(01)=462.43$ Prob \geq $\chi^2=0.000$

Overall model $\chi^2=35.41$ p=.0000 Pseudo $R^2=0.0535$

McFadden's Adjust $R^2 = 0.038$

Table 4. Multivariate negative binomial regression of urinary tract infection rate and studied variables

Variable	Coef	SE	Z	P value	Adjusted IRR
Nursing working hours per patient day	.34	.15	2.31	.021	1.41
Proportion of expert position professional nurses	-.02	.01	-2.41	.006	.98
Unit types					
- Medical	1.00				
- Surgical	-.74	.27	-2.73	.016	.48
Constant	-4.73	.75	-6.28	.000	

n = 98

Likelihood ratio test of $\alpha=0$: $\chi^2(01)=172.39$ Prob $\geq\chi^2=0.000$

Overall model $\chi^2=27.34$ p=.0000 Pseudo $R^2=0.0577$

McFadden's Adjust $R^2 = 0.037$

REFERENCES

- American Nurses Association. 1997. Implementing nursing's report card: A study of RN staffing, length of stay and patient outcomes. American Nurses, Washington D.C.
- American Nurses Association. 2000. Nurse staffing and patient outcomes in the inpatient hospital setting. American Nurses Association, Washington, DC.
- Blegen, M.A., and T. Vaughn. 1998. A multisite study of nurse staffing and patient occurrences. *Nursing Economics* 16:196-203.
- Blegen, M.A., C.J. Goode, and L. Reed. 1998. Nurse staffing and patient outcomes. *Nursing Research* 47:43-50.
- Blegen, M.A., T.E. Vaughn, and C.J. Goode. 2001. Nurse experience and education: effect on quality of care. *Journal of Nursing Administration* 31:33-39.
- Bureau of Nursing, Department of Medical Science, Ministry of Public Health, Thailand. 2004. In-hospital nursing quality indicators. Bangkok.
- Cheung, R.B. 2002. The relationship between nurse staffing, nursing time, and adverse events in an acute care hospital. Ph.D. Dissertation, University of South Florida, Florida, USA.
- Cho, S.-H., S. Ketefian, V.H. Barkauskas, and D.G. Smith. 2003. The effects of nurse staffing on adverse events, morbidity, mortality, and medical costs. *Nursing Research* 52:71-79.
- Donabedian, A. 1980. Exploration in quality assessment and monitoring volume I: The definition of quality and approaches to its assessment. Health Administration, Ann Arbor, MI USA.
- Donabedian, A. 2003. An introduction to quality assurance in health care. Oxford University, New York.
- Doran, D. (ed) 2003. Nursing-sensitive outcomes: State of the science. Jones and Bartlett, Sudbury.

- Hoffman, J.P. 2004. *Generalized linear models: An applied approach* Pearson Education, Boston.
- Joint Committee on Accreditation of Healthcare Organizations. n.d. Risk Adjustment [Online] <http://www.jcaho.org/pms/core+measures/6ariskadjustment.pdf> (verified November 8).
- Jumpamool, A. 2003. Relationships among nursing demographics, nursing unit characteristics and quality of care in Thailand. Ph.D. Dissertation, University of California, San Francisco, USA.
- Kaestner, R. 2005. An overview of public policy and the nursing shortage. *Journal of Nursing Administration* 35:8-9.
- Kane, R.L. 1997. Risk adjustment. p. 127 - 128. In R. L. Kane (ed) *Understanding health care outcomes research*. An Aspen, Gaithersburg.
- Khumyu, A. 2002. Nurse staffing, nurses' job satisfaction, and patient satisfaction with nursing care in public hospitals in Thailand. Ph.D. Dissertation, The University of Alabama at Birmingham, Alabama, USA.
- Kovner, C., and P.J. Gergen. 1998. Nurse staffing levels and adverse events following surgery in U.S. hospitals. *Image: Journal of Nursing Scholarship* 30:315-321.
- Kovner, C., C. Jones, C. Zhan, P.J. Gergen, and J. Basu. 2002. Nurse staffing and postsurgical adverse events: an analysis of administrative data from a sample of U.S. hospitals, 1990-1996. *Health Services Research* 37:611-629.
- Kunaviktikul, W., R.L. Anders, W. Srisuphan, R. Chontawan, R. Nantasupawat, and O. Pumarporn. 2001. Development of quality of nursing care in Thailand. *Journal of Advanced Nursing* 36:776-784.
- Kunaviktikul, W., R. Chontawan, R. Nunsupawat, W. Srisuphan, O. Pumarporn, S. Hanuchareonkul, S. Hirunnuj, and R. Anders. 2002. Nursing quality indicators: Definition and implication. Unpublished Research, Chiang Mai, Thailand.
- Kunaviktikul, W., R.L. Anders, R. Chontawan, R. Nunsupawat, W. Srisuphan, O. Pumarporn, S. Hanuchareonkul, and S. Hirunnuj. 2005. Development of indicators to assess the quality of nursing care in Thailand. *Nursing and Health Sciences* 7:273 - 280.
- Lichtig, L.K., R.A. Knauf, and D.K. Milholland. 1999. Some impacts of nursing on acute care hospital outcomes. *Journal of Nursing Administration* 29:25-33.
- Long, J.S. 1997. *Regression models for categorical and limited dependent variables*. SAGE Publications, Thousand Oaks.
- Long, J.S., and J. Freese. 2001. *Regression models for categorical dependent variables using stata*. A Stata Press, Texas.
- Needleman, J., and P. Buerhaus. 2003. Nurse staffing and patient safety: Current knowledge and implications for action. *International Journal for Quality in Health Care* 15:275-277.
- Ritter-Teitel, J. 2001. An exploratory study of a predictive model for nursing-sensitive patient outcomes derived from patient care unit structure and process variables. Ph.D. Dissertation, University of Pennsylvania, Pennsylvania, USA.

- Ryan, S., A.B. Hassell, M. Lewis, and A. Farrell. 2006. Impact of a rheumatology expert nurse on the wellbeing of patients attending a drug monitoring clinic. *Journal of Advanced Nursing* 53:277-286.
- Sasíchay-Akkadechanunt, T., C.C. Scalzi, and A.F. Jawad. 2003. The relationship between nurse staffing and patient outcomes. *Journal of Nursing Administration* 33:478-485.
- Silen Lipponen, M., K. Tossavainen, H. Turunen, and A. Smith. 2005. Potential errors and their prevention in operating room teamwork as experienced by Finnish, British and American nurses. *International Journal of Nursing Practice* 11:21-31.
- Sovie, M.D., and A.F. Jawad. 2001. Hospital restructuring and its impact on outcomes: nursing staff regulations are premature. *Journal of Nursing Administration* 31:588-600.
- Sujijantararat, R. 2001. Nursing-sensitive quality indicators: Nosocomial urinary tract infection in a Thai hospital. Ph.D. Dissertation, The University of Alabama at Birmingham, Alabama, USA.
- Tabachnick, B.G., and L.S. Fidell. 2001. *Using Multivariate Statistics*. 4th. ed. Allyn & Bacon, Boston.
- Unruh, L. 2003. Licensed nurse staffing and adverse events in hospitals. *Medical Care* 41:142-152.
- Wheeler, E.C. 2000. The CNS's impact on process and outcome of patients with total knee replacement. *Clinical Nurse Specialist* 14:159-172.
- World Health Organization. 2002. *Strategic directions for strengthening nursing and midwifery services*. World Health Organization, Geneva.