Title: Nursing Intellectual Capital Theory: Testing selected propositions

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Nursing Intellectual Capital Theory: Testing the propositions

ABSTRACT

Aims: To test selected propositions of the middle-range theory of nursing intellectual capital.

Background*:* The nursing intellectual capital theory conceptualizes nursing knowledge's influence on patient and organizational outcomes. The theory proposes nursing human capital, nurses' knowledge, skills and experience, is related to the quality of patient care and nurse recruitment and retention of an inpatient care unit. Two factors within the work environment, nurse staffing and employer support for

nurse continuing professional development, are proposed to influence nursing human capital's association with patient and organizational outcomes.

Design: A cross-sectional survey design.

Methods: The study took place in 2008 in 6 Canadian acute care hospitals. Financial, human resource and risk data were collected from hospital departments and unit managers. Clearly specified empirical indicators quantified the study variables. The propositions of the theory were tested with data from 91 inpatient care units using structural equation modeling.

Results: The propositions associated with the nursing human capital concept were supported. The propositions associated with the employer support for nurse continuing professional development concept were not. The proposition that nurse staffing's influences on patient outcomes was mediated by the nursing human capital of an inpatient unit, was partially supported.

Conclusion: Some of the theory's propositions were empirically validated. Additional theoretical work required to refine the operationalization and measurement of some of the theory's concepts. Additional research with larger samples of data from different geographical settings and types of hospitals is required to determine if the theory can withstand empirical scrutiny.

Keywords*:* Nursing Theory, Continuing Education, Human Capital, Nurse Staffing, Structural Equation Modeling

SUMMARY STATEMENT

Why is this research needed?

- Investing in the knowledge and skill development of nurses is cost prohibitive for many organizations and countries.
- Little empirical evidence is available to assist administrative decision-making with determining if investing in the knowledge and skill development of nurses results in better quality patient care or influences the recruitment and retention of nurses.
- Nursing intellectual capital theory provides theoretical and methodological guidance for studying the influence of nurse' knowledge and skills on the quality of patient care outcomes and organizational outcomes associated with the recruitment and retention of nurses.

What are the key findings?

- Nurses' knowledge (academic preparation), skills (specialty certification) and experience (professional experience, unit tenure) were directly and indirectly associated with better quality of patient care and nurse recruitment and retention of hospital inpatient care units.
- Nurse staffing measured as a concept was directly and indirectly associated with the quality of patient care of the inpatient unit.
- The influence of nurse staffing on the quality of patient care outcome of hospital acquired infections was partially mediated by academic preparation of the nursing staff.

How should the findings be used to influence policy/practice/research/education?

- Measuring nurse staffing as a latent variable may assist researchers with reconciling the conflicting evidence related to the influence of nurse staffing on quality of patient care outcomes.
- The findings may assist decision-making related to the allocation of financial and human resources for the knowledge and skill development of nurses within hospitals.
- The findings may guide policy development governing the nurses' academic preparation and the continuing professional development.

INTRODUCTION

In effort to control health care costs there has been heightened interest in determining if advanced levels of academic preparation and credentialing for nurses result in better quality care and health outcomes for patients. As such, internationally, researchers have conducted several studies to explore the relationship between nursing knowledge and patient outcomes (Aiken et al. 2011, Duffield et al. 2011, Sasichay-Akkadechanunt et al. 2003, Tourangeau et al. 2007). However the findings have been inconsistent. It has been surmised that methodological and conceptual issues (Jiang, Stocks et al. 2006, Clarke & Donaldson 2008), specifically variability in the conceptualization and operationalization of nursing knowledge may have contributed to the contradictory findings. The middle range theory of nursing intellectual capital theory attempts to address some of these theoretical and methodological issues by providing a comprehensive perspective of the nursing knowledge available within an organization and its association with patient and organizational outcomes (Covell 2008). This paper reports on testing the propositions of the nursing intellectual capital theory.

Background

Organizations invest in a knowledgeable and skilled nursing staff in order to ensure the provision of high quality patient care and retain an experienced nursing staff. To develop nurses' knowledge and skills, many organizations offer nurses financial assistance to attend continuing education activities including academic courses and clinical workshops. They also employ clinical nurse specialists and educators, implement practice guidelines and provide clinical care maps to assist nurses with their clinical decision-making. However due to the complexities involved in studying the influence of nursing knowledge on patient and organizational outcomes, little empirical evidence is available to assist administrators with decision-making associated with investing in the knowledge and skill development of nurses. Determining if high levels of nursing knowledge result in better patient care is important and timely as initiatives supporting the continuing professional development (CPD) of nurses are costly and thus

currently cost-prohibitive for many health care organizations and countries. The nursing intellectual capital theory was developed to address this gap.

Nursing intellectual capital theory

The nursing intellectual capital theory was developed by using the strategies of theory derivation outlined by Walker and Avant (2010). Derived from intellectual capital theory, which is grounded in the fields of economics and accounting, the nursing intellectual capital theory conceptualizes the *stocks* of nursing knowledge in an acute care organization and delineates its relationships with patient and organizational outcomes (for details, refer to Covell 2008). Nursing knowledge is embedded in two concepts: nursing human capital and nursing structural capital. The nursing intellectual capital theory proposes that two environmental factors affect nursing human capital: nurse staffing and employer support for CPD.

Nursing human capital

The nursing intellectual capital theory defines nursing human capital as the nursing knowledge that resides within the nursing staff. It encompasses theoretical and practical knowledge needed for the delivery of care. Nurses acquire theoretical and practical knowledge from obtaining academic degrees, participating in continuing education, in-service education, and specialty training. Nurses refine their practical knowledge through experience that is, working as a nurse (Covell 2008). Nurses' academic preparation and experience have been significantly associated with better quality of patient care or lower rates of adverse events (Aiken et al. 2011, Duffield et al. 2011, Tourangeau et al. 2007). Nurse participation in continuing education has been found to increase knowledge and change professional practice behaviors associated with improving the quality of care provided to patients (Brunt 2000, Umble et al. 2000).

Nursing structural capital

Nursing structural capital is knowledge converted into information structures that nurses can use to assist with their clinical decision-making and care planning (Covell 2008). Nursing structural capital in the form of practice guidelines, care maps or protocols is believed to provide relevant information to nurses for improving the quality of care they deliver (Miller & Kearney 2004, Ring et al. 2005). Care maps, practice guidelines and protocols have been found to contribute to improved patient outcomes and reduce the rate of adverse events (Duffield et al. 2011, Tourangeau et al. 2007).

Nurse staffing

Nurse staffing is the available supply of nurses who possess the theoretical and practical knowledge to competently care for patients on the unit (American Nurses Association [ANA] 1999). Nurse staffing as conceptualized for the nursing intellectual capital theory, reflects a stable base of nurses with the capabilities and expertise to provide the care required by the patients hospitalized on the unit (Covell 2008). High levels of nurse staffing have been significantly related to lower adverse events including hospital-acquired infection (Kovner & Gergen 1998), mortality rates (Sales et al. 2009, Tourangeau et al. 2007), medication errors (Blegen & Vaughn 1998) and patient falls (Duffield et al. 2011).

Employer support for nurse CPD

Employer support for nurse CPD is the investment by the organization in the knowledge and skill development of nurses (Covell 2008). Nurses report that after they enter the profession they require access to financial and human resources, such as bursaries and clinical nurse educators respectively, to update their knowledge and skills (Canadian Nurses Advisory Council 2002, Kramer & Schmalenberg 2004; Hughes 2005). Duffield et al. (2011) found the presence of nurse educators on a unit was associated with fewer medication errors.

The nursing intellectual capital theory proposes that nursing human capital is related to variables within the work environment, nurse staffing and employer support for nurse CPD, which in turn, is associated with the quality of patient care (low adverse events) and the recruitment and retention of

nurses. The theory also proposes that nursing structural capital, nursing knowledge available within organizational structures such as practice guidelines, is associated with the quality of patient care (Figure 1).

THE STUDY

Aim

The aim of this study was to test selected propositions of the middle-range theory of nursing intellectual capital theory. The hypotheses tested in this study include: a) Nursing units with higher levels of nurse staffing have high levels of nursing human capital, which in turn, provide higher levels of quality patient care captured in low adverse events, and higher nurse recruitment and retention; and b) Nursing units with higher levels of employer support for nurse CPD have higher levels of nursing human capital, which in turn, are associated with higher levels of quality patient care capture in low adverse events, and nurse recruitment and retention.

Design

A cross-sectional correlational design was used to collect data for inpatient care units. Data were obtained in 2008 from acute care hospitals in Canada.

Sample

The study took place in two large metropolitan cities in Ontario and Quebec, Canada. Six university affiliated acute care hospitals, three from each province, participated in the study. The hospitals were evenly distributed among small (< 500 beds), medium (501-100 beds) and large (>500 beds) sized hospitals.

A convenience sample of inpatient units (N= 147) within the participating hospitals was used. Inpatient units were included if they had a patient length of stay >24 hours. Units were excluded if they cared for neonates or infants since they could not provide meaningful data for some outcome variables (e.g., fall rates). Ninety-one units (62%) provided data for all variables. A sample size of 91 units

provided 6.5 cases per variable, which met the guidelines of 5-10 cases per variable for establishing adequate power when using SEM analysis to test relationships among latent and observed variables (Schumacker & Lomax 2010).

Data collection

Data were obtained from the finance, human resources and risk departmental databases for all eligible inpatient units. A short survey was sent to all unit managers to collect the data unavailable from the departmental databases. Data were annualized for one fiscal year. The data source and formulae for quantifying the indicators for each variable are presented in Table 1. The indicator variables used to measure the nursing intellectual capital concepts reflected registered nurses (RNs) and were collected for the inpatient unit level.

The accuracy of the indicators in reflecting their respective concepts was examined in a methodological study (Current authors in review). The latter study tested the concepts' factorial structures using exploratory factor analysis (EFA), and the results are briefly reviewed below.

The proposed factorial structure of the nurse staffing concept was empirically validated. This concept was well represented by the indicator variables of skill mix, RN-to-patient ratio and hours per patient per day (HPPD). As proposed, the empirically validated nurse staffing concept was brought forward for model testing.

The results of the EFA of nursing human capital concept suggested a two-factor model. The two factors were theoretically meaningful. The first factor reflected nurses' practical knowledge and was operationalized by the three indicator variables of specialty certification, professional experience and unit tenure. This concept captured the nursing human capital–clinical expertise. The second factor reflected nurses' theoretical knowledge and was represented by two indicator variables: academic preparation and continuing education. Since having a factor with only two indicators is not recommended (Schumacker &

Lomax 2010), the two indicator variables, academic preparation and continuing education were retained as individual indicators of theoretical knowledge, when testing the propositions of the theory.

The indicator variables for the employer support for nurse CPD concept consisted of financial assistance, replacement, time off to learn and clinical educators. The four indicators did not load on to one factor; therefore employer support for nurse CPD was represented by the individual indicator variables when testing the propositions of the theory.

The data obtained for the nursing structural capital concept was highly skewed because the majority of units reported having guidelines for the management of adverse events; therefore, the factorial structure for the concept could not be tested. Non-normally distributed data are not suitable for SEM analysis as they contribute to discrepancies between the hypothesized and observed model, leading to the rejection of the model (Schumacker & Lomax 2010). Consequently, the indicator variables for the nursing structural capital concept were not included when testing the propositions of the theory.

Ethical consideration

Approval to conduct the study was received from the participating hospitals' ethics review boards. Consent to conduct the study was obtained from the chief nursing officer of each hospital.

Data Analysis

To characterize the units, descriptive statistics were used to examine the frequency distribution, and measures of central tendency and dispersion for all variables of interest with SPSS 17. Analysis of covariance (ANOVA) was conducted to determine if the indicator variables varied by unit type. Since the units differed significantly on the variables of interest, unit type was controlled for when testing the proposed relationships among the concepts. The units were categorized into adult medical-surgical, specialty and long-term care. The use of categorical variables with SEM is appropriate when there are > 3 categories and the data are normally distributed (Byrne 2010) as they were in this study.

Structural equation modeling (SEM) was applied to test the proposed relationships among the nursing intellectual capital concepts with AMOS 17. As suggested by Schumacker & Lomax (2010), model testing is done in two steps. The first step consisted of validating the measurement model, that is, the accuracy with which the indicator variables reflected the respective concepts was examined. Indicators showing significant loadings on their respective concepts are retained in the second step. The second step focused on evaluating the structural model that is, the proposed relationships among the concepts as operationalized with the indicator variables validated in the first step. The statistical fit of the whole model (i.e., incorporating the validated measurement and the proposed structural models) and substantive meaning of the model was assessed using three criteria the: a) model fit criteria, indicated by a nonstatistically significant chi-square test; a small value (≤ 0.05) of the root-mean square error approximation (RMSEA); and a comparative fit index (CFI) ≥ 0.90; b) statistical significance of individual parameter estimates for the hypothesized paths in the model; and (c) the magnitude and direction of the parameters (Schumacker & Lomax 2010).

Validity and reliability

To ensure consistency and reduce response bias, clear and detailed directions accompanied the data collection forms and unit manager survey (available from first author upon request). For the Quebec sites, the data collection forms and survey translated to French and back translated to English. Discrepancies in the translations were identified and corrected. The English and French versions of the data collection forms and survey were pilot tested for face validity prior to their use in this study.

RESULTS

Unit characteristics

About half of the units (n= 46, 51/5%) represented general medical and/or surgical clinical programs; the other half was divided between specialty units (n = 24, 26%) and long-term care units (n = 21, 23%).

The size of units varied with a mean of 27 beds (*Range* = 6-65; *SD* = 10.57) and median length of stay was 8.7 days (*Range* = 1.5-1080; *SD* =245). The mean age of the RNs assigned to the participating units was 42 years (*SD* = 5; *Range* = 34-57).

Indicator variables

The indicator variables were normally distributed (Table 2). The nurse staffing concept was represented by three indicator variables: HPPD, skill-mix and RN-to-patient ratio. The participating units had a mean of 7 HPPD, a 67% RN skill-mix and a RN-to-patient ratio of 1:4.

The five indicator variables for the nursing human capital concept revealed that one third of the RNs on the participating units held university degrees; while 10% were specialty certified. The RNs were experienced as on average they had 12 years of professional experience and had worked on the participating unit for close to 6 years. The number of hours of continuing education attended by the RNs varied, with the majority attending on average,1371 (*SD* = 1733) hours.

The four indicator variables for employer support for the nurse CPD concept were financial assistance, replacement, time off to learn and clinical educator. On average the majority (56%) of employers provided financial support to RNs and approximately 15 hours paid time off to attend CPD activities. The RNs were replaced 80% of the time when they were away from the unit to learn. The RNs also had access to clinical educators to assist them with their clinical decision-making.

Confirming the measurement model

Confirmatory factor analysis was used to test the measurement model. It examined the accuracy of operationalizing the nurse staffing and the nursing human capital-clinical expertise concepts with their respective indicator variables, while accounting for measurement error. The indicator variables significantly loaded on to the nurse staffing concept: skill mix (*ß* = .685, *SEB* .02, *CR* = 3.74, $p < .001$) and RN-to-patient ratio (*ß* = -.723, *SEB* = .188, *CR* = -3.38, $p < .001$); HPPD loading was constrained to 1.0 to standardize the factor variance. However, not all of indicator variables for the nursing human

capital-clinical expertise loaded on to their related concepts. Specialty certification was constricted to 1.0. Only professional experience (*ß* = .502, *SEB* = 25.02, *CR* = 1.96, $p < .05$) accurately reflected this concept; while unit tenure (*ß* = .660, *SEB* = 20.87, *CR* = 1.63, $p = .103$) did not. The fit indices for the measurement model indicated inadequate fit ($\chi^{2\,(9)} = 16.12$; $p = .064$; *CFI* = .882; *RMSEA* =.094, *PClose* = .153). Therefore only the nurse staffing concept was included when testing the proposed structural model. The indicator variables representing the nursing human capital-clinical expertise concepts, with specialty certification, unit tenure and professional experience, were brought forward as individual variables when testing the propositions of the theory.

Fitting the structural model

The relationships among the concepts, as proposed by the theory, were tested. The results of the measurement model testing guided the operationalization of the concepts in order to maintain consistency. Specifically the nurse staffing concept and the individual indicator variables for nursing human capital and employer support for nurse CPD concepts were brought forward to test the propositions of the theory. Unit type was included as a covariate and its influence was controlled for statistically through the addition of paths between unit type and these variables (Figure 2). The relationships among the 13 variables were reflective and consistent with the propositions of the theory; however, the fit indices indicated the model had poor fit to the data ($\chi^{2\,(68)} = 120.5$; $p = .01$; *CFI* = .769; *RMSEA* = .093; *PClose* = .009).

A modified structural model was tested to improve the fit. The modification entailed eliminating nonsignificant paths and adding paths based on the modification indices produced by AMOS. The modification indices were carefully reviewed and paths were added only if they were theoretically meaningful that is, congruent with the theory. The nonsignificant path from academic preparation to medication errors was removed. The additional paths included the direct path from nurse staffing to medication errors, nurse staffing to patient falls, nurse staffing to hospital-acquired infections, professional experience to unit tenure, and unit tenure to specialty certification. Once the path was added

from nurse staffing to patient falls, the path from academic preparation to patient falls became nonsignificant and thus was removed from the model. The modification indices suggested adding associations between professional experience and unit tenure, and unit tenure and specialty certification. The fit indices for the modified structural model indicated a good fit ($\chi^{2\,(73)} = 80.57$; $p = .254$; *CFI* = .967; *RMSEA* = .034; *PClose* = .718).

In the modified final model (Figure 3), only nurse staffing was represented as a concept, measured with its 3 empirical indicators. HPPD (*B* = 15.21, *SE* = 2.79, *CR* = 5.45, $p < .001$) loaded positively and RN-to-patient ratio (*B* = -6.64, *SE* = 1.26, *CR* = -5.29, $p < .001$) loaded negatively onto the nurse staffing concept. This pattern of loading indicated that on units with high nurse staffing (high HPPD), the RNs care for fewer patients (low RN-to-patient ratio). The nurse staffing concept was directly related to the patient falls (*B* = -8.38, *SE* = 2.27, *CR* = -3.69, $p < .01$); hospital-acquired infections (*B*= 4.06, *SE* = .853, *CR* = 4.79, $p < .001$) and medication errors (*B* = 7.32, *SE* = 2.21, *CR* = 3.30, $p < .001$). These direct relationships suggest that when there are high levels of nurse staffing on participating units there also are low rates of patient falls and high rates of hospital-acquired infections and medication errors.

Nurse staffing also predicted nurses' academic preparation (*B* = .781, *SE* = .182, *CR* = 4.29, $p < .001$), meaning that on units with high levels of nurse staffing there was a high proportion of RNs with academic degrees. In turn, nurses' academic preparation was significantly related to the hospital-acquired infections (*B* = -2.20, *SE* = .426, *CR* = -5.16, $p < .001$). This implies an indirect relationship between nurse staffing and the hospital-acquired infections being partially mediated by the academic preparation of the nurses. In other words, on units with high levels of nurse staffing, there also was a high proportion of RNs with degrees, which in turn, was associated with reduced rates of hospital-acquired infections.

Of the indicators for the human capital concept, specialty certification was related with the hospital-acquired infections of a unit (*B* = -2.24, *SE* = .562, *CR* = -3.99, $p < .001$). Specialty certification also was

associated with recruitment rates (B = -.251, SE = .090, CR = -2.79, $p < .01$). These findings indicate that units reporting a high proportion of RNs with specialty certification had low rates of hospital-acquired infection and hired fewer new RNs.

As suggested by the beta coefficients, professional experience was associated with the number of orientation hours used by the unit (B = -.001, SEB = .000, CR = -3.67, $p < .001$). Specifically, units with high professional experience use a small proportion of their inpatient earned hours to orient RNs. Unit tenure also contributed to lower recruitment and vacancy rates of a unit. Units with high unit tenure had low recruitment (B = -.014, SE =.005, CR = -2.74, $p < .01$) and vacancy rates (B = -.009, SEB = .004, CR = -2.05, $p < .05$), as well as a high proportion of RNs with specialty certification (B = .013, SE = .006, CR = 2.24, $p < .05$).

DISCUSSION

This is the first study to empirically test the nursing intellectual capital theory, using carefully specified indicators and guidelines for data extraction. Overall the final model supported the main propositions of the theory. It suggests that nursing knowledge influences the quality of patient care and nurse recruitment and retention within hospital inpatient units. Specifically, the model reveals that it is the combination of nursing human capital attributes (academic preparation, specialty certification and experience) that are associated with better quality patient care.

As depicted by the relationships among the nursing human capital indicator variables and lower hospital-acquired infections, the theory proposition that nursing human capital is associated with better quality patient care is empirically support. These relationships are of moderate magnitude and support the study hypothesis that units with high levels nursing human capital have high quality of patient care (lower adverse events). These findings are consistent with previous research that found a significant association between academic preparation and lower hospital-acquired pneumonias and urinary tract infections

(Blegen 2001). They are also similar to findings from studies conducted in the field of business that found significant associations between high levels of human capital and high organizational performance (Bontis & Fitz-enz 2002).

The proposition that nursing human capital is associated with better recruitment and retention was also empirically supported. Specifically, the findings are consistent with the hypothesis that units with high levels of specialty certification have low vacancy (less unfilled positions) and recruitment (less need to hire nurses) rates. Additionally, the proposition is further supported by the finding that units with high professional experience use less orientation hours. These results are similar to those of Rondeau et al. (2009) who found that organizations reporting high turnover had low human capital, implying that organizations that invest in nursing human capital retain a large number of RNs. They are also comparable to the findings from the intellectual capital literature which reports that a high amount of human capital is associated with high organizational performance (Bontis & Fitz-enz 2002).

Interestingly, the results of model testing reveal a difference in the direction of the relationships between nurse staffing and specific indicators of the quality of patient care outcomes. While high nurse staffing levels were found to be directly associated with high rates of hospital-acquired infections and medication errors; they were also associated with low rates of patient falls. Although this study did not hypothesize direct relationships between nurse staffing of hospital-acquired infections or medication errors, the direct relationships are consistent with previous research conducted in different countries (Blegen et al. 1998, 2001; Van den Heede et al. 2009; Whitman et al. 2002). The difference in the direction of the relationships detected in this study could be the result of nurse staffing being represented as a concept which was simultaneously measured with three nurse staffing indicators (HPPD, skill-mix, RN-to-patient ratio); this operationalization differs from the unidimensional one often applied in other studies (Jiang et al. 2006, Clarke & Donaldson 2008). The conceptualization of nurse staffing as a latent variable, introduces a comprehensive operationalization of this concept that incorporates not only hours of

care available per patient; but also the amount of RNs available on the unit to provide patient care. Measuring nurse staffing as a latent variable may help researchers begin to reconcile the different measures and conflicting results currently reported in the literature.

Nurse staffing was also indirectly associated with low hospital-acquired infections through the proportion of RNs with degrees. This finding indicates that the relationship between nurse staffing and hospital-acquired infections is partially reduced by the level of academic preparation of the nursing staff. This partially mediated relationship begins to explain the mechanisms underlying the association of nurse staffing with better patient outcomes and provides initial support for the study hypothesis that units with high nurse staffing have high levels of nursing human capital, and in turn, high quality patient care.

The nursing intellectual capital theory proposes that nurse staffing influences the nursing human capital of a unit and in turn the recruitment and retention of nurses. This study found nurse staffing was not related to units' recruitment and retention of nurses. This indicates that the amount of nurse staffing does not seem to be indirectly related to the nurse recruitment and retention of a unit as hypothesized.

In summary, this study supported the theory's propositions associated with the nursing human capital concept. The proposition associated with the employer support for nurse CPD was not supported as the final model did not include any of the indicator variables reflecting the employer support for nurse CPD concept. In addition, the propositions associated with the nursing structural capital could not be tested since the indicator variables associated with the concept were non-normally distributed and not suitable for SEM analysis.

Study strengths and limitations

Despite the potentially limited representativeness of the participating units and the small sample size, the results are encouraging as they support the main propositions of the theory. The participation of solely university affiliated teaching hospitals in large urban areas may have affected the findings related to type of nursing and staffing patterns since previous research indicates there are significant differences in unit

type and staffing levels between different types of hospitals (Welton et al. 2006). Additionally, nurses employed in urban, university affiliated teaching hospitals may have access to more educational resources, than nurses who work in community or rurally located hospitals (Penz et al. 2007; Rondeau et al. 2009). Since nurses do not migrate considerably between cities and provinces (Canadian Institute for Health Information 2007), it can be surmised that nurses' knowledge and skills as well as recruitment and retention rates may vary geographically in ways that could not be captured in this study.

The sources of the data used to measure some of the variables may have affected the congruence between the indicators and their related concepts or outcomes (Clarke & Donaldson 2008). Although the conceptual and empirical indicators were derived from previous research or created from the empirical literature, they were limited by the data accessible within the participating hospitals such as the data used to measure the units' patient falls and medication error rates. These measures relied on incident report data and despite it being the most feasible method for collecting these data, incident report data may produce underreporting and reporting biases (Mark & Belyea 2009).

This study had a number of strengths including the methods used to obtain and manage the data, a theory-guided research design and the use of SEM analysis. Several strategies were implemented prior, during and following data collection to ensure precision in the data extracted for each study variable. An additional strength of the study is the theory-based design used to test the relationships. The nursing intellectual capital theory provided a novel paradigm for exploring the proposed theoretical links. It offered clear rationalization for the inclusion of previously unrelated variables and meaning for their proposed interrelationships. The use of SEM provided an uncommon opportunity to simultaneously test the interrelationships among the variables. SEM accounted for measurement error during the statistical analysis which increased the accuracy of parameter estimates (Byrne 2010).

CONCLUSION

The results of this study which tested selected propositions for the nursing intellectual capital theory provided emerging evidence supporting the proposition that nursing human capital influences the quality of patient care and the recruitment and retention of RNs. It also begins to illuminate possible empirical linkages between nurse staffing and patient outcomes by recognizing that the nurse staffing is related to nursing knowledge available on a unit, which in turn, is related to the quality of patient care.

Although this study did not empirically validate all of the theory's propositions, the theory does have the potential to contribute to the advancement of nursing. Many of the indicators did not represent their related concept well, thus further theoretical work is needed to refine the operationalization and measurement of some of the theory's concepts. In particular, the operational definitions and indicators of the nursing structural capital concept could be revised to reflect nurses' *use* of practice guidelines, technology or portable computerized devices; or the number of knowledge structures available to nurses (Current authors in review). Because the work environment is complex, a single mediator cannot completely explain the relationship between nurse staffing and patient outcomes, thus future research to explore other potential mediating relationships (Mark et al. 2004) is recommended.

Testing the theory by modifying the existing outcomes or using different patient and organizational outcomes is also suggested. This could involve adapting the patient outcomes to reflect adverse events that *cause* patient harm such as patient falls with injury or are positive in nature such as patient functional status or symptom management (Doran 2011). Patient characteristics were not included in the model testing as the nursing intellectual capital theory does not stipulate how patient characteristics may influence nurses' knowledge, skills and experience, and in turn patient and organizational outcomes. However since previous research has accounted for the influence of patient characteristics on unit-level nurse staffing, future testing of the theory while controlling for patient acuity or risk for experiencing the adverse event may be considered (Clarke & Donaldson 2008). Conducting such research may clarify the relationships found in this study which are opposite to what was hypothesized; specifically the

relationships between high levels of nurse staffing and high rates of hospital-acquired infections, and medication errors.

Refinement and testing of nursing intellectual capital theory in different geographical settings, types of hospitals and larger samples are required prior to determining if the theory can withstand empirical scrutiny. Conducting studies that use the organization as the level of analysis, using multiple sources of data and advanced statistical techniques that account for nested data, are suggested. In the meantime, in order to ensure high quality and cost-effective patient care, unit managers may consider retaining nursing staff with high human capital and investing in advanced education and specialty certification for nurses.

References

Aiken, L., Clarke, S. P., & Sloane, D. M. (2002) Hospital nurse staffing and patient mortality, nurse burnout, and job satisfaction. *Journal of the American Medical Association* (*JAMA), Oct 23-30, 28(16),* 1987-1993.

Aiken, L.M., Cimiotti, J. P., Sloane, D.M., Smith, H. L., Flynn, L., Neff, D. F. (2011) Effects of nurse staffing and nurse education on patient deaths in hospital with different nurse work environments. *Medical Care*, 49(12), 1047-1053.

American Nurses Association (1999) *Principles of Nurse Staffing*. Available from: <http://www.nursingworld.org/ > [21 March 2012].

Blegen M.A. & Vaughn T. (1998) A multisite study of nurse staffing and patient occurrences. *Nursing Economics* 16(4), 196–203.

Blegen, M.A., Vaughn, T. E., & Goode, C. J. (2001) Nurse experience and education: Effect on quality of care. *Journal of Advanced Nursing, 31*(1), 33-39.

Bontis, N. & Fitz-enz, J. (2002) Intellectual capital ROI: A causal map of human capital antecedents and consequents. *Journal of Intellectual Capital, 3*(3), 223-247.

Brunt B. (2000) Continuing education evaluation of behavior change. *Journal for Nurses in Staff Development*, 16(2), 49–54.

Byrne, B.M. (2010) *Structural Equation Modeling with AMOS. Basic Concepts, Applications and Programming (2nd ed).* Mahwah, New Jersey: Lawrence Erlbaum Associates.

Canadian Institute for Health Information [CIHI]. (2006) *Measuring the retention of nurses in Canada: A study of 2000-20004 registration data*. Canadian Institute for Health Information. Available at www.cihi.ca.

Canadian Institute for Health Information [CIHI]. 2007 *Distribution and Internal Migration of Canadian Registered Nurse Workforce. Available at: http://www.cihi.ca/CIHI-ext-portal/pdf/internet/2007_rn_en*.

Canadian Nurses Advisory Committee [CNAC] (2002) *Our Health, Our Future. Creating Quality Workplaces for Canadian Nurses*. *Final Report of the Canadian Nursing Advisory Committee*, Advisory Committee on Health Human Resources, Available from: <http://www.hc-sc.gc.ca/>. [21 March 2012].

Clarke, S.P., & Donaldson, N.E. (2008) Nurse staffing and patient care quality and safety. In *Patient Safety and Quality: An Evidence-Based Handbook for Nurses.* (AHRQ Publication No. 08-0043). Agency for Healthcare Research and Quality, Rockville, MD. http://www.ahrq.gov/qual/nurseshdbk.

Costello, AB, Osborne, JW (2005) Best practice in exploratory factor analysis: four recommendations for getting the most from your analysis. *Practical Assessment Research & Evaluation* 10. Available from: <http://pareonline.net/getvn.asp?v=10&n=7/>.
[21 March 2012].

Covell, C.L. (2008) The middle-range theory of nursing intellectual capital. *Journal of Advanced Nursing 63*(1), 94-103.

Current authors. (In review) Nursing Intellectual Capital Theory: Operationalization and Empirical Validation of the Concepts.

Donaldson, N. E., Strorer Brown, D. & Aydin, C. E. (2001) Nurse staffing in California Hospitals 1998-2000: Findings from the California Nursing Outcome Coalition Database Project. *Policy, Politics, & Nursing Practice, 2*(1), 20-29.

Doran, D. (Ed.). (2011) *Nursing-Sensitive Outcomes. State of the Science*. (2nd ed.) Mississauga, Ontario: Jones and Bartlett Publishers: Canada.

Duffield, C., Diers, D., O'Brien-Pallas, L., Aisbett, C, Roche, M., King, M., & Aisbett, K (2011) Nursing staffing, nursing workload, the work environment and patient outcomes. *Applied Nursing Research* 24, 244-255.

Edvinsson, L. & Malone, M. S. (1997) Intellectual Capital: Realizing your company's true value by finding its hidden brainpower. New York: Harper Business.

Hughes, E (2005) Nurses' perceptions of continuing professional development. *Nursing Standard*, 19, 41-49.

Jiang, H.J., Stocks, C & Wong, C.J. (2006) Disparities between two common data sources on hospital nurse staffing. *Journal of Nursing Scholarship*, 38, 187-193.

Kovner C. & Gergen P. (1998) Nurse staffing levels and adverse events following surgery in U.S. hospitals. *Image-The Journal of Nursing Scholarship* 30(4), 315–321.

Kramer, M., Schmalenberg, C. (2004) Essentials of a magnetic work environment. Part 3. *Nursing 2004, 34*(8), 44-47.

Lankshear, A. J., Sheldon, T. A. & Maynard , A. (2005). Nurse staffing and health care outcomes. *Advances in Nursing Science 28*(2), 163-174.

Mark, B. A., Hughes L. C., Bland Jones, C. (2004) The role of theory in improving patient safety and quality health care. Nursing Outlook, 52: 11-16.

Mark, B.A., Belyea, M. (2009) Nurse staffing and medication errors: cross-sectional or longitudinal relationships? *Research in Nursing & Health*, 32 (1), 18-30.

McGillis Hall, L. (2003) Nursing intellectual capital: A theoretical approach for analyzing nursing productivity. *Nursing Economics 2*(1), 14-19.

Miller, M & Kearney, N (2004) Guidelines for clinical practice: development, dissemination and implementation. *International Journal of Nursing Studies*, 41, 813-821.

O'Brien-Pallas L., Tomblin Murphy G., White S., Hayes L., Baumann A., Higgin A., Pringle D., Birch S., McGillis Hall L., Kephart G. & Wang S. (2005) *Building the Future: An Integrated Strategy for Nursing Human Resources in Canada-Research Synthesis Report of Research Findings* (English, PDF). Nursing Sector Study Corporation, Ottawa, Ontario. ISBN0-9738052-0-X.

Penz, K., D'Arcy, C., Stewart, N., Kosteniuk, J., Morgan, D. & Smith, B. (2007) Barriers to participation in continuing education activities among rural and remote nurses. T*he Journal of Continuing Education in Nursing*, *38*(2), 58-66.

Ring, N, Malcolm, C, Coull, A, Murphy-Black, T & Watterson, A (2005) Nursing best practice statements: an exploration of their implementation in clinical practice. *Journal of Clinical Nursing*, 14, 1048-1058.

Rondeau, K.V., Williams, E. S. & Wagar, T.H. (2009) Developing human capital: what is the impact on nurse turnover? *Journal of Nursing Management, 17*(6), 739-748.

Sales, A., Sharp , N., Li, Y., Lowy, E., Greiner, G., Liu, C., et al. (2008) The association between nursing factor and patient mortality in the Veterans Health Administration. *Medical Care*, 46(9), 938-945.

Sasichay-Akkadechanunt, T, Scalzi, C & Abbas, J (2003) The relationship between nurse staffing and patient outcomes. *Journal of Nursing Administration* 33, 478-485.

Schumacker, R.E. & Lomax, R.G. (2010) *A Beginner's Guide to Structural Equation Modeling*. (3rd ed.) Mahwah, New Jersey: Lawrence Erlbaum Associates.

Smith, JE (2004) Exploring the efficacy of continuing education mandates. *JONA's Health care Law, Ethics, and Regulation*, 6, 22-31.

Stewart, T. A. (2001) The wealth of knowledge: Intellectual capital and the twenty-first-century organizations. New York, U.S.A.: Currency Doubleday.

Tourangeau, A., Doran, D., McGillis Hall, L., O'Brien-Pallas, L., Pringle, D., Tu, J.V. & et al. (2007) Impact of hospital nursing care on 30-day mortality for acute medical patients. *Journal of Advanced Nursing 57*(1), 32-44.

Umble K.E., Cervero R.M., Yang B. & Atkinsion W.L. (2000) Effects of traditional classroom and distance continuing education: a theory-driven evaluation of a vaccine-preventable disease course. *American Journal of Public Health* 90(8), 1218–1225.

Van den Heede, K., Lesaffre, E., Diya, L., Vleugels, A., Clarke, S.P., Aiken, L. H., & Sermeus, W. (2009) The relationship between inpatient cardiac surgery mortality and nurse numbers and educational level: Analysis of administrative data. *International Journal of Nursing Studies*, 46(6), 796-803.

Walker, L. O. & Avant, K. C. (2010) *Strategies for theory construction in nursing*. (5th ed.) New Jersey: Pearson/Prentice Hall.

Welton, J.M., Unruh, L. & Halloran, E.J. (2006) Nurse staffing, nurse intensity, staff mix, and direct nursing care costs across Massachusetts hospitals. *Journal of Nursing Administration, 36(*9), 416-425.

Whitman, G. R., Kim, Y., Davidson, L. H., Wolf, G. A. & Wang, S. (2002) The impact of staffing on patient outcomes across specialty units. *Journal of Nursing Administration,* 32(12), 633-639.

Table 1. Study Variables, Empirical Indicators and Data Sources (Current authors in review)

Concept	Indicator Variable	Empirical Definition	Empirical Indicator	Data Source
Nursing human capital	Academic preparation	Proportion of RNs with degrees	Number of RNs with BN or higher/Total number of RNs	Human Resources
Nursing human capital	Specialty certification	Proportion of unit RNs with specialty certification	Number of RNs with Specialty Certification/ Total number of RNs	Unit Manager
Nursing human capital	Continuing education	The number of hours of CE attended by unit RNs	Total number of hours of CE attended by unit RNs	Unit Manager
Nursing human capital	Professional experience	The unit RN professional experience rate (mean number of years of unit RNs professional experience)	Total number of years of RN professional experience/Total number of RNs	Human Resources
Nursing human capital	Unit tenure	The unit RN unit tenure rate (mean number of years of unit RNs seniority or tenure with the unit)	Total number of years of RN unit tenure (seniority)/Total number of RNs	Human Resources
Nurse staffing	Skill-mix	The proportion of RN hours to nursing staff hours.	In-patient RN earned hours/RN + RPN + non-professional earned hours	Finance
Nurse staffing	RN-to-patient ratio	The mean number of patient cared for by one RN day shift	RN to patient ratio for days (weekdays & weekends)	Unit Manager
Nurse staffing	Hours per patient per day (HPPD)	Total in-patient worked hours (excluding hours for benefits) used for all unit staff including purchased hours for float, agency staff or sitters per patient day.	Total nursing care worked hours/ patient day	Finance

Table 1 continued. Study Variables, Empirical Indicators and Data Sources (Current authors in review)

Concept	Indicator Variable	Empirical Definition	Empirical Indicator	Data Source
Employer support for nurse CPD	Financial assistance	Mean number of unit RNs who received financial assistance from the organization to attend CPD activities.	Number of RNs that received financial assistance from hospital to attend CPD activities/Total number of RNs	Finance
Employer support for nurse CPD	Replacement	Provision of replacement staff for RNs while they are away to learn	Percent of time the RNs are replaced when away from the unit to learn.	Unit Manager
Employer support for nurse CPD	Time off to learn	Proportion of nursing staff hours used for RNs to attend CPD activity plus the total number of unpaid hours or absences allocated for RNs to learn including unpaid study leaves.	Total number of earned hours of paid & unpaid time off (or absences) allocated to RNs for time off to attend CPD activities/Total in-patient nursing earned hours	Finance
Employer support for nurse CPD	Clinical educator	Ratio of clinical nurse educators to RNs.	Number of FTE clinical educators/ Number of RN FTE	Unit Manager

Table 1 continued. Study Variables, Empirical Indicators and Data Sources (Current authors in review)

Concept	Indicator Variable	Empirical Definition	Empirical Indicator	Data Source
Quality of patient care	Patient falls	Unit rate of patient falls	Number of patient falls / 1,000 patient days	Risk Management
Quality of patient care	Hospital-acquired infections	Unit rate of hospital-acquired infections	Number of C-Difficile, MRSA &VRE Infections / 1,000 patient days	Risk Management
Quality of patient care	Medication errors	Unit rate of medication errors	Number of medication errors / 1,000 patient days	Risk Management
Recruitment and retention of nurses	Orientation hours	The proportion of unit hours used for RN orientation	Number of earned orientation hours used for newly hired RNs / RN inpatient earned hours	Finance
Recruitment and retention of nurses	Vacancy	Unit rate for RN vacancy	Number of vacant RN budgeted FTE positions / Number of RN budgeted FTE positions	Human Resources
Recruitment and retention of nurses	Turnover	Unit rate for RN turnover	Number of voluntary RN FTE separations / Total number of RN budgeted FTE positions	Human Resources
Recruitment and retention of nurses	Recruitment	Unit rate for RN recruitment	Number of newly hired RN FTEs / Total number of RN budgeted FTE positions	Human Resources

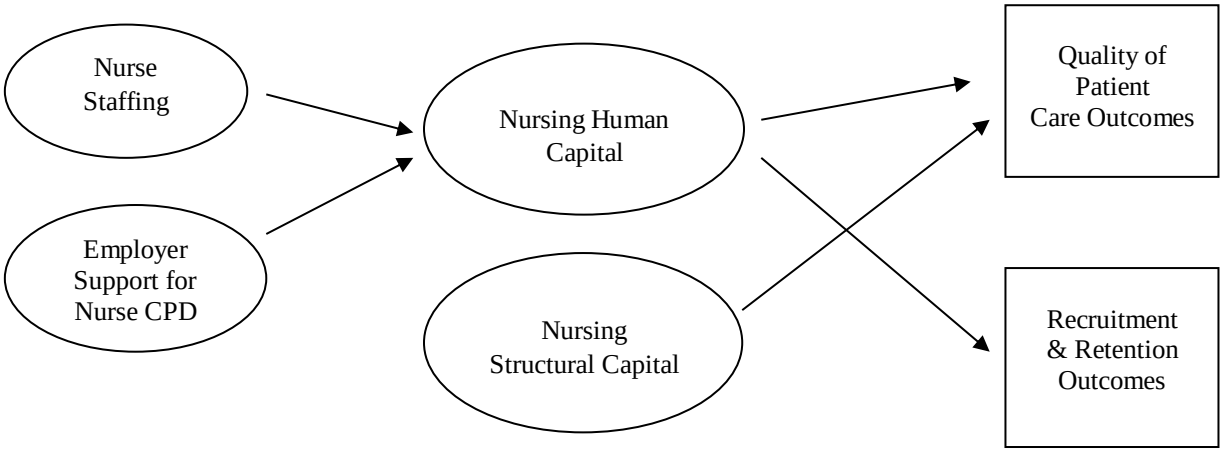
Note. RN(s) = registered nurse(s); BN =Bachelors Degree in Nursing; RPN= Registered practical nurse, CPD = continuing professional development; FTE(s) = full time equivalent(s). CE= continuing education, MRSA= methicillin-resistant staphylococcus aureus, VRE= vancomycin-resistant enterococci. Some of the definitions & indicators have been obtained or adapted from Edvinsson & Malone (1997), Lankshear, Sheldon & Maynard (2005), McGillis Hall (2003), Stewart (2001).

Table 2. Study Variables

Concept or outcomes	Study variables	Study sample N =91 *M(SD)*
Nurse staffing concept	HPPD	7.11 (3.44)
	Skill-mix	.67 (.19)
	RN-to-patient ratio	4.13 (1.50)
Nursing human capital concept	Academic preparation	.34 (.18)
	Specialty certification	.10 (.13)
	Continuing education	13.71 (1733)
	Professional experience	12.05 (4.88)
	Unit tenure	5.74 (2.93)
Employer support for nurse CPD concept	Financial assistance	.56 (.39)
	Time off to learn	14.96 (11.71)
	Clinical educator	.02 (.02)
	Replacement	79.51 (30.04)
Quality of patient care outcomes	Patient falls	3.48 (2.71)
	Hospital-acquired infections	.70 (.89)
	Medication errors	3.42 (2.72)
Nurse recruitment and retention outcomes	Orientation hours	.03(.02)
	Vacancy	.10 (.10)
	Turnover	.10(.09)
	Retention	.16 (.12)

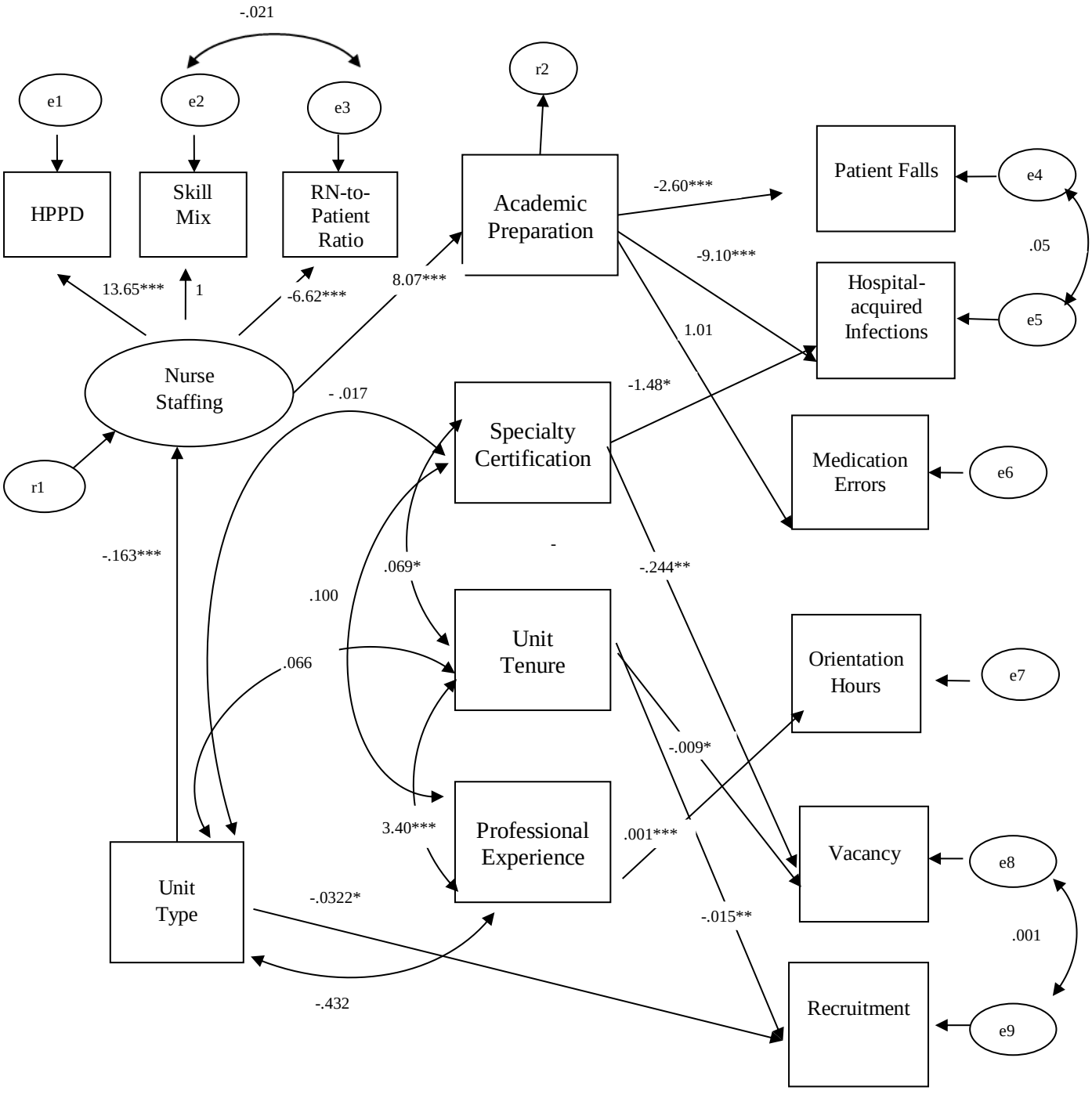
Note. HPPD = hours per patient per day; RN = registered nurses; CE = continuing education.

Figure 1. Middle-range theory nursing intellectual capital



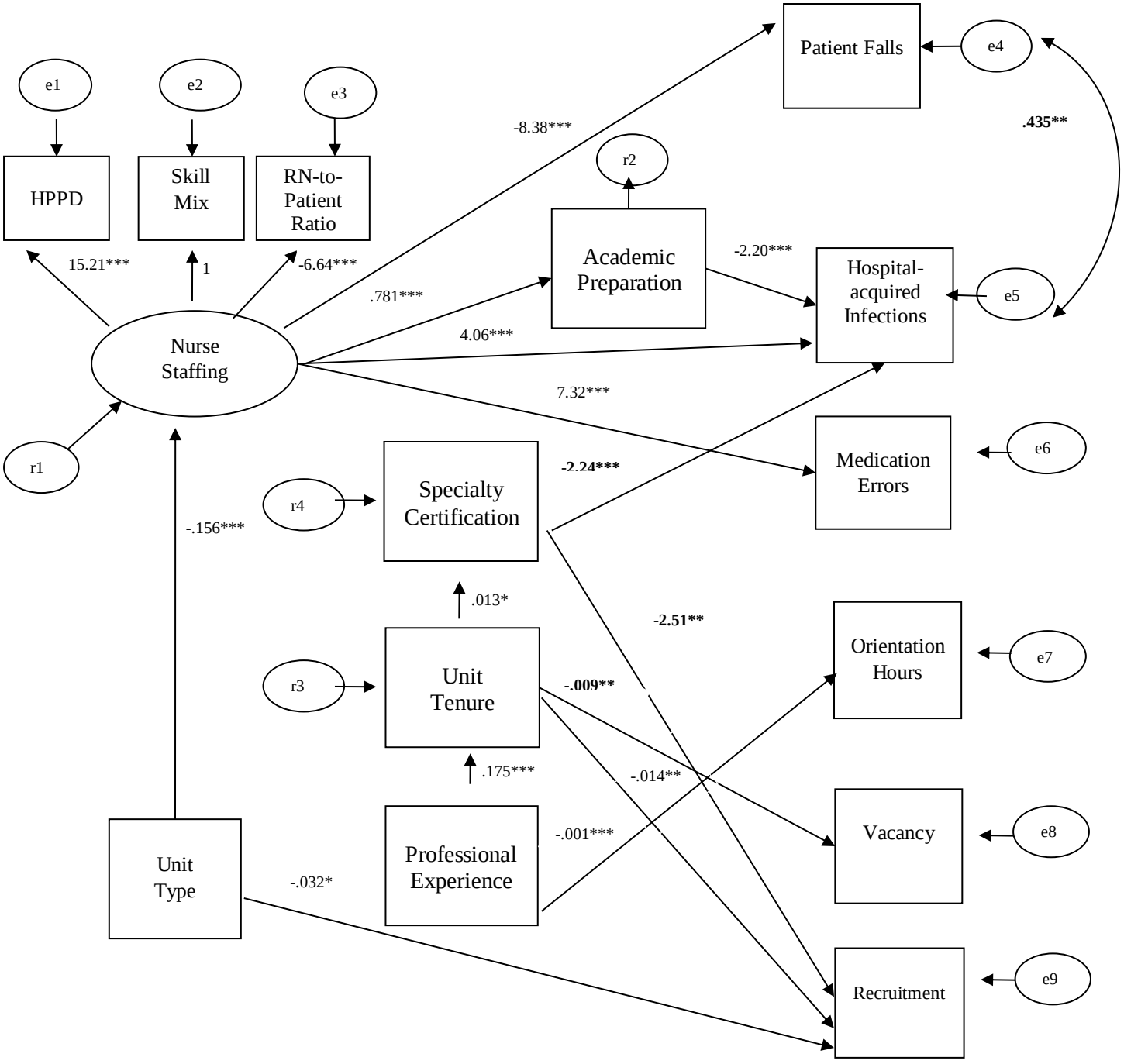
(Covell 2008)

Figure 2. Structural model-reflecting the middle-range theory of nursing intellectual capital



* < .05; ** < .01; *** < .001

Figure 3. Modified structural model-reflecting the middle-range theory of nursing intellectual capital



*<.05; **< .01; **< .001