SPATIAL ABILITY IN REGISTERED NURSES

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Spatial ability is the skill associated with mental relations among objects, the process of maintaining the physical aspects of an object after mentally rotating it in space. Many studies report a strong association of spatial ability with success in various areas of health care, especially surgery, radiology and dentistry. To date, similar investigations in professional nursing could not be located.

Registered nurses, employed in an acute care multi-hospital setting, were surveyed using the Shipley-2Block Pattern Test, the Group Embedded Figures Test, and a newly created test of general nursing knowledge. The sample size of 123 nurses was composed of 31 male nurses and 92 female nurses. Data was collected between May and August of 2013 and analyzed using R, version 2.15.2.

The present study did not demonstrate a statistically significant effect for gender differences on two measures of spatial ability. However, Cohen’s d effect sizes for mean gender differences in the present study are consistent with prior studies. This may suggest the nursing profession is comparable with other professions where males perform higher than females on spatial ability. The present study should be considered an initial step toward evaluating the relevance of spatial ability in the performance of nursing care.
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SPATIAL ABILITY IN REGISTERED NURSES

Abstract

Aim

To examine individual differences in spatial ability among professional registered nurses.

Background

Spatial ability is the skill associated with mental relations among objects, the process of maintaining the physical aspects of an object after mentally rotating it in space. Many studies report a strong association of spatial ability with success in various areas of health care, especially surgery, radiology and dentistry. To date, similar investigations in professional nursing could not be located.

Design

Cross-sectional.

Methods

Registered nurses, employed in an acute care multi-hospital setting, were surveyed using the Shipley-2Block Pattern Test, the Group Embedded Figures Test, and a newly created test of general nursing knowledge. The sample size of 123 nurses was composed of 31 male nurses and 92 female nurses. Data was collected between May and August of 2013 and analyzed using R, version 2.15.2.
Findings

The present study did not demonstrate a statistically significant effect for gender differences on two measures of spatial ability. However, Cohen’s $d$ effect sizes for mean gender differences in the present study are consistent with prior studies. This may suggest the nursing profession is comparable with other professions where males perform higher than females on spatial ability.

Conclusion

The present study should be considered an initial step toward evaluating the relevance of spatial ability in the performance of nursing care.

Summary Statement

Why is this research needed?

With continual changes in health care, evaluating nurses for general knowledge, skills, and traits may enhance our understanding of the nursing profession and the skills or abilities possessed by successful nursing practitioners.

What are the key findings?

- Sex is a predictor of spatial ability, in favor of males.
- Professional specialty certification is a predictor for general nursing knowledge.

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

- Additional research will be needed to evaluate the importance of spatial ability within
nursing, specifically the possibility of spatial ability assessments as a screening tool for enrollment to nursing school.

- The present study provides an adapted general nursing knowledge assessment that is both brief and exhibits good reliability.

Keywords: nursing, spatial ability, individual differences, nurse knowledge, nursing students, gender, education

Introduction

Medicine, healthcare and nursing are rooted in scientific findings and practices. Barrett (2002) defines nursing as a basic science and describes the practice of nursing as the scientific art of applying knowledge of humans in combination with their environment for their well-being. Nursing informatics, a nursing specialty approved in 1992 by the American Nurses Association, is using information and technology to advance the field of nursing, bridging the gap from the art of nursing to the science of nursing (Bond, 2009; Saba, 2001).

For more than 50 years, a link between those successful in science and spatial ability has been consistently demonstrated (Wai, Lubinski & Benbow, 2009). Spatial ability is described by Voyer, Voyer, and Bryden (1995) as a collection of different skills or abilities instead of a unitary construct. The construct of spatial ability is often divided into sub-factors depending on the emphasis given to a specific aspect of mental process on visualizing images (Maedo & Yoon, 2013; Pittalis & Christou, 2010). Researchers often differ on the number of dimensions for spatial ability but most agree with the inclusion of spatial visualization (Maedo & Yoon, 2013). Spatial visualization, often referred to as visual spatial processing, involves the spatial transformation of objects, the ability to mentally rotate a two-dimensional or three-dimensional
object rapidly and accurately, while maintaining the characteristics of the object (Maeda & Yoon, 2013). Mental rotation testing, commonly used as an assessment tool for spatial ability, is known to be highly sensitive for gender differences in favor of males (Debelak, Gittler, & Arendasy, 2014; Nazareth, Herrara, & Pruden, 2013; Voyer, Voyer, & Bryden, 1995).

Spatial ability, specifically mental rotation, is associated with success in the learning of anatomy and physiology, as well as basic courses in medical training (Hegarty, Kehner, Khooshabeh, & Montello, 2009; Hoyek et al., 2009; Langlois et al., 2009; Stransky, Wilcox, & Dubrowski, 2010; Stull, Hegarty, & Mayer, 2009). For complex surgeries, visual spatial ability has been related to competency and quality of results (Wanzel, Hamstra, Anastakis, Matsumoto, & Cusimano, 2002). The ability to mentally rotate an object in 3 dimensions, visualizing structures from several viewpoints with three dimensional images, carries significant importance in surgeons learning spatially complex surgical technical skills, echoing other studies where surgical skills are strongly dependent on spatial skills (Brandt & Davies, 2006; Stransky et al., 2010). Health care studies for spatial ability have been published on surgeons, radiologists, and dentists; however, nurses are lacking in published studies (Hegarty et al., 2009).

Although most nurses are not familiar with the term spatial ability, activities associated with spatial ability are part of everyday activities as a registered nurse. When auscultating heart sounds a nurse mentally visualizes the anatomy of the heart to evaluate adverse sounds. Nurses mentally visualize the features of the trachea, larynx and esophagus while inserting a nasogastric tube for successful placement as it is a blind insertion. PICC (peripherally inserted central catheter) lines and peripheral intravenous lines are activities that also require mental visualization for placement as they are essentially blind insertions. These are but a few examples of spatial ability in nursing. Making use of simulated mental imagery to solve problems is the
basis of visual processing, Gv (McGrew, 2013). As spatial visualization is a common construct for spatial ability, the present study focuses on visual processing for assessing registered nurses for spatial ability.

Changes in Nursing

Role Changes

Over the past 50 years, changes in nursing such as job demands, technology, work environments, patient acuity, litigation, salaries, education, and uniforms have dramatically impacted the role of the professional nurse (Blanche, 2010). Nurses monitor complex physiological data, operate lifesaving equipment, administer high cost health care programs and coordinate the delivery of multiple patient services (Weld & Bibb, 2009).

Changes in Job Skills

Nurses must use critical thinking skills with assessment, interpretation, and decision making to provide patient care, ensuring patient safety at all times. Clinical knowledge is estimated to double every 18 months (van Terheyden, 2007). Medical practices, pharmaceuticals, regulations and standards of care require constant assimilation of new information. As health care technology advances and patients require higher levels of care, nurses must incorporate new practices and workflows to meet the changes (Kalisch & Begeny, 2010). Integrating technology to improve clinical nursing practice enhances patient care quality; therefore, today’s nurse must utilize technology to support their workflow as well as support their patient’s use of increased technology (Bond, 2009; Saba, 2001). Creation of EHRs (electronic health record) using CPOE (computerized physician order entry) and interfacing of
various electronic applications has created a complex and dynamic work environment for nurses (Institute of Medicine [IOM], 2010). Expansion of biometric devices such as automated insulin pumps and implantable cardiac defibrillators require nurses to continually expand the use of technology in patient care.

The practice of nursing care is discipline specific, but also requires multidisciplinary knowledge in such areas as respiratory therapy, pharmacy, rehabilitation, and surgery (Giuliano, Tyer-Viola, & Lopez, 2005). Nurses must be proactive problem solvers and collaborative interdisciplinary team members (Hodges, 2011). Foundational science and math knowledge in areas such as anatomy and physiology, pharmacology and human behavior are necessary for nurses in today’s workplace. The nurse is the last safety check in the chain of events from prescription to medication administration, before reaching the patient (Leufer & Cleary-Holdforth, 2013). Nurses must use basic math functions and algebraic equations to calculate doses of medications (Maag, 2004). Research has shown spatial visualization abilities to be positively related with performance on math tasks, as well as tasks in science, technology, and engineering (Hinze et al., 2013).

Advances in Medical Care

Many advances in medical care have resulted in greater numbers of hospitalized patients, more critically ill patients upon admission to hospitals, and aging patients as well as improved survival from critical events (Kuehn, 2007; Lynn & Redman, 2005). Increased patient acuity levels with shortened lengths of hospital stays create intensive and accelerated health care processes (Hirschkorn, West, Hill, Cleary, & Hewlett, 2010). Nurses complete an average of 100 tasks per shift, with an interruption every 3 minutes, often resulting in cognitive overload
(Hendren, 2011). All of these improvements and changes rely on tremendous knowledge and a skill set that allows the nursing professional to deliver optimal care demanded in such situations.

Gender Participation in Nursing

The current nursing workforce contains a disproportionate number of females. While most disciplines within the health professional workforce have become more gender balanced, the same has not been true for nursing. The number of men who become nurses has grown in the last two decades however men account for only 7% of the current RN workforce (US Department of Health and Human Services, 2010). Stereotypes, role support, and academic acceptance are some challenges men encounter when entering the nursing profession (IOM, 2011). Moreover, there is little recognition of unique skills or abilities of males as nurses, and the turnover rate for male nurses is twice that of females (Hsu, Chen, Yu, & Lou, 2010). While more men are being drawn to nursing, especially as a second career, the field of nursing must continue to recruit men as their unique perspectives and skills are important to the profession and will help contribute additional diversity to the workforce (IOM, 2011). Given the disparity between the number of males and females employed as professional nurses, gender differences in ability are important to determining skill acquisition/possession across the entire field of nursing.

Licensing and Certification

RN licensure indicates entry-level competence to the nursing field where certification verifies specialty knowledge, skills, experience and clinical judgment (American Association of Critical-Care Nurses, 2013; American Board of Nursing Specialties, 2005). Certification reflects self-mastery with an emphasis on self-evaluation (Crist, Russell, & Farber, 2012). Specialty
certifications include, at a minimum, a practice component with required knowledge testing (Briggs, Brown, Kesten, & Heath, 2006; Grief, 2013).

Professional Certification and Patient Outcomes

The connection between certified nurses and quality patient care is well established (Crist et al., 2012). Specialty nurse certification is increasing in value as more evidence suggests that certification is a factor in improving patient outcomes (Fleischman, Meyer, & Watson, 2011, 2011; Timmerman, 2008). RNs with a BSN degree and a specialty certification are associated with improved patient outcomes, decreased mortality, and decreased failure to rescue in general surgical patients (Kendall-Gallagher, Aiken, Sloane, & Cimiotti, 2011).

Competency or Proficiency

There has been little progress in the nursing profession towards the development of a general tool to evaluate overall nursing knowledge and skills outside of nursing schools (IOM, 2011; Long, Mitchell, Young, & Rickard, 2013). The National Council of State Boards of Nursing (NCSBN) requires all nurse licensing candidates to pass an examination that measures the competencies required to perform safe and effective patient care as a newly licensed entry-level nurse, namely the NCLEX-RN (National Council Licensure Examination for Registered Nurses), and graduate from an accredited school of nursing (National Council of State Boards of Nursing, 2013). Upon graduation from an accredited school of nursing and passing the NCLEX-RN, the student applies for a nursing license allowing the individual to practice nursing within the state where the requirements were met (Simon, McGinniss, & Krauss, 2013). The HESI (Health Education Systems, Inc.) Exit Exam, an external independent assessment of a student’s
competency at a higher cognition level of application, analysis, and synthesis, is often administered to senior level nursing students to determine a student’s readiness to take the NCLEX-RN (Schooley & Kuhn, 2013).

Currently, in most states a nurse is considered proficient or competent upon initial licensing, with assumed proficiency or competency going forward unless otherwise discovered (Tilley, 2008). Tilley (2008) describes the confusion associated with competency and proficiency as related to two different uses of the terms: initial licensure and ongoing maintenance.

Nursing Shortage

The nursing profession is experiencing a national workforce shortage of critical proportion (Juraschek, Zhang, Ranganathan & Lin, 2012). This shortage is predicted to worsen, with an expected national shortage of 300,000 to 1 million RNs in 2020, and continued shortages throughout the country through 2030 (Juraschek et al.). A report from the U.S. Department of Health and Human Services (2010) predicted a nursing shortage equating to a 36% shortage.

The aging RN workforce strongly impacts the projected nursing shortage (Juraschek et al., 2012). Nurses that were 50 years of age or older comprised 25% of the nursing workforce in 1980, 33% of the nursing workforce in 2000, and 45% of the nursing workforce in 2008 (Juraschek et al.; US Department of Health and Human Services, 2010). It is estimated that 55% of currently employed nurses plan to retire before 2020 (Hirschkorn et al., 2010). Social support from supervisors and coworkers, job demands, and self-efficacy were reported to be significantly related to job dissatisfaction, while demands and support from coworkers were related to intention to leave the profession (Peterson, Hall, O’Brien-Pallas, & Cockerill, 2011). Job
dissatisfaction was a strong determinant of turnover among new nursing graduates, with interpersonal relationships having the strongest impact (Cho, Lee, Mark, & Yun, 2012). The shortage of nursing educators also has impacted the nursing shortage (Rich & Nugent, 2010). In 2012, U.S. nursing schools declined almost 80,000 qualified applicants for baccalaureate and graduate nursing programs due to a lack of faculty, clinical sites, clinical preceptors and budget constraints (AACN, 2014). Higher financial compensation in clinical settings is enticing current and potential nursing faculty away from the academic setting (AACN).

Spatial Ability

General Cognitive Ability - $g$

Charles Spearman introduced the first theory of intelligence in 1904, identifying general mental ability as a trait based on his findings that all mental test scores were positively correlated (Floyd, McGrew, Barry, Rafael, & Rogers, 2009; Jensen, 1987). General cognitive ability has been identified as the primary predictor for occupational success in the United States (Kane & Brand, 2003).

Raymond Cattell suggested human intelligence is comprised of two complementary intelligence factors--crystallized and fluid intelligence (Horn & Cattell, 1966). John Horn furthered Cattell’s research in 1965 by adding six broad factors, resulting in the Cattell-Horn Gf-Gc theory (Kane & Brand, 2003; McGrew, 2009).

Carroll’s research proposed a hierarchical model of intelligence, describing cognitive abilities in terms of a three-stratum model (Carroll, 1997; Kane & Brand, 2003). Stratum 1 is composed of a large number of narrow abilities, such as language development, reading, and spelling. Stratum II consists of 10 broad abilities, such as fluid intelligence, crystallized
intelligence, general memory and processing speed (Kane & Brand, 2003). The highest stratum, Stratum III, consists of only one single factor, \( g \), generalized intelligence (Carroll, 1997).

### Cattell-Horn-Carroll Theory

The Cattell Horn Carroll (CHC) theory of intelligence was developed by merging the Cattell-Horn Gf-Gc model with Carroll’s three-tiered stratum model to form a broader hierarchical model of \( g \) (Floyd, Evans, & McGrew, 2003; McGrew, 2009). General cognitive ability, \( g \), is the highest level of the hierarchy at Stratum III (Bickley, Keith, & Wolfe, 1995; Parkin & Beaujean, 2012). Figure 1 provides a visual illustration, comparing Carroll's three-stratum, Cattell–Horn's extended Gf–Gc, and the integrated Cattell–Horn–Carroll models of human cognitive abilities (McGrew, 2009).

**Figure 1.** Schematic representation and comparisons of Carroll's three-stratum, Cattell–Horn's extended Gf–Gc, and the integrated Cattell–Horn–Carroll models of human cognitive abilities. (McGrew, 2009).
The present study focuses on the Stratum II broad ability of visual processing, G\textsubscript{v}. Higher G\textsubscript{v} ability allows an individual to see more than the object by imagining the object from a different view after mental rotation, mentally taking a complex item apart and reassembling the item (Schneider & McGrew, 2013). Lower G\textsubscript{v} levels decrease an individual’s ability to perform mental rotations causing the person to wait until an object is physically rotated to see the change (Schneider & McGrew, 2013).

Gender Differences in Spatial Ability

Findings supporting gender differences in spatial ability are abundant; and, mental rotation testing is consistently more sensitive to gender differences than other spatial ability tasks (Brownlow, McPherson, & Acks, 2003; Ceci & Williams, 2010; Geary, Gilger, & Elliott-Miller, 1990; Geiser, Lehmann, & Eid, 2008; Jansen & Heil, 2010; Terlecki, Newcombe, & Little, 2008; Voyer et al., 1995; Voyer & Doyle, 2010). With the imbalance among the number of male and female nurses and the commonly accepted finding of males performing higher than females on mental rotation tests for spatial ability, looking at spatial ability in nurses could provide additional information to address gender differences and nursing shortages within the profession.

Several explanations for gender differences in spatial ability have been provided, such as socioeconomic status (SES), environmental, or biological factors (Levine, Vasilyeva, Lourenco, Newcombe, & Huttenlocher, 2005). Brain maturation, hormonal changes, personal beliefs and motivation have also been reported as possible explanations for gender differences in spatial abilities (Moe & Pazzaglia, 2006; Kozaki & Yasukouchi, 2009; Yilmaz, 2009).
The Study

Aim

The aim of the present study is to assess registered nurses for spatial ability, and determine if individual differences exist as a function of gender, years of work experience, working environment, and number of professional certifications. The research questions guiding the investigation are as follows:

Research Question 1: Are individual differences in spatial ability related to gender in RNs?

Research Question 2: Is spatial ability of RNs, as defined by either the Shipley-2 Block or Group Embedded Figures Test, related to years of experience, gender, and work environment (critical or non-critical care)?

Research Question 3: Is spatial ability, work environment, years of nursing experience, number of certifications possessed, and gender predictive of a measure of nursing content knowledge (a proxy for nurse competency)?

Design

The present study utilized a cross-sectional research design. Cross-sectional studies involve data collection at a defined time. This type of study collects data to make inferences about a population of interest at one point in time; often described as snapshots of a population (Carlson & Morrison, 2009).

Sample/Participants

Sixteen acute care hospitals within a multi-hospital setting were used to establish a population of registered nurses for the present study. Contact was made with supervisors of selected nursing groups with a request that they provide information about the study to the RNs within their group and the need for research participants. Respondents were screened for
eligibility and provided with study information and informed consent forms. The sample consisted of 123 registered nurses ($M_{age} = 44.47$ years, $SD = 9.98$) employed with an acute care multi-hospital setting. Male nurses accounted for 31 of the total participants ($M_{age} = 42.87$ years, $SD = 8.94$), with a range of professional certifications from 0 to 4 ($M_{cert} = 1.32$, $SD = 0.94$), and a range of nursing experience years from 1 to 38 ($M_{yrs} = 14.71$, $SD = 8.98$). Female nurses accounted for 92 of the total participants ($M_{age} = 45.01$ years, $SD = 10.29$), with a range of professional certifications from 0 to 6 ($M_{cert} = 1.42$, $SD = 1.21$), and a range of nursing experience years from 3 to 46 ($M_{yrs} = 19.05$, $SD = 10.69$).

Eligibility for inclusion required participants to be currently employed as a registered nurse at one of the 16 acute care hospitals. Speaking and understanding English did not exclude any participant from the present study, as English language competency is a requirement for employment.

**Data Collection**

**Sampling Procedures**

After obtaining Institutional Review Board approval recruitment of RN nurse participants began with an attempt to obtain equal participation of females and males. Because of the small sampling frame for males, emphasis was placed on identification and securing male participants. After exhausting all available nurse supervisors, a total of 31 males who agreed to participate in the study were identified. Consequently, to maintain adequate statistical power, additional female participants were recruited ($n = 92$) resulting in a total sample of 123 (25% male).
Research Methods

Each participant was scheduled for an individual research appointment, in which the nurse was individually administered a battery of assessments, using the same protocol for administration for all participants. The protocol order was as follows: a brief demographic and work history survey, the Shipley-2 Block Pattern Test, the Group Embedded Figures Test, and a test of general nursing knowledge. Each of these measures is described below.

Instrumentation

Demographic and Work History

The demographic and work history survey included each participant’s name, date of birth, gender, highest level of completed education, years worked as RN, current work place environment, and identification of the titles of the professional certifications currently held. The American Nurses Credentialing Center (ANCC) lists 25 professional specialty certifications for RNs (American Nurses Credentialing Center, 2013). The present study included additional certifications such as Advanced Critical Life Support (ACLS) and Sexual Assault Nurse Examiner (SANE).

Shipley-2 Block Pattern Test

The Shipley-2 Block Pattern Test is a nonverbal assessment of fluid cognitive ability in the spatial (Gv) domain (Western Psychological Services, 2012). The revision and restandardization of the original 1940 Shipley Institute of Living Scale, along with the adaptation of Kohs Block Design Test resulted in the current version of the Shipley-2 Block Pattern Test (Beaujean et al., 2011). Administering a non-verbal block patterns test provides a method of
measuring abstract thinking ability in an easily understandable way (DARA Thailand, Drug and Alcohol Rehab Asia, 2008). The Shipley-2 Block Pattern Test is a 2-page paper-and-pencil assessment, composed of 26 multiple choice-matching items in which participants view a stimulus mosaic block diagram that has an essential piece(s) missing, and determine from a variety of provided graphics, which piece(s) is needed to complete the stimulus graphic (Shipley, Gruber, Martin, & Klein, 2009). The participant has 10 minutes to complete the tasks. The Block Pattern test has a mean internal consistency of 0.92 for adults. This instrument can be administered individually or in a group setting, is a quick measure of intellectual functioning, and has been standardized for use with children ages 7 to 19 years, and adults ages 17 to 89 years (Shipley et al.).

**Group Embedded Figures Test**

The Group Embedded Figures Test (GEFT), developed in 1977, is an adaptation of the original 1971 Embedded Figures Test (EFT) and can be administered in individual or group settings to examine cognitive functioning in the spatial (Gv) domain (Witkin, Oltman, Raskin, & Karp, 2002). The GEFT has a reported reliability of $r = 0.89$ for males and females (Rittschof, 2010). This measurement tool is the most widely recognized measure for cognitive styles of field-dependence and field-independence (Beres, Magyar, & Turscanyi-Szabo, 2012; Blanton, 2004).

Finding common geometric shapes in a larger design provides information about field dependence and field independence (Thompson & Melancon, 1987). As reported by Khatib and Hosseinpur (2011), field-independent respondents tend to view concepts analytically, have less difficulty with problem solving, and are intrinsically motivated. Field-dependent individuals
often struggle to solve problems, tend to be extrinsically motivated, and are reported to learn
better when the organization and structure is provided to them (Robinson, Kitchel, & Garton,
2009). A high GEFT score (15-18) indicates the individual can separate the simple figure from
the complex figure and has habits associated with field-independence (Blanton, 2004).
According to Blanton (2004), a low GEFT score (0-5) indicates the individual has tendencies
towards field-dependence. Individuals with mid-range GEFT scores (6-14) are associated with a
combination of field-dependence and field-independence (Blanton, 2004).

Participants are provided a booklet with simple visual figures embedded inside
progressively more complicated visual figures. The GEFT contains 18 complex figures, each
with an embedded simple figure. The participant’s task on each item is to locate a previously
seen simple figure within a larger complex figure which is organized as to obscure the simple
figure (Khatib & Hosseinpur, 2011). Participants must ignore confusing visual information to
find and outline the hidden figure (Noble, Miller, & Heckman, 2008). The test includes three
sections. The first section, with a time limit of two minutes, has seven practice examples that
demonstrate the process for each participant. The first section is not included in the total score of
the GEFT. The second and third sections each consist of 9 items, with a 5-minute time limit for
each section. Scoring is based on the number of simple forms correctly identified within the
second and third sections, ranging from 0 to 18 (Guillot, Champely, Batier, Thiriet & Collet,
2007).

*General Nursing Knowledge*

There has been little progress in the nursing profession towards the development of a
general tool to evaluate overall nursing knowledge and skills outside of nursing schools (Long et
al., 2013). Assessing general nursing knowledge and fundamental competencies identifies areas for professional development and educational needs; as well as ensuring nurse capabilities are matched to patient needs (O'Leary, 2012). As there are no validated tools for assessing general nursing knowledge outside of certification/licensing exams, an assessment was created using sample review questions for the NCLEX-RN exit exam and the HESI exit exam (Suhonen, Schmidt, & Radwin, 2007) as a proxy for nursing competency.

The NCBSN does not provide, recommend, or endorse any specific review program for the NCLEX-RN exam (National Council of State Boards of Nursing, 2013). Sample review questions from free online NCLEX-RN and HESI Exit Exam study websites were selected to create the knowledge assessment for the present study. From an item pool \( n = 192 \) of NCLEX-RN and HESI Exit Exam review questions, a random sample of items were selected from each topical area, resulting in an assessment containing 52 items.

**Ethical Considerations**

Institutional Review Board approval was obtained from the multi-site hospital and the author’s institution. All participants completed informed consent forms approved for the present study.

**Data Analysis**

Statistical analysis was performed using R, version 2.15.2 (R Development Core Team, 2013). Data was screened for normality and missing data prior to analysis. Six observations were missing from the general nursing knowledge survey. One observation was missing from each of the survey tools (Shipley-2-Block pattern test and Group Embedded Figures Test).
These observations were deleted prior to analysis. Descriptive statistics were performed to evaluate the data. Multivariate analyses of variance, followed by \( t \)-tests and multiple regression, were conducted. The internal consistency reliability of each continuously scored measure was computed using Cronbach’s alpha.

**Reliability**

Internal consistency reliability was examined using Cronbach’s alpha, a commonly used index of test reliability (Tavakol & Dennick, 2011). Alpha values \( \geq 0.90 \) are considered excellent, and scores \( \leq 0.90 \) and \( \geq 0.70 \) are considered good (Adamson et al., 2011). Both the Shipley-2 Block (26 items, \( \alpha = 0.81 \)) and the GEFT (18 items, \( \alpha = 0.89 \)) were determined to have good reliability in this sample. The test of general nursing knowledge (52 items, \( \alpha = .74 \)) also possesses acceptable reliability in this sample. As the test of general nursing knowledge is a newly created/adapted measure in addition to the fact that the test is rather brief for addressing a very wide range of content, and since a Cronbach’s alpha of 0.70 or greater is often considered acceptable for research purposes (Bland & Altman, 1997), the assessment performs adequately for the present study.

**Results**

Study participants \( (n = 123) \) were registered nurses working within an acute care multi-hospital setting. Descriptive statistics are provided in Table 1.

The \( t \)-test on the two measures of spatial ability, Shipley-2 Block, and GEFT, revealed no statistically significant mean differences for sex, Shipley-2 Block, \( t_{(121)} = 1.70, p = 0.092 \), and GEFT, \( t_{(121)} = 1.07, p = .285 \). However, Cohen’s \( d \) effect sizes for mean sex differences in the
present study are consistent with prior studies (Voyer et al., 1995) for Shipley-2Block ($d = 0.35$
[95% CI = -0.06:0.76]) and GEFT ($d = 0.22$ [95% CI = -0.19:0.63]).

Table 1

**Descriptive Statistics**

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>25</td>
<td>25</td>
<td>66</td>
<td>44.47</td>
<td>9.98</td>
</tr>
<tr>
<td>Years as RN</td>
<td>1</td>
<td>1</td>
<td>46</td>
<td>17.96</td>
<td>10.43</td>
</tr>
<tr>
<td>Proficiency Certifications</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>1.40</td>
<td>1.14</td>
</tr>
<tr>
<td>GEFT</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>10.07</td>
<td>4.98</td>
</tr>
<tr>
<td>Shipley</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>16.04</td>
<td>4.28</td>
</tr>
</tbody>
</table>

Gender

- Male ($M_{age} = 42.87$ years) 31
- Female ($M_{age} = 45.01$ years) 92

Ethnicity

- Asian Pacific 7
- Black 9
- Hispanic 5
- White 101
- Other 1

Education

- Assoc/Diploma 20
- Bachelor Degree - Nursing 59
- Bachelor Degree - Other 2
- Master Degree - Nursing 37
- Master Degree - Other 5

Critical Care Work Environment ($N=56$)

- Surgery/PACU 11
- ICU 28
- NICU 12
- Emergency Dept 5

Non-Critical Care Work Environment ($N=67$)

- Ambulatory 1
- Medical/Surgical 47
- OB/Women 19
GEFT scores were reviewed for field-dependence and field-independence. Nurses with GEFT scores of 15-18, \((n = 30)\) were considered field-independent \((M_{male} = 16.82, SD = 1.25; M_{female} = 16.32, SD = 1.16)\) and comprised 24.6% of all participants. The majority of participants, \((n = 68)\) had GEFT scores of 6-14 \((M_{male} = 9.75, SD = 2.26; M_{female} = 9.63, SD = 2.45)\). Nurses with GEFT scores of 0-5 \((n = 23)\) are considered field-dependent, \((M_{male} = 3.0, SD = 1.63; M_{female} = 2.63, SD = 1.78)\).

MANOVA was conducted to determine if the independent variables of sex, age, years working as RN, the number of professional certifications, working in a critical care work environment or a measure of general nursing knowledge impacted scores on the Shipley-2 Block or GEFT. A one-way MANOVA revealed a significant multivariate main effect for GEFT \((F(1,114) = 6.66, p<.011)\) and Shipley-2 Block \((F(1,114) = 12.5, p<.0006)\). The number of years working as an RN was the only variable that was statistically significant for GEFT \((F(1,114) = 8.81, p = .004)\) and Shipley-2 Block \((F(1,114) = 11.77, p = .0008)\).

Table 2 provides results that include years of nursing experience, sex, and work environment regressed onto Shipley-2 Block scores for the first model tested, the same predictor variables regressed onto GEFT scores for the second model tested. Both models are statistically significant, where “Years of Experience as an RN” is predictive of spatial ability. The models indicate that nurses with greater years of nursing experience have lower levels of spatial ability.
Table 2

Summary of Regression Models with Effects Predicting Shipley 2 Block Pattern Test and Group Embedded Figures Test (N = 122)

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>SE</th>
<th>β</th>
<th>p</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1 (Shipley) *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>19.39</td>
<td>1.80</td>
<td></td>
<td></td>
<td>15.82</td>
<td>22.96</td>
</tr>
<tr>
<td>Sex</td>
<td>-0.84</td>
<td>0.92</td>
<td>-0.09</td>
<td>0.36</td>
<td>-2.67</td>
<td>0.99</td>
</tr>
<tr>
<td>Years as RN</td>
<td>-0.12</td>
<td>0.04</td>
<td>-0.28</td>
<td>0.002</td>
<td>-0.19</td>
<td>-0.04</td>
</tr>
<tr>
<td>Critical Care Work Place</td>
<td>0.42</td>
<td>0.79</td>
<td>0.05</td>
<td>0.60</td>
<td>-1.15</td>
<td>1.98</td>
</tr>
<tr>
<td>Model 2 (GEFT) **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>13.76</td>
<td>2.13</td>
<td></td>
<td></td>
<td>9.55</td>
<td>17.98</td>
</tr>
<tr>
<td>Sex</td>
<td>-0.72</td>
<td>1.09</td>
<td>-0.06</td>
<td>0.51</td>
<td>-2.87</td>
<td>1.44</td>
</tr>
<tr>
<td>Years as RN</td>
<td>-0.13</td>
<td>0.04</td>
<td>-0.26</td>
<td>0.004</td>
<td>-0.21</td>
<td>-0.04</td>
</tr>
<tr>
<td>Critical Care Work Place</td>
<td>-0.40</td>
<td>0.93</td>
<td>-0.26</td>
<td>0.67</td>
<td>-2.87</td>
<td>1.45</td>
</tr>
</tbody>
</table>

* Model 1: $R^2 = 0.10$, adjusted $R^2 = 0.08$, df = (3,118), $F = 4.43$, $p = 0.005$.
** Model 2: $R^2 = 0.08$, adjusted $R^2 = 0.06$, df = (3,118), $F = 3.66$, $p = 0.02$.

The final model, Table 3, examined spatial ability, sex, chosen work environment (critical or non-critical), years working as an RN, and the number of professional certifications regressed onto the measure of general nursing knowledge. This model was not significant, and no interaction effects were present on sex or work environment. Moreover, spatial ability as measured by the Shipley-2 Block or GEFT did not predict general nursing knowledge. However, the number of professional certifications possessed by nurses did correlate with general nursing knowledge, as would be expected.
Table 3

Summary of Regression Models with Effects Predicting General Nursing Knowledge (N = 117)

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>β</th>
<th>p</th>
<th>Confidence Interval</th>
<th>Lower</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1*</td>
<td>Constant</td>
<td>30.11</td>
<td>3.99</td>
<td>0.49</td>
<td>0.620</td>
<td></td>
<td>23.2</td>
<td>39.01</td>
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<tr>
<td></td>
<td>Shapley 2 Block</td>
<td>0.71</td>
<td>0.14</td>
<td>0.49</td>
<td>0.620</td>
<td></td>
<td>-0.21</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>-0.98</td>
<td>1.44</td>
<td>-0.07</td>
<td>0.498</td>
<td></td>
<td>-3.83</td>
<td>1.87</td>
</tr>
<tr>
<td></td>
<td>Critical Care Work Place</td>
<td>0.52</td>
<td>1.22</td>
<td>0.42</td>
<td>0.669</td>
<td></td>
<td>-1.90</td>
<td>2.95</td>
</tr>
<tr>
<td></td>
<td>Yrs as RN</td>
<td>0.08</td>
<td>0.06</td>
<td>0.13</td>
<td>0.194</td>
<td></td>
<td>-0.04</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>Professional Certifications</td>
<td>1.06</td>
<td>0.53</td>
<td>0.19</td>
<td>0.048</td>
<td></td>
<td>0.01</td>
<td>2.10</td>
</tr>
<tr>
<td>Model 2 **</td>
<td>Constant</td>
<td>29.87</td>
<td>3.19</td>
<td></td>
<td></td>
<td></td>
<td>23.54</td>
<td>36.20</td>
</tr>
<tr>
<td></td>
<td>GEFT</td>
<td>0.21</td>
<td>0.12</td>
<td>0.16</td>
<td>0.089</td>
<td></td>
<td>-0.03</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>-0.96</td>
<td>1.41</td>
<td>-0.07</td>
<td>0.497</td>
<td></td>
<td>-3.76</td>
<td>1.84</td>
</tr>
<tr>
<td></td>
<td>Critical Care Work Place</td>
<td>0.41</td>
<td>1.21</td>
<td>0.03</td>
<td>0.734</td>
<td></td>
<td>-1.98</td>
<td>2.80</td>
</tr>
<tr>
<td></td>
<td>Yrs as RN</td>
<td>0.09</td>
<td>0.06</td>
<td>0.15</td>
<td>0.120</td>
<td></td>
<td>-0.02</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Professional Certifications</td>
<td>1.20</td>
<td>0.52</td>
<td>0.21</td>
<td>0.028</td>
<td></td>
<td>0.13</td>
<td>2.28</td>
</tr>
</tbody>
</table>

* Model 1: \( R^2 = 0.07 \); adjusted \( R^2 = 0.03 \); \( df = (5, 110) \); \( F = 1.59 \); \( p = 0.168 \).

** Model 2: \( R^2 = 0.09 \); adjusted \( R^2 = 0.05 \); \( df = (5, 110) \); \( F = 2.28 \); \( p = 0.267 \).

Discussion

Unlike previous studies of spatial ability in health care, the present study examined registered nurses exclusively. The present study contains similar but slightly different measures of spatial ability that permit replication analyses. Additionally, the study contains a newly developed brief measure of general nursing knowledge constructed from existing items that was shown to possess adequate reliability and convergent validity with professional certifications held by RNs. This brief measure may be of value for future studies and should be subjected to further psychometric investigation to determine, among other features, the internal factorial structure and whether key areas of nursing are not addressed.
Gender Differences in Spatial Ability

The majority of studies in spatial ability have reported a significant sex difference in favor of males. The present study did not demonstrate a statistically significant effect for sex differences on two measures of spatial ability, Shipley-2 Block or GEFT. However, Cohen’s $d$ effect sizes for mean sex differences on both assessments are consistent with prior studies, where meta-analytic mean sex differences across 286 studies were estimated to be $ES_{\text{weighted}} = 0.37$ (Voyer et al., 2009). This outcome from the present study may suggest the nursing profession is comparable with other professions where males perform higher than females on spatial ability. In that male nurses from the present study outperform female nurses on measures of spatial ability, the findings from the present study may support screening to increase enrollment in nursing schools for those possessing the trait.

Years of Nursing and Spatial Ability

An increase in the number of years of experience held by nurses appears to be negatively related to greater spatial ability, regardless of sex, consequently nurses with fewer years of experience possess greater spatial ability. Perhaps, the increased requirements and competitiveness for admission to nursing school in recent years has changed the composition of nurses currently entering the profession. Nursing programs now require students to possess strong science and math skills for success, skills that have been consistently correlated with spatial ability. It seems plausible that continued insistence on science and math would increase the presence of spatial ability in the profession, and conversely, the screening of those without such abilities may result in the selection of more males to the nursing workforce if the effect size
differences presented represent significant differences in male/female participants in the profession.

Inpatient work environments, categorized as critical or non-critical in the present study, did not explain individual differences in spatial ability. Historically, individuals with higher levels of spatial ability have been correlated with more complex work environments. Critical care nursing areas typically encompass advanced technology and require nurses to critically think under pressure. The present findings may suggest that spatial abilities are fundamental to many areas of nursing and not specific to any given working environment. Perhaps the various nursing work environments, critical and non-critical, include elements of complexity specific to the department.

Professional Nursing Certifications Predict General Nursing Knowledge

While more work needs to be done to improve the newly developed measure of general nursing knowledge, the final model(s) indicated that general nursing knowledge was only indicated by the number of professional certifications obtained by the nurse. While professional certifications are role-specific, recognizing individuals with increased expertise in specialty areas of nursing (American Nurses Credentialing Center, 2013), RNs must complete eligibility requirements prior to applying for certification examinations such as a minimum degree (Bachelor of Science in Nursing), a minimum number of continuing education hours in the area of specialty, and a minimum number of hours/experience/practice in the area of specialty.

It seems logical nurses with professional certifications would score well on a measure of nursing knowledge given that professional certification indicates superior knowledge, skills and patient care in an area of specialty, exceeding basic nursing information (Bell-Kotwall, Frierson,
Nurses with a professional specialty certification would be expected to have mastery far above foundational nursing information measured by a general nursing knowledge tool.

Years of nursing work history did not predict general nursing knowledge. While this low correlation is likely influenced by the fact that this measure represents current nursing knowledge and practice representative of nursing school curriculum, it appears as though nurses do not appear to be acquiring such skills as a result of time on the job. More interesting for the present study is that years of experience were significantly correlated with spatial ability. These alternative findings suggest that the general nursing knowledge assessment possesses discriminant validity for varying outcomes (spatial ability and years of work).

**Significance**

The present study contributes to the literature on spatial abilities in a previously unstudied population of workers. Given demand for qualified nurses, shifting skill requirements, and gender imbalance in the nursing workforce, the present study provides information that might be useful with nursing student recruitment or screening for nursing schools.

**Limitations**

A limitation with the present study is the sample participants are all employed in one of sixteen acute care multi-centered hospital locations. The omission of RNs working outside of acute care (e.g., ambulatory settings, school settings, academia, or private practice) poses a limitation to the generalization of the present study. The sample of nurses may not be representative of nurses in general.
Additionally, restricting participation to only registered nurses somewhat limits the findings. Considering the various roles in nursing (Licensed Vocational Nurse, Nurse Aide, Nurse Assistant, Nurse Technician) the findings may not be appropriate for these roles.

Conclusions

Activities and skills using spatial ability are omnipresent in many areas of professional nursing every day. Auscultating breath sounds for proper placement of an endotracheal tube requires a nurse to mentally visualize the pulmonary system. Listening for the presence or absence of abnormal breath sounds in patients with shortness of breath requires mental imagery of the lungs to determine a plan of action. Nurses mentally visualize the features of the trachea, larynx and esophagus while inserting a feeding tube for successful placement as it is a blind insertion. Insertions of ewald tubes and foley catheters are activities that also require mental visualization for proper placement. These are but a few examples of spatial ability in nursing.

Assuming the sample for the present study is representative of RNs in general, nurses with more experience, ones that are likely to be leaving the profession soon, do not possess spatial abilities to the extent as those with fewer years of experience. It is important that the field is adapting or reflecting abilities related to the needs of a complex work environment, and it appears as though this is occurring throughout the entire profession, not just the more complex areas. More attention to the shifting nature of the nursing work environment is warranted to assure that the field continues to progress and adapt to present needs.

References


ADVANCED EDUCATION AND CERTIFICATIONS FOR NURSING – DO THEY MAKE A DIFFERENCE?

Introduction

Professional Nursing

Over the past 50 years, changes in nursing, such as job demands, work environments, litigation, salaries, education, uniforms, and technology, have dramatically impacted the role of the professional nurse (Blanche, 2010). In today’s health care environment, nurses monitor complex physiological data, operate lifesaving equipment, administer high cost health care programs and coordinate the delivery of multiple patient services (Weld & Bibb, 2009). The states of New York and New Jersey have proposed all nurses, by 2020, have a minimum of a bachelor of science degree in nursing to enter the profession (Maneval & Teeter, 2010). During the 1980s, a master’s degree became the minimum requirement for an advanced nurse practitioner and a Doctor of Nurse Practice (DNP) will be required by 2015 (McBride, 1999).

Medicine, healthcare and nursing are rooted in scientific findings and practices. Barrett (2002) defines nursing as a basic science and describes the practice of nursing as the scientific art of applying knowledge of humans in combination with their environment for their well-being. Both understanding scientific problem solving and having a strong knowledge base in science are critically important in training nursing students for clinical practice (Johnston & McAllister, 2008). A recent study with over four thousand nursing students, compared admission criteria for nursing programs with a standardized RN fundamentals assessment (Wolkowitz & Kelley, 2010). Wolkowitz and Kelley (2010) reported science coursework as a statistically significant predictor and the strongest predictor for nursing program success. Scores for biology and
chemistry coursework were significant predictors for success with readiness practice exams for RN licensing (Simon, McGinniss & Krauss, 2013).

The nursing profession requires expertise in both science and math (Maag, 2004). Prerequisite requirements for entrance into the Bachelor of Science in Nursing (BSN) program in Texas include courses in biology, microbiology, chemistry, pharmacology, anatomy and physiology. The nursing profession requires nurses to develop areas of specialized knowledge within a broad knowledge base, extensive skill sets, and work in a high stress environment assuming great responsibilities (Brodie, Andrews, Thomas, Wong & Rixon, 2004).

Skill sets required for professional nursing are complex and extensive. The practice of nursing care is discipline specific, but also requires multidisciplinary knowledge, in such areas as respiratory therapy, pharmacy, rehabilitation and surgery (Giuliano, Tyer-Viola, & Lopez, 2005). Foundational science and math knowledge is required in areas such as anatomy and physiology, pharmacology and human behavior. Registered nurses working today utilize skills in assessment, critical thinking, and communication extensively – and must be able to act quickly and decisively. Giuliano, Tyler-Viola, & Lopez (2005) reported that nursing knowledge must be grounded in assessment, interpreting and describing events, predicting outcomes and selecting appropriate nursing care.

Weakness in these required skills can have disastrous consequences. The nurse is the last person in the chain of events from prescription to medication administration, before reaching the patient (Leufer & Cleary-Holdforth, 2013). In the United States alone, over eight million families had at least one family member affected by a medication or medical error (Maag, 2004). Nurses must use basic math functions and algebraic equations to calculate doses of medications and determine intravenous (IV) drip rates (Maag, 2004). In addition to the math computations
necessary to deliver medication safely, nurses must utilize critical thinking and nursing judgment to review the accuracy and appropriateness of a physician’s order, and know the pharmacological implications of all medications they administer to the patients.

Nurses are an essential member of every hospital quality team, as nursing is associated with quality performance metrics (Kohlbrenner, Whitelaw, & Cannaday, 2011). Nursing performance is more important today than ever before as individuals and communities have access to hospital performance and outcome measures by accessing Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) scores (Leibert, 2011). The Joint Commission Leadership Standards identified RNs as the most important contributor of patient safety and quality (Kohlbrenner et al., 2011).

*Magnet Recognition Program*

Hospitals strive to obtain Magnet recognition, a credentialing indicating quality patient care, innovations in professional nursing practice, and nursing excellence (American Nurses Credentialing Center, 2013). Recognition as a Magnet Hospital by the American Nurses Credentialing Center (ANCC) is the gold standard for excellence in nursing practice (Parsons, & Cornett, 2011). The Magnet recognition program began in 1983 when the American Academy of Nursing (AAN) Task Force on Nursing Practice in Hospitals conducted a study to identify work environments that attract and retain well-qualified nurses who promote quality patient, resident and client care. There are currently 393 hospitals with Magnet recognition, approximately 6.9% of all registered hospitals in the United States, with 31 in the state of Texas (ANCC, 2013).
A Magnet hospital is a workplace where nursing staff turnover is low, nurses have high job satisfaction, patients have exemplary outcomes, and nurses have a voice in patient care and are involved with data collection (“Credentialing requirements,” 2013). Consumers, as well as many regulatory agencies, trust a Magnet designation as the ultimate credential for superior quality nursing (ANCC, 2013).

The ANCC is acclaimed for the credentialing programs to certify and recognize nurses in areas of specialty, recognize healthcare systems for promoting safe work environments, and accredit continuing nursing education organizations (ANCC, 2013). Magnet credentialing is governed by the ANCC as the focus is on nursing processes and nurses (“Credentialing requirements,” 2013). A Magnet culture encompasses empowerment, shared decision making, and accountability for nurses (Frellick, 2013; Long, McGee, Kinstler & Huth, 2011). Frellick (2013) describes the 14 Forces of Magnetism, included visionary nursing leadership, creating a workplace that encourages publication, having strong nursing representation at the top levels of management, and empowering nurses in patient care. To provide clarity and direction, the ANCC reconfigured the 14 Forces of Magnetism into 5 Model Components (ANCC, 2013). The updated model represents a greater focus on outcome measurement while retaining the 14 Forces of Magnetism as the foundation (ANCC, 2013). The five components of the updated model are (a) transformational leadership, (b) structural empowerment, (c) exemplary professional practice, (d) new knowledge, innovation and improvements, and (e) empirical quality results (ANCC, 2013). Global issues in nursing and health care, while not a component, includes various issues and challenges facing health care and nursing today (ANCC, 2013). Global issues envelope all of the five model components (ANCC, 2013).
Nursing education is an important segment of the Magnet recognition program. Minimal educational requirements for different nursing roles are included, and the requirements have increased over the years (ANCC, 2013). ANCC (2013) requires the Chief Nursing Officer (CNO) to hold a master’s degree in nursing. Per the ANCC (2013), 75% of all nurse managers within an organization must hold a minimum of a bachelor’s of science in nursing (BSN). Effective January 1, 2013, the education requirement for nurse managers was expanded; 100% of nurse managers must have a BSN or graduate degree in nursing (Hawkins & Shell, 2012). The ANCC (2013) has strongly encouraged Magnet organizations to increase their number of BSN prepared nurses without specifically stating a minimum number. Hawkins and Shell (2012) report a typical Magnet facility has 48.4% of direct care BSN prepared nurses currently. All organizations applying for magnet status after June 1, 2013, must provide an action plan that includes a goal for 80% of registered nurses attaining a degree in nursing (BSN or graduate degree) by 2020 (ANCC, 2013).

**Nursing Education**

Three common avenues to obtain an RN license are a 2-year associate degree program (ADN), a 3-year diploma program, and a 4-year BSN (Lawrence, 2011). According to Lawrence (2011), nursing care provided by four year and higher-degree educationally prepared nurses is potentially related to lower patient mortality. Miner (2012) challenges the nursing profession to abandon the multiple pathways in nursing education and join in adopting the BSN as the entry level education required for nursing practice. The states of New York and New Jersey have proposed all nurses, by 2020, have a minimum of a Bachelor of Science degree in nursing to enter the profession (Maneval & Teeter, 2010). During the 1980’s, a Master’s degree was
established as the minimum requirement for an advanced nurse practitioner. A Doctorate of Nurse Practice (DNP) will be the minimally accepted requirement by 2015 (McBride, 1999).

A BSN education, although not the cure for all that is expected of nurses in the future, does introduce nursing students to a wider range of competencies in areas such as quality improvement, leadership, public health, and health care policy (Institute of Medicine [IOM], 2010). An increase in the number of nurses with a BSN would establish a workforce positioned to achieve education at the master’s and doctoral levels (IOM, 2010). According to the Institute of Medicine (IOM), there is a great demand across the nursing profession for master and doctoral prepared nurses to serve as nurse researchers, primary care providers, and nursing instructors (IOM, 2011).

The IOM (2010) recommends new approaches and educational models for nursing. Basic concepts that apply across many situations should be taught instead of requiring rote memorization (IOM, 2010). The IOM (2010) requests nursing competencies move from task-based proficiencies to higher-level competencies which would provide a foundation for care management and decision-making skills in multiple settings. New competencies in decision making, quality improvement, and team leadership should be incorporated in all parts of nursing education (IOM, 2011).

Nursing education should serve as a platform for lifelong learning, including opportunities for transition to higher degree programs (IOM, 2011). According to the IOM (2010), nurses with an initial ADN degree are just as likely as BSN prepared nurses to seek a higher degree. Approximately two-thirds of nurses today receive an ADN as their initial degree and approximately 80% of these nurses fail to move beyond a BSN degree (IOM, 2011). As advanced nursing degrees are required for nursing faculty, the high numbers of nurses starting
with ADN pose a challenge to have sufficient nursing faculty available to instruct nursing students (IOM, 2011). Currently, 13% of nurses have a graduate degree in nursing; however, less than 1% of nurses have doctoral degrees (IOM, 2012). As doctoral prepared nurses are needed as faculty members to teach future nurses the IOM (2012) recommends doubling the number of doctoral trained nurses by 2020.

Certifications

Licensing and Certification

RN licensure indicates entry-level competence to the nursing field where certification verifies specialty knowledge, skills, experience and clinical judgment (American Association of Critical-Care Nurses, 2013; American Board of Nursing Specialties, 2005). Certification reflects self-mastery with an emphasis on self-evaluation (Crist, Russell, & Farber, 2012). According to Wynd (2003), nursing professionalism is significantly related to years of nursing experience, higher educational degrees in nursing, professional organizational memberships and specialty certification. Nurses with specialty certification have expressed feelings of personal accomplishment, personal and professional satisfaction (Knudson, 2013).

Specialty certifications, respected by nursing staff, employers, and patients, include, at a minimum, a practice component with required knowledge testing (Briggs, Brown, Kesten, & Heath, 2006; Grief, 2013). Nursing specialty certifications provide benefits to the certified nurse, the nursing profession, and the community, including improved patient safety and a commitment to lifelong learning (Williams & Counts, 2013). The American Nurses Credentialing Center (ANCC) is the nationally recognized agency to provide professional
nursing credentialing programs to certify and recognize nurses in areas of specialty (ANCC, 2013).

The majority of hospitals in the United States seek accreditation from the Joint Commission (Williams & Counts, 2013). Many hospitals apply for the Malcolm Baldrige National Quality Award, the American Association of Critical-Care Nurses Beacon Award for Excellence, and for Magnet recognition (Williams & Counts, 2013). All of these programs, whether accrediting, recognizing or awarding, include nursing certifications as an integral factor in demonstrating nursing excellence (Fleischman, Meyer, & Watson, 2011; Williams & Counts, 2013).

Professional Certification and Patient Outcomes

The connection between certified nurses and quality patient care is well established (Crist et al., 2012). Specialty nurse certification is increasing in value as more evidence suggests that certification is a factor in improving patient outcomes (Fleischman et al., 2011; Timmerman, 2008). Studies indicating a correlation between CIC (Certification in Infection Prevention and Control) and reduced infection rates and improved outcomes are starting to be reported (Crist et al., 2012). RNs with a BSN degree and a specialty certification are associated with improved patient outcomes, decreased mortality, and decreased failure to rescue in general surgical patients (Kendall-Gallagher, Aiken, Sloane, & Cimiotti, 2011).

Challenges for Nursing

Role Changes

Over the past 50 years, changes in nursing such as those related to job demands,
technology, work environments, patient acuity, litigation, salaries, education, and uniforms have dramatically impacted the role of the professional nurse (Blanche, 2010). In today’s health care environment, nurses monitor complex physiological data, operate lifesaving equipment, administer high cost health care programs and coordinate the delivery of multiple patient services (Weld & Bibb, 2009). The high demands of academic knowledge and clinical expertise are often unexpected to individuals new to the profession (Brodie et al, 2004; Andrews, Thomas, Wong, & Rixon, 2004). Nursing informatics, a nursing specialty approved in 1992 by the American Nurses Association, is using information and technology to advance the field of nursing, bridging the gap from the art of nursing to the science of nursing (Bond, 2009; Saba, 2001).

Changes in Job Skills

Nurses must use critical thinking skills with assessment, interpretation, and decision making to provide patient care, ensuring patient safety at all times. Clinical knowledge is estimated to double every 18 months (van Terheyden, 2007). Medical practices, pharmaceuticals, regulations and standards of care require constant assimilation of new information. Health care professionals must stay in a continual mode of learning as the field of health care is constantly changing (Hodges, 2011). Providing continual education and training to nurses and health care providers is challenging as individuals often have different learning styles (Fleming, Mckee, Huntley-Moore, 2011; Lockie, van Lanen, & McGannon, 2013).

As health care technology advances and patients require higher levels of care, nurses must incorporate new practices and workflows to meet the changes (Kalisch & Begeny, 2010). Using integrating technology to improve clinical nursing practice enhances the quality of patient
care (Saba, 2001). Today’s nurse must use technology to support workflow as well as support
the patient’s use of increased technology (Bond, 2009). The technology required by nurses may
vary; however, the core skills of basic computer proficiency, information technology, and
information systems for health care practice that comprise the foundations of nursing informatics
are essential for all nurses (Bond, 2009).

The American Recovery and Reinvestment Act (ARRA) of 2009 included incentives for
use of health information technology (HIT) for meaningful use (IOM, 2011). Creation of EHRs
(electronic health record) using CPOE (computerized physician order entry) and interfacing of
various electronic applications has created a complex and dynamic work environment for nurses
(IOM, 2011). Expansion of biometric devices such as automated insulin pumps and implantable
cardiac defibrillators require nurses to continually expand the use of technology in patient care.

Skill sets required for professional nursing are complex and extensive. The practice of
nursing care is discipline specific, but also requires multidisciplinary knowledge in such areas as
respiratory therapy, pharmacy, rehabilitation, and surgery (Giuliano et al., 2005). Nurses must
be proactive problem solvers and collaborative interdisciplinary team members (Hodges, 2011).
Foundational science and math knowledge are required for nurses in areas such as anatomy and
physiology, pharmacology and human behavior. Registered nurses working today extensively
utilize skills in assessment, critical thinking, and communication and must be able to act quickly
and decisively. Giuliano, Tyler-Viola, & Lopez (2005) reported that nursing knowledge must be
grounded in assessment, interpreting and describing events, predicting outcomes and selecting
appropriate nursing care

The nurse is the last safety check in the chain of events from prescription to medication
administration, before reaching the patient (Leufer & Cleary-Holdforth, 2013). In the United
States alone, over 8 million families had at least one family member affected by a medication or medical error (Maag, 2004). Nurses must use basic math functions and algebraic equations to calculate doses of medications and determine intravenous (IV) drip rates (Maag, 2004). Research has shown spatial visualization abilities to be positively related with performance on math tasks, as well as tasks in science, technology, and engineering (Hinze et al., 2013). In addition to the math computations necessary to deliver medication safely, nurses must also utilize critical thinking and nursing judgment to review the accuracy and appropriateness of a physician’s order and know the pharmacological implications of all medications they administer to their patients.

Nurses are associated with quality performance metrics and are therefore essential members of every hospital quality team (Kohlbrenner et al., 2011). Nursing performance is more important today than ever before as communities can access hospital performance and outcome measures by accessing Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) scores (Leibert, 2011). The Joint Commission Leadership Standards identified RNs as the most important contributor of patient safety and quality (Kohlbrenner et al., 2011).

Advances in Medical Care

Many advances in medical care have resulted in greater numbers of hospitalized patients, more critically ill patients upon admission to hospitals, and aging patients as well as improved survival from critical events (Kuehn, 2007; Lynn & Redman, 2005). Increased patient acuity levels with shortened lengths of hospital stays create intensive and accelerated health care processes (Hirschkorn, West, Hill, Cleary, & Hewlett, 2010). The practice of a clinical nurse can
be challenging and chaotic, often impacted by personnel shortages, decreasing resources, and seemingly unending documentation (Kramer et al., 2013). Nurses complete an average of 100 tasks per shift, with an interruption every 3 minutes, often resulting in cognitive overload (Hendren, 2011). All of these improvements and changes rely on tremendous knowledge and a skill set that allows the nursing professional to deliver optimal care demanded in such situations.

Nursing Shortage

Predictions

The nursing profession is experiencing a national workforce shortage of critical proportion (Juraschek, Zhang, Ranganathan & Lin, 2012). The current shortage of Registered Nurses (RNs) in the Unites States is unlike any previous nursing shortage to date (Goodin, 2003). Beginning in 1998, the United States has experienced an increasing RN deficit, primarily due to the growing elderly population and aging nurses (Juraschek et al., 2012). This shortage is predicted to worsen, with an expected national shortage of 300,000 to 1 million RNs in 2020, and continued shortages throughout the country through 2030 (Juraschek et al., 2013). The shortage in the number of working RNs is projected to begin around 2015 and will continue to increase threefold, more than any nursing deficit previously experienced in the US over the past 50 years (Buerhaus, 2008). A report from the U.S. Department of Health and Human Services (2010) predicted a nursing shortage equating to a 36% shortage.

Aging Workforce

The aging RN workforce strongly impacts the projected nursing shortage (Juraschek et al., 2012). Nurses that were 50 years of age or older comprised 25% of the nursing workforce in
1980, 33% of the nursing workforce in 2000, and were accountable for 45% of the nursing workforce in 2008 (Juraschek et al.; US Department of Health and Human Services, 2010). A survey conducted in 2013 reported that 55% of the current RN workforces is age 50 or older (Budden, Zhong, Moulton, & Cimiotti, 2013). It is estimated that 55% of currently employed nurses plan to retire before 2020 (Hirschkorn et al., 2010).

**Job Dissatisfaction**

Social support from supervisors and coworkers, job demands, and self-efficacy were reported to be significantly related to job dissatisfaction, while demands and support from coworkers were related to intention to leave the profession (Peterson, Hall, O’Brien-Pallas, & Cockerill, 2011). Job dissatisfaction was a strong determinant of turnover among new nursing graduates, with interpersonal relationships having the strongest impact (Cho, Lee, Mark, & Yun, 2012). Cho, Lee, Mark & Yun (2012) reported nurse’s dissatisfaction with work content to be impacting nursing turnover (Cho et al., 2012). Nurses new to the profession are often disillusioned when what they learned nursing should be is different from the reality of nursing practice in their work place (Cho et al., 2012).

**Nursing Faculty Shortage**

There are many factors for the nursing shortage with a shortage of nursing educators being one of the factors (Rich & Nugent, 2010). The American Association of Colleges of Nurses (AACN) reported shortages of nursing school faculty across the country are limiting nursing student enrollment capacity (AACN, 2014). In 2012, U.S. nursing schools declined almost 80,000 qualified applicants for baccalaureate and graduate nursing programs due to a lack
of faculty, clinical sites, clinical preceptors and budget constraints (AACN, 2014). Higher financial compensation in clinical settings is enticing current and potential nursing faculty away from the academic setting (AACN, 2014).

Addressing the Nursing Shortage

In addressing the nursing shortage created by increasing demand for nursing services, caused partially from an aging population and increased rates of insurance coverage, the nursing workforce must expand by encouraging younger individuals to join the profession (IOM, 2011). Identifying reasons why nurses are leaving the profession is another important step in addressing the impending nursing shortage. Nurse leaders and managers play critical roles in supporting new graduates with developing interpersonal relationships among nursing staff and other personnel (Cho et al., 2012). Addressing the new nurse’s dissatisfaction with their work content poses many challenges. Ensuring nursing students have realistic nursing experiences during school may address this issue (Cho et al., 2012). Clear job descriptions and clear expectations provided to potential nursing students may assist with providing students a realistic picture of the nursing profession.

Another process to address the predicted nursing shortage would be to ensure those entering the profession possess essential aptitudes for a career in nursing. In this manner, the profession of nursing might benefit from alignment with current strategies of early identification of individuals with potential for success, as is being done in science, technology, engineering, and math (STEM) fields.

Students often enter the field of nursing with common misconceptions, such as nursing is a subordinate occupation, requiring only common sense and little intellectual capacity (Brodie et
al., 2004). Students are surprised, even overwhelmed, by the required high academic standards in nursing. The unexpected demands of academic knowledge and clinical expertise have been identified as a source of nursing student attrition (Brodie et al., 2004) Acquiring the required knowledge and skills often overwhelms students preparing for a nursing career. Through their nursing education, students learn to accept and value the tremendous knowledge, skill set and responsibilities of nurses (Brodie et al., 2004). Harvey and McMurray (1997) reported that 81% of students dropping from a pre-nursing course cited a perceived discrepancy between the content of their course and their preconceived ideas of the nursing profession. Failure to recognize that nursing is based on science and requires a complex and specialized skill set with the ability to think critically and act decisively underlies much of that perceived discrepancy (Harvey & McMurray, 1997).

**Spatial Ability**

General Cognitive Ability - $g$

Charles Spearman introduced the first theory of intelligence in 1904, identifying general mental ability as a trait based on his findings that all mental test scores were positively correlated (Floyd, McGrew, Barry, Rafael, & Rogers, 2009; Jensen, 1987). Spearman proposed general intelligence, $g$, as the identified factor that accounted for correlations among cognitive ability tests (Carroll, 1997). Researchers generally agree that intelligence is not the amount of information people have but their ability to recognize, acquire, organize, update, select and apply information (Gottfredson, 1997).

General cognitive ability ($g$) is the capacity to work with cognitive complexity, more specifically, complex informational processing (Gottfredson, 1997; 2002). An application
definition of general cognitive ability (g) is the aptitude to learn moderately complex material quickly and efficiently and the ability to prevent cognitive errors (Gottfredson, 2002). The g factor is the main underlying construct for most ability tests, accounting for the majority of these tests’ predictive ability, and is the most important predictor of job performance (Gottfredson, 2002). Gottfredson (2002) reports the more a test is g-loaded, the greater the test predicts performance in school, employment, and income. General cognitive ability has been identified as the primary predictor for occupational success in the United States (Kane & Brand, 2003).

Raymond Cattell suggested human intelligence is comprised of two complementary intelligence factors--crystallized and fluid intelligence (Horn & Cattell, 1966). Crystallized intelligence, gc, represents specific knowledge that one obtains from learning, education and experience, such as general information, vocabulary, and math. In contrast, fluid intelligence, gf, represents the capacity to solve problems, think logically, and reason independent of acquired knowledge (Jensen, 1987). John Horn furthered Cattell’s research in 1965, confirming the gf/gc relationship as well as identifying new broad factors of visual processing, auditory processing, long term storage and retrieval, cognitive processing speed, and short term memory (Kane & Brand, 2003). These findings resulted in an expanded theory of intelligence, the Cattell-Horn Gf-Gc theory (McGrew, 2009).

Carroll (1997) reported general cognitive ability (g) is more likely an indicator of how fast an individual can learn rather than an indicator of an individual’s capability of learning. Carroll’s research proposed a hierarchical model of intelligence, describing cognitive abilities in terms of a three-stratum model (Carroll, 1997; Kane & Brand, 2003). Stratum 1 is composed of a large number of narrow abilities, such as language development, reading, and spelling. Stratum II consists of 10 broad abilities, such as fluid intelligence, crystallized intelligence,
general memory and processing speed (Kane & Brand, 2003). The highest stratum, Stratum III, consists of only one single factor, \( g \), generalized intelligence (Carroll, 1997). Halpern (1998) reports critical thinking skills are often associated with higher order cognitive skills, in comparison to simpler or lower order thinking skills.

Cattell-Horn-Carroll Theory

The Cattell Horn Carroll (CHC) theory of intelligence was developed by merging the Cattell-Horn Gf-Gc model with Carroll’s three-tiered stratum model to form a broader hierarchical model of \( g \) (Floyd, Evans, & McGrew, 2003; McGrew, 2009). CHC theory allows researchers to assess the relationships between cognitive abilities and academic achievements, an important element of learning and education (McGrew & Wendling, 2010). Keith and Reynolds (2010) report the CHC theory provides the best description of human intelligence functions as both a working theory for describing and understanding cognitive abilities and a guide for development of new assessment tools.

General cognitive ability, \( g \), is the highest level of the hierarchy at Stratum III (Bickley, Keith, & Wolfe, 1995; Parkin & Beaujean, 2012). Stratum II contains 10 broad CHC abilities with visual processing, \( \text{Gv} \), being one of the ten (Rozencwajg, Schaffer, & Lefebvre, 2010). Making use of simulated mental imagery to solve problems is the basis of visual processing (McGrew, 2013). Visual-spatial ability includes many specific perceptual abilities, being cognizant of complex visual patterns, being aware of where items are located in space, in addition to visualizing objects as they would appear from a different angle (Schneider & McGrew, 2012; 2013). According to McGrew (2009), \( \text{Gv} \) abilities are often measured by tasks that require retaining the spatial orientation of an object after the object has been moved or
changed. Figure 2 provides a visual illustration, comparing Carroll's Three-Stratum, Cattell–Horn's Extended Gf–Gc, and the integrated Cattell–Horn–Carroll models of human cognitive abilities (McGrew, 2009).

Figure 2. Schematic representation and comparisons of Carroll's three-stratum, Cattell–Horn's extended Gf–Gc, and the integrated Cattell–Horn–Carroll models of human cognitive abilities. (McGrew, 2009).

General cognitive ability, $g$, is the highest level of the hierarchy at Stratum III (Bickley et al., 1995; Parkin & Beaujean, 2012). Stratum II contains 10 broad CHC abilities: (a) fluid intelligence, (b) quantitative knowledge, (c) crystalized intelligence, (d) reading and writing ability, (e) short-term memory, (f) visual processing, (g) auditory processing, (h) long-term retrieval, (i) processing speed, and (j) decision/reaction time/speed (Rozenewajg et al., 2010). Over 100 narrow abilities are included in Stratum I and are subsumed under the broader abilities in Stratum II (Parkin & Beaujean, 2010)
The current study focused on the broad ability of visual processing, Gv. Visual-spatial ability, using simulated mental imagery to solve problems, includes many specific perceptual abilities, being cognizant of complex visual patterns, being aware of the location of items in space, in addition to visualizing objects as they would appear from a different angle (McGrew, 2013; Schneider & McGrew, 2012; 2013). According to McGrew (2009), Gv abilities are often measured by tasks that require retaining the spatial orientation of an object after the object has been moved or changed. Higher Gv ability allows an individual to see more than the object by imagining the object from a different view after mental rotation, mentally taking a complex item apart and reassembling the item (Schneider & McGrew, 2013). Lower Gv levels decrease an individual’s ability to perform mental rotations causing the person to wait until an object is physically rotated to see the change (Schneider & McGrew, 2013). McGrew (2013) explains that after the eyes have transmitted visual information, the visual system of the brain performs a number of basic computations, such as edge detection, light/dark perception, color-differentiation, and motion-detection. These activities are used by more high level processors to create more complex aspects of the image, such as spatial configuration (McGrew, 2013).

Spatial Ability and Job Performance

General cognitive ability, g, is a significant component of individual differences in job performance associated with informational processing skills (Lubinski, 2000). Greater levels of g are associated with higher levels of performance in all jobs and within all dimensions of performance (Gottfredson, 2002). Health care organizations are frequently described within the context of complexity, situations involving people working independently and collectively to manage an unpredictable work environment over time (Fairchild, 2010). Individuals with high
general cognitive ability are needed in the nursing profession. As nursing requires strong information processing activities for successful patient care assessing individuals considering entering the nursing profession for general cognitive ability, specifically spatial visualization, might be beneficial.

Spatial Ability in Health Care

Over 50 years of research exists on the importance of using spatial ability, specifically in the realm of science, technology, engineering, and math (STEM), for selection and instruction in education (Wai, Lubinski, & Benbow, 2009). Spatial ability, often neglected in complex work environments, is a powerful systematic source of individual differences (Lubinski, 2010). Snow (1999) expressed concern about the absence of spatial ability in applied educational settings:

There is good evidence that [spatial ability] relates to specialized achievements in fields such as architecture, dentistry, engineering, and medicine...Given this plus the longstanding anecdotal evidence on the role of visualization in scientific discovery... it is incredible that there has been so little programmatic research on admissions testing in this domain. (p. 136)

A recent study with over 4000 nursing students, compared admission criteria for nursing programs with a standardized RN (Registered Nurse) Fundamentals assessment (Wolkowitz & Kelley, 2010). Wolkowitz and Kelley (2010) reported science coursework as a statistically significant predictor and the strongest predictor for nursing program success. Scores for biology and chemistry coursework were significant predictors for success with readiness practice exams for RN licensing (Simon et al., 2013). As science is fundamental for nursing education and higher spatial ability levels are associated with success in math, nursing should consider joining efforts with educational departments in evaluating spatial ability in efforts to identify potential candidates to enter professional nursing.
Health care professions must use critical thinking skills with assessment, interpretation, and decision making to provide patient care, ensuring patient safety at all times. The field of medicine is constantly changing, requiring health care professions to stay in a continual mode of learning (Hodges, 2011). Clinical knowledge is estimated to double every 18 months (van Terheyden, 2007). Medical practices, pharmaceuticals, regulations and standards of care require constant assimilation of new information. Providing continual education and training to health care providers is challenging as individuals often have different learning styles (Fleming et al., 2011; Lockie et al., 2013).

Spatial ability, specifically mental rotation, is associated with success in the learning of anatomy and physiology, basic courses in medical training (Hegarty, Keehner, Khooshabeh, & Montello, 2009, Hoyek et al., 2009; Langlois et al., 2009; Stransky, Wilcox & Dubrowski, 2010; Stull, Hegarty & Mayer, 2009). For complex surgeries, visual spatial ability has been related to competency and quality of results (Wanzel, Hamstra, Anastakis, Matsumoto & Cusimano, 2002). The ability to mentally rotate an object in 3 dimensions, visualizing structures from several viewpoints with three dimensional images, carried significant importance in learning spatially complex surgical technical skills, echoing other studies that found surgical skills to be strongly dependent on spatial skills (Brandt & Davies, 2006; Stransky et al., 2010).

The Study

Aim

The aim of the present study was to survey registered nurses for education history, years of nursing experience, and specialty certifications to determine if there are individual differences in education and specialty certifications. The research questions were:
Research Question 1: Does the education of an RN, general nursing knowledge or years worked as an RN have an impact on the number of professional certifications obtained?

Research Question 2: Does the number of certifications a nurse has obtained, general nursing knowledge, or years worked as an RN predict a nurse’s education?

Design

The present study utilized a cross-sectional research design. Cross-sectional studies involve data collection at a defined time. This type of study collects data to make inferences about a population of interest at one point in time; often described as snapshots of a population (Carlson & Morrison, 2009).

Participants

Sixteen acute care hospitals within a multi-hospital setting were used to establish a population of registered nurses for the present study. Contact was made with supervisors of selected nursing groups with a request that they provide information about the study to the RNs within their group and the need for research participants. Respondents were screened for eligibility and provided with study information and informed consent forms. The sample consisted of 123 registered nurses ($M_{age} = 44.47$ years, $SD = 9.98$) employed with an acute care multi-hospital setting. Male nurses accounted for 31 of the total participants ($M_{age} = 42.87$ years, $SD = 8.94$), with a range of professional certifications from 0 to 4 ($M_{cert} = 1.32$, $SD = 0.94$), and a range of nursing experience years from 1 to 38 ($M_{yrs} = 14.71$, $SD = 8.98$). Female nurses accounted for 92 of the total participants ($M_{age} = 45.01$ years, $SD = 10.29$), with a range of professional certifications from 0 to 6 ($M_{cert} = 1.42$, $SD = 1.21$), and a range of nursing experience years from 3 to 46 ($M_{yrs} = 19.05$, $SD = 10.69$).
Eligibility for inclusion required participants to be currently employed as a registered nurse at one of the 16 acute care hospitals. Speaking and understanding English did not exclude any participant from the study as English language competency is a requirement for employment.

Data Collection

Sampling Procedures

Using G*Power3.1 (Faul, Erdfelder, Lang, & Buchner, 2007), an a priori estimate of sufficient sample size required to achieve power (1 - β) = .80 was conducted. Targeting a medium effect size (Cohen’s d = 0.5) with α = 0.05, the initial sample estimate was N = 102, assuming the sample allocation ratio was 1:1 for females and males. After obtaining Institutional Review Board approval recruitment of RN nurse participants began with an attempt to obtain 51 females and 51 males. Because of the small sampling frame for males, emphasis was placed on identification and securing male participants. After exhausting all available nurse supervisors, a total of 31 males who agreed to participate in the study were identified. Consequently, to maintain adequate statistical power, additional female participants were recruited (N = 92) resulting in a total sample of 123 (25% male).

Research Methods

Each participant was scheduled for an individual research appointment, in which they were individually administered a battery of assessments using the same protocol for administration for all participants. The protocol order was as follows: a brief demographic and work history survey, the Shipley-2 Block Pattern Test, the Group Embedded Figures Test, and a test of general nursing knowledge. Each of these measures is described.
Each participant was scheduled for an individual research appointment, in which the nurse was individually administered a battery of assessments, using the same protocol for administration for all participants. The protocol order was as follows: a brief demographic and work history survey, the Shipley-2 Block Pattern Test, the Group Embedded Figures Test, and a test of general nursing knowledge. Each of these measures is described below.

**Instrumentation**

*Demographic and Work History*

The demographic and work history survey included each participant’s name, date of birth, gender, highest level of completed education, years worked as RN, current work place environment, and identification of the titles of the professional certifications currently held. The American Nurses Credentialing Center (ANCC) lists 25 professional specialty certifications for RNs (*American Nurses Credentialing Center*, 2013). The current study included additional certifications such as Advanced Critical Life Support (ACLS) and Sexual Assault Nurse Examiner (SANE).

*Shipley-2 Block Pattern Test*

The Shipley-2 Block Pattern Test is a nonverbal assessment of fluid cognitive ability in the spatial (Gv) domain (*Western Psychological Services*, 2012). The revision and restandardization of the original 1940 Shipley Institute of Living Scale, along with the adaptation of Kohs Block Design Test resulted in the current version of the Shipley-2 Block Pattern Test (*Beaujean et al.*, 2011). Administering a non-verbal block patterns test provides a method of measuring abstract thinking ability in an easily understandable way (*DARA, Drug and Alcohol*
Rehab Asia, 2008). The Shipley-2 Block Pattern Test is a 2-page paper-and-pencil assessment, composed of 26 multiple choice-matching items in which participants view a stimulus mosaic block diagram that has an essential piece(s) missing, and determine from a variety of provided graphics, which piece(s) is needed to complete the stimulus graphic (Shipley, Gruber, Martin, & Klein, 2009). The participant has 10 minutes to complete the tasks. Per the Shipley 2 Manual the Block Pattern test has a mean internal consistency of 0.92 for adults. This instrument can be administered individually or in a group setting, is a quick measure of intellectual functioning, and has been standardized for use with children ages 7 to 19 years, and adults ages 17 to 89 years (Shipley et al., 2009).

**Group Embedded Figures Test**

The Group Embedded Figures Test (GEFT), developed in 1977, is an adaptation of the original 1971 Embedded Figures Test (EFT) and can be administered in individual or group settings to examine cognitive functioning in the spatial (Gv) domain (Witkin, Oltman, Raskin, & Karp, 2002). The GEFT has a reported reliability of $r = 0.89$ for males and females (Rittschof, 2010). This measurement tool is the most widely recognized measure for cognitive styles of field-dependence and field-independence, measuring a style of cognitive perceptual ability (Beres, Magyar, & Turscanyi-Szabo, 2012; Blanton, 2004).

Finding common geometric shapes in a larger design provides information about field dependence and field independence (Thompson & Melancon, 1987). Field-independent respondents are often more autonomous in the development of restructuring skills, required during technical tasks with which the individual is not necessarily familiar (Khatib & Hosseinpur, 2011). As reported by Khatib and Hosseinpur (2011), field-independent
respondents tend to view concepts analytically, have less difficulty with problem solving, and are intrinsically motivated. On the other end of the spectrum, field-dependent individuals often struggle to solve problems, tend to be extrinsically motivated, and are reported to learn better when the organization and structure is provided to them (Robinson, Kitchel, & Garton, 2009). A high GEFT score (15-18) indicates the individual can separate the simple figure from the complex figure and has habits associated with field-independence (Blanton, 2004). According to Blanton (2004), a low GEFT score (0-5) indicates the individual has tendencies towards field-dependence. Individuals with mid-range GEFT scores (6-14) are associated with a combination of field-dependence and field-independence (Blanton, 2004).

Participants are provided a booklet with simple visual figures embedded inside progressively more complicated visual figures. The GEFT contains 18 complex figures, each with an embedded simple figure. The participant’s task on each item is to locate a previously seen simple figure within a larger complex figure which is organized as to obscure the simple figure (Khatib & Hosseinpur, 2011). Participants must ignore confusing visual information to find and outline the hidden figure (Noble, Miller, & Heckman, 2008). The test includes three sections. The first section, with a time limit of two minutes, has seven practice examples that demonstrate the process for each participant. The first section is not included in the total score of the GEFT. The second and third sections each consist of 9 items, with a 5-minute time limit for each section. Scoring is based on the number of simple forms correctly identified within the second and third sections, ranging from 0 to 18 (Guillot, Champely, Batier, Thiriet & Collet, 2007).
General Nursing Knowledge

There has been little progress in the nursing profession towards the development of a general tool to evaluate overall nursing knowledge and skills outside of nursing schools (Long, Mitchell, Young, & Rickard, 2013). Assessing general nursing knowledge and fundamental competencies identifies areas for professional development and educational needs; as well as ensuring nurse capabilities are matched to patient needs (O'Leary, 2012). As there are no validated tools for assessing general nursing knowledge outside of certification/licensing exams, an assessment was created using sample review questions for the NCLEX-RN exit exam and the HESI exit exam (Suhonen, Schmidt, & Radwin, 2007) as a proxy for nursing competency.

The NCBSN does not provide, recommend, or endorse any specific review program for the NCLEX-RN exam (National Council of State Boards of Nursing, 2013). Sample review questions from free on-line NCLEX-RN and HESI Exit Exam study websites were selected to create the knowledge assessment for the present study. Content for the NCLEX-RN and HESI Exit exams, based on client needs, is grouped into four categories, with subcategories for two of the four groups (National Council of State Boards of Nursing, 2013).

- Safe Effective Care Environment
  - Management of Care
  - Safety and Infection Control
- Health Promotion and Maintenance
- Psychosocial Integrity
- Physiological Integrity
  - Basic Care and Comfort
  - Pharmacological and Parenteral Therapies
Reduction of Risk Potential

Physiological Adaptation

From an item pool \((n = 192)\) of NCLEX-RN and HESI Exit Exam review questions, a random sample of items were selected from each topical area, resulting in an assessment containing 52 items.

**Ethical Considerations**

Institutional Review Board approval was obtained from the multi-site hospital and the author’s institution. All participants completed informed consent forms approved for the present study.

**Data Analysis**

Statistical analysis was performed using R, version 2.15.2 (R Development Core Team, 2013). Data was screened for normality and missing data prior to analysis. Six observations were missing from the nurse proficiency survey. Six observations were missing from general nursing knowledge survey. These observations were deleted prior to analysis. Descriptive statistics were performed to evaluate the data. The internal consistency reliability of each continuously scored measure was computed using Cronbach’s alpha.

**Reliability**

Internal consistency reliability was examined using Cronbach’s alpha, a commonly used index of test reliability (Tavakol & Dennick, 2011). Alpha values \(\geq 0.90\) are considered excellent and scores \(\leq 0.90\) and \(\geq 0.70\) are considered good (Adamson et al., 2011). The test of general
nursing knowledge (54 items, $\alpha = .74$) also possesses acceptable reliability in this sample. As the test of general nursing knowledge is a newly created measure, a Cronbach’s alpha of 0.70 or greater is considered acceptable (Bland and Altman, 1997).

Results

Study participants ($n = 123$) were registered nurses working within an acute care multi-hospital setting. Descriptive statistics are provided in Table 4.

Table 4

Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>$N$</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
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<td>25</td>
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<td>9.98</td>
</tr>
<tr>
<td>Years as RN</td>
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Gender

- Male ($M_{age} = 42.87$ years) 31
- Female ($M_{age} = 45.01$ years) 92

Ethnicity

- Asian Pacific 7
- Black 9
- Hispanic 5
- White 101
- Other 1

Education

- Assoc/Diploma 20
- Bachelor Degree - Nursing 59
- Bachelor Degree - Other 2
- Master Degree - Nursing 37
- Master Degree - Other 5

Critical Care Work Environment ($N = 56$)

- Surgery/PACU 11
- ICU 28
- NICU 12
- Emergency Dept 5

Non-Critical Care Work Environment ($N = 67$)

- Ambulatory 1
- Medical/Surgical 47
- OB/Women 19
MANOVA was conducted to determine if the independent variables of education, general nursing knowledge, or years working as an RN impacted the number of professional certifications for a nurse. The results are displayed in Table 5. The model is statistically significant where general nursing knowledge is predictive of professional certifications.

Table 5

Summary of Regression Model with Effects Predicting Professional Certification (N = 116)

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* Model 1: $R^2 = 0.07$; adjusted $R^2 = 0.05$; df = (3,113); $F = 2.91$; $p = 0.038$.

Table 6 provides results that include professional certifications, general nursing knowledge, and years working as an RN regressed onto education. This model was not significant and none of the independent variables predicted professional certifications.

Table 6

Summary of Regression Model with Effects Predicting Education (N = 116)

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* Model 2: $R^2 = 0.009$; adjusted $R^2 = 0.02$; df = (3,113); $F = 0.33$; $p = 0.802$. 
Discussion

Unlike previous studies of professional nursing certification, the present study examined registered nurses across various work environments. Additionally, the present study examined registered nurses exclusively for spatial ability. The study contains similar but slightly different measures of spatial ability that permit replication analyses. The study contains a newly developed brief measure of general nursing knowledge constructed from existing items that was shown to possess adequate reliability and convergent validity with professional certifications held by RNs. This brief measure may be of value for future studies, and should be subjected to further psychometric investigation to determine, among other features, the internal factorial structure and whether key areas of nursing are not addressed.

Predictors of General Nursing Knowledge

While more work needs to be done to improve the newly developed measure of general nursing knowledge, it seems apparent from the first model that professional certifications are impacted by general nursing knowledge. In other words, nurses with a mastery of general nursing knowledge are more apt to obtain professional nursing certifications.

Professional certifications are role-specific, recognizing individuals with increased expertise in specialty areas of nursing (American Nurses Credentialing Center, 2013). RN’s must complete eligibility requirements prior to applying for certification examinations. There are various required criteria, dependent on the certification; however most specialty certifications require a minimum degree (Bachelor of Science in Nursing), a minimum number of continuing education hours in the area of specialty, and a minimum number of hours/experience/practice in the area of specialty.
One can understand that nurses with a mastery of general nursing knowledge would also be likely to obtain professional certifications, given that professional certification indicates superior knowledge, skills and patient care in an area of specialty, exceeding basic nursing information (Bell-Kotwall, Frierson, & Kuiper, 2012). Nurses with a professional specialty certification would be expected to have mastery far above foundational nursing information measured by a general nursing knowledge tool. A possible explanation why years of nursing experience did not predict nursing knowledge or professional certifications may be based on the concept that length of time working in nursing doesn’t necessarily imply increased knowledge. Nurses who work in single field of practice for many years might not achieve specialty skills or advanced knowledge. Another explanation is that the current nursing profession is diverse, providing many options of work specialties. A nurse may move frequently between different work areas. In this situation, the nurse would not be able to obtain the required work history in any given area of specialty to allow the nurse to apply for certification.

Significance

The present study adds to the overall knowledge base on professional nursing certifications and general nursing knowledge. The present study contributes to the vast literature on spatial abilities in a previously unstudied population of workers. Given the present demand for qualified nurses, the shifting skill requirements, and gender imbalance in the nursing workforce, the present study provides information that might be useful with nursing student recruitment. The fact that gender differences have been reported with spatial ability in professions outside of nursing and the history of nursing as a predominantly female career, the
present study enhances the current literature on spatial ability and gender differences, specifically in health care.

Limitations

A limitation with the present study is the sample participants are all employed in one of sixteen acute care multi-centered hospital locations. The omission of RNs working outside of acute care (ambulatory setting, school setting, academia, or private practice) poses a limitation to the generalization of the present study. The present study sample of nurses may not be representative of nurses in general.

Additionally, restricting participation to only registered nurses added restrictions to the findings. Considering the various roles in nursing (Licensed Vocational Nurse, Nurse Aide, Nurse Assistant, Nurse Technician) the present study may have limited findings.

Conclusions

In the continually changing field of professional nursing, ensuring nurses have a mastery of general nursing knowledge is vital to all patients. Additionally, as health care is assessed and reported on patient outcomes and as hospitals are competing for national recognition, it is important to increase the number of nurses with professional certifications. The next step will be to establish ways to encourage more nurses to obtain professional certifications and advanced nursing degrees.

References


APPENDIX A

NURSING KNOWLEDGE ASSESSMENT
Sample Questions from NCLEX (National Council Licensure Examination)

1. What is the first intervention for a patient experiencing chest pain and an Sp02 of 89%?  
   a. Administer morphine  
   b. Administer oxygen  
   c. Administer sublingual nitroglycerin  
   d. Obtain an electrocardiogram (ECC)

2. Which of the following signs and symptoms usually signifies rapid expansion and impending rupture of an abdominal aortic aneurysm?  
   a. Abdominal pain  
   b. Absent pedal pulses  
   c. Chest pain  
   d. Lower back pain

3. In which of the following types of cardiomyopathy does cardiac output remain normal?  
   a. Dilated  
   b. Hypertrophic  
   c. Obliterative  
   d. Restrictive

4. Which of the following interventions should be your first priority when treating a patient experiencing chest pain while walking?  
   a. Have the patient sit down  
   b. Get the patient back to bed  
   c. Obtain an ECG  
   d. Administer sublingual nitroglycerin.

5. Which of the following positions would best aid breathing for a patient with acute pulmonary edema?  
   a. Lying flat in bed  
   b. Left side-lying position  
   c. High Fowler’s position  
   d. Semi-Fowler’s position

6. A pregnant woman arrives at the emergency department (ED) with abruptio placentae at 34 weeks’ gestation. She’s at risk for which of the following blood dyscrasias?  
   a. Thrombocytopenia  
   b. Idiopathic thrombocytopenic purpura (ITP).  
   c. Disseminated intravascular coagulation (DIC)  
   d. Heparin-associated thrombosis and thrombocytopenia (HATT).
7. A 16-year-old patient involved in a motor vehicle accident arrives in the ED unconscious and severely hypotensive. He’s suspected to have several fractures of his pelvis and legs. Which of the following parenteral fluids is the best choice for his current condition?
   a. Fresh Frozen Plasma (FFP)
   b. 0.9% sodium chloride solution
   c. Lactated Ringer’s solution
   d. Packed red blood cells

8. Corticosteroids are potent suppressors of the body’s inflammatory response. Which of the following conditions or actions do they suppress?
   a. Cushing syndrome
   b. Pain receptors
   c. Immune response
   d. Neural transmission

9. A patient infected with human immunodeficiency virus (HIV) begins zidovudine therapy (AZT). Which of the following statements best describes this drug’s action?
   a. It destroys the outer wall of the virus and kills it
   b. It interferes with viral replication
   c. It stimulates the immune system
   d. It promotes excretion of viral antibodies

10. A 20-year-old patient is being treated for pneumonia. He has a persistent cough and complains of severe pain on coughing. What could you tell him to help him reduce his discomfort?
    a. “Hold your cough as much as possible”
    b. "Place the head of your bed flat to help with coughing."
    c. "Restrict fluids to help decrease the amount of sputum."
    d. "Splint your chest wall with a pillow for comfort."

11. A 19-year-old patient comes to the ED with acute asthma. His respiratory rate is 44 respirations per minute, and he appears to be in acute respiratory distress. Which of the following actions should you take first?
    a. Take a full medical history
    b. Give a bronchodilator by nebulizer
    c. Apply a cardiac monitor to the patient
    d. Provide emotional support for the patient.

12. A firefighter who was involved in extinguishing a house fire is being treated for smoke inhalation. He develops severe hypoxia 48 hours after the incident, requiring intubation and mechanical ventilation. Which of the following conditions has he most likely developed?
    a. Acute respiratory distress syndrome (ARDS)
    b. Atelectasis
    c. Bronchitis
    d. Pneumonia.
13. Which of the following measures best determines that a patient who had a pneumothorax no longer needs a chest tube?
   a. You see a lot of drainage from the chest tube
   b. Arterial blood gas (ABG) levels are normal
   c. The chest X-ray continues to show the lung is 35% deflated
   d. The water-seal chamber doesn’t fluctuate when no suction is applied

14. Which of the following nursing interventions should you use to prevent footdrop and contractures in a patient recovering from a subdural hematoma?
   a. High-top sneakers
   b. Low-dose heparin therapy
   c. Physical therapy consultation
   d. Sequential compressive device.

15. Which of the following signs of increased intracranial pressure (ICP) would appear first after head trauma?
   a. Bradycardia
   b. Large amounts of very dilute urine
   c. Restlessness and confusion
   d. Widened pulse pressure.

16. When giving intravenous (I.V.) phenytoin, which of the following methods should you use?
   a. Use an in-line filter
   b. Withhold other anticonvulsants
   c. Mix the drug with saline solution only
   d. Flush the I.V. catheter with dextrose solution.

17. After surgical repair of a hip, which of the following positions is best for the patient’s legs and hips?
   a. Abduction
   b. Adduction
   c. Prone
   d. Subluxated

18. Which of the following factors should be the primary focus of nursing management in a patient with acute pancreatitis?
   a. Nutritional management
   b. Fluid and electrolyte balance
   c. Management of hypoglycemia
   d. Pain control

19. After a liver biopsy, place the patient in which of the following positions?
   a. Left side-lying, with the bed flat
   b. Right side-lying, with the bed flat
   c. Left side-lying, with the bed in semi-Fowler’s position
   d. Right side-lying, with the bed in semi-Fowler’s position
20. Which of the following potentially serious complications could occur with therapy for hypothyroidism?
   a. Acute hemolytic reaction
   b. Angina or cardiac arrhythmia
   c. Retinopathy
   d. Thrombocytopenia

21. Adequate fluid replacement and vasopressin replacement are objectives of therapy for which of the following disease processes?
   a. Diabetes mellitus
   b. Diabetes insipidus
   c. Diabetic ketoacidosis
   d. Syndrome of inappropriate antidiuretic hormone secretion (SIADH)

22. Patients with Type 1 diabetes mellitus may require which of the following changes to their daily routine during periods of infection?
   a. No changes
   b. Less insulin
   c. More insulin
   d. Oral diabetic agents

23. On a follow-up visit after having a vaginal hysterectomy, a 32-year-old patient has a decreased hematocrit level. Which of the following complications does this suggest?
   a. Hematoma
   b. Hypovolemia
   c. Infection
   d. Pulmonary embolus (PE)

24. A patient has partial-thickness burns to both legs and portions of his trunk. Which of the following I.V. fluids is given first?
   a. Albumin
   b. D5W
   c. Lactated Ringer’s solution
   d. 0.9% sodium chloride solution with 2 mEq of potassium per 100 ml

25. Which of the following techniques is correct for obtaining a wound culture specimen from a surgical site?
   a. Thoroughly irrigate the wound before collecting the specimen
   b. Use a sterile swab and wipe the crusty area around the outside of the wound
   c. Gently roll a sterile swab from the center of the wound outward to collect drainage
   d. Use a sterile swab to collect drainage from the dressing

26. A patient tells you that her urine is starting to look discolored. If you believe this change is due to medication, which of the following patient's medication does not cause urine discoloration?
a. Sulfasalazine  
b. Levodopa  
c. Phenolphthalein  
d. Aspirin

27. You are responsible for reviewing the nursing unit's refrigerator. If you found the following drug in the refrigerator it should be removed from the refrigerator's contents?
   a. Corgard  
b. Humulin (injection)  
c. Urokinase  
d. Epogen (injection)

28. A second year nursing student has just suffered a needlestick while working with a patient that is positive for AIDS. Which of the following is the most important action that nursing student should take?
   a. Immediately see a social worker  
b. Start prophylactic AZT treatment  
c. Start prophylactic Pentamidine treatment  
d. Seek counseling

29. A thirty five year old male has been an insulin-dependent diabetic for five years and now is unable to urinate. Which of the following would you most likely suspect?
   a. Atherosclerosis  
b. Diabetic nephropathy  
c. Autonomic neuropathy  
d. Somatic neuropathy

30. You are taking the history of a 14 year old girl who has a (BMI) of 18. The girl reports inability to eat, has induced vomiting and severe constipation. Which of the following would you most likely suspect?
   a. Multiple sclerosis  
b. Anorexia nervosa  
c. Bulimia  
d. Systemic sclerosis

31. A 24 year old female is admitted to the ER for confusion. This patient has a history of a myeloma diagnosis, constipation, intense abdominal pain, and polyuria. Which of the following would you most likely suspect?
   a. Diverticulosis  
b. Hypercalcemia  
c. Hypocalcaemia  
d. Irritable bowel syndrome

32. Rhogam is most often used to treat____ mothers that have an ____ infant.
   a. RH positive, RH positive  
b. RH positive, RH negative
c. RH negative, RH positive
d. RH negative, RH negative

33. A new mother has some questions about (PKU). Which of the following statements made by
a nurse is not correct regarding PKU?
a. A Guthrie test can check the necessary lab values
b. The urine has a high concentration of phenylpyruvic acid
c. Mental deficits are often present with PKU
d. The effects of PKU are reversible

34. A patient has taken an overdose of aspirin. Which of the following should a nurse most
closely monitor for during acute management of this patient?
a. Onset of pulmonary edema
b. Metabolic alkalosis
c. Respiratory alkalosis
d. Parkinson's disease type symptoms

35. A fifty-year-old blind and deaf patient has been admitted to your floor. As the charge nurse
your primary responsibility for this patient is?
a. Let others know about the patient's deficits
b. Communicate with your supervisor your concerns about the patient's deficits
c. Continuously update the patient on the social environment
d. Provide a secure environment for the patient

36. A nurse is caring for an infant that has recently been diagnosed with a congenital heart
defect. Which of the following clinical signs would most likely be present?
a. Slow pulse rate
b. Weight gain
c. Decreased systolic pressure
d. Irregular WBC lab values

37. A mother has recently been informed that her child has Down's syndrome. You will be
assigned to care for the child at shift change. Which of the following characteristics is not
associated with Down's syndrome?
a. Simian crease
b. Brachycephaly
c. Oily skin
d. Hypotonicity

38. A patient has recently experienced a myocardial infarction (MI) within the last 4 hours.
Which of the following medications would most likely be administered?
a. Streptokinase
b. Atropine
c. Acetaminophen
d. Coumadin
39. A nurse is putting together a presentation on meningitis. Which of the following microorganisms has not been linked to meningitis in humans?
   a. S. pneumonia
   b. H. influenza
   c. N. meningitis
   d. Cl. difficile

40. A nurse is administering blood to a patient who has a low hemoglobin count. The patient asks how long do RBC's last in my body? The correct response is
   a. The life span of RBC is 45 days
   b. The life span of RBC is 60 days
   c. The life span of RBC is 90 days
   d. The life span of RBC is 120 days

41. A 65 year old man has been admitted to the hospital for spinal stenosis surgery. When does the discharge training and planning begin for this patient?
   a. Following surgery
   b. Upon admit
   c. Within 48 hours of discharge
   d. Preoperative discussion

42. A nurse is making rounds taking vital signs. Which of the following vital signs are abnormal?
   a. 11 year old male – 90 pulse, 22 resp/min., 100/70 mm Hg
   b. 13 year old female – 105 pulse, 22 resp/min., 105/60 mm Hg
   c. 5 year old male- 102 pulse, 24 resp/min., 90/65 mm Hg
   d. 6 year old female- 100 pulse, 26 resp/min., 90/70mm Hg

43. When you are taking a patient's history, she tells you she has been depressed and is dealing with an anxiety disorder. Which of the following medications would the patient most likely be taking?
   a. Elavil
   b. Calcitonin
   c. Pergolide
   d. Verapamil
   e. 

Sample Questions from HESI Exit Exam (Health Information Systems, Inc.)

44. A client’s caregiver is learning how to care for a client’s wound and drains. Which technique of cleansing, if taught to the caregiver, would decrease the chance of the client developing an infection?
   a. Cleansing from the area of most drainage to the least drainage
   b. Cleansing from the area of most inflammation to the least inflammation
   c. Cleansing from the drain site outward away from the drain site
   d. Cleansing from a few inches away from the drain and moving to the inner portion of the drain
45. The healthcare provider performs peritoneal dialysis on a client, after which 2 liters of fluid are drained. What action should the nurse complete first?
   a. Assess for signs and symptoms of infection
   b. Palpate for a thrill
   c. Auscultate for a bruit
   d. Assess vital signs

46. A client is prescribed to receive one-quarter strength tube feeding at 40 ml per hour. If the nurse has 80 ml of full strength tube feeding solution, how many hours of feeding is available? __________ (numeric value only)

47. Following a stressful life event, a client comes into the Emergency Department for evaluation. Which manifestation demonstrates severe anxiety or panic?
   a. Dilated pupils
   b. Blurred vision
   c. Diminished hearing
   d. Faster respirations

48. A nurse is assigned to four patients. Which patient is the highest priority for this nurse to assess?
   a. A patient who is 72 hours post-op from a hernia repair with abdominal distention and fever
   b. A patient who is 36 hours post right lower lobe lobectomy
   c. A patient in overhead traction for a knee injury
   d. A patient with diabetes and a blood glucose of 100 mg/dL

49. A patient is experiencing pulseless ventricular tachycardia (VT). What action should the nurse perform first?
   a. Administer epinephrine intravenously
   b. Prepare the patient for synchronized cardioversion
   c. Administer procainamide intravenously
   d. Prepare the patient for defibrillation

50. The nurse is instructing a client newly diagnosed with diabetes – on the signs and symptoms of hypoglycemia. Which of the following should the nurse include in the instructions? Select all that apply
   a. Tremors
   b. Irritability
   c. Bradycardia
   d. Nausea
   e. Hypertension

51. The nurse in the emergency department is using the simple triage and rapid transport (START) system to assess victims of a hurricane. Which statement correctly describes a yellow disaster tag?
   a. A yellow disaster tag means critical injuries and requires immediate intervention
b. A yellow disaster tag means no critical injuries and can ambulate

c. A yellow disaster tag means injuries need attention, but are not life-threatening

d. A yellow disaster tag means deceased or likely to die

52. A patient is demonstrating atrial fibrillation with a heart rate of 54 beats per/minute. Which of the following should the nurse do regarding the prescribed digoxin (Lanoxin) to the patient?

a. Administer the scheduled dose of digoxin while maintaining cardiac telemetry monitoring

b. Administer the scheduled dose of digoxin and continue to monitor the patient’s heart rate

c. Administer the scheduled dose of digoxin and notify the patient’s healthcare provider

d. Hold the scheduled dose of digoxin and inform the patient’s healthcare provider
APPENDIX B

DEMOGRAPHIC AND WORK HISTORY QUESTIONNAIRE
Name

Date of Birth

Gender

- Female
- Male

Ethnicity

- White
- Hispanic or Latino
- Black or African American
- Native American or American Indian
- Asian / Pacific Islander
- Other

What is the highest degree or level of school you have completed?
If currently enrolled, highest degree received.

- Some college credit, no degree
- Associate degree  Yes / No
- Bachelor’s degree  Yes / No
  - Specific Degree
  - Major Area of Focus
- Master’s degree  Yes / No
  - Specific Degree
  - Major Area of Focus
- Professional degree  Yes / No
  - Specific Degree
  - Major Area of Focus
- Doctorate degree  Yes / No
• Specific Degree
  • Major Area of Focus

How long have you worked as a Registered Nurse? ________________

How many years have you (did you) worked in Patient-Care as a Registered Nurse? ________________

If not currently in patient care - how many years since you performed bed-side patient care? __________

Do you own any professional certifications?
  • No
  • Yes – for Registered Nurses
    • CMSRN: Certified Medical-Surgical Registered Nurse
    • ACLS: Advanced Cardiac Life Support (ACLS)
    • Adult Nurse Practitioner-Board Certified (ANP-BC)
    • Advanced Oncology Certified Nurse (AOCN)
    • Advanced Practice Nurse (APN)
    • Advanced Practice
    • Certified Bariatric Nurse (CBN)
    • Certified Case Manager (CCM)
    • Certified Clinical Nurse Specialist (CCNS)
    • Certified Critical Care Nurse (CCRN)
    • Certified Dialysis Nurse (CDN)
    • Certified Emergency Nurse (CEN)
    • Certified Hospice and Palliative Care Nurse (CHPN)
    • Certified Hyperbaric Registered Nurse (CHRN)
    • Certified Infection Control/Prevention (CIC)
    • Certified Nurse Educator (CNE)
    • Certified Nurse Leader (CNL)
    • Certified Ostomy Care Nurse (COCN)
    • Certified Pediatric Emergency Nurse (CPEN)
    • Certified Registered Nurse Anesthetists (CRNA)
    • Certified Wound, Ostomy, Continence Nurse (CWOCN)
    • Certified Wound Specialist (CWS)
    • Oncology Certified Nurse (OCN)
    • Registered Nurse Clinical Specialist (RNCS)
    • Registered Nurse Certified Specialist (RNCS)
    • Sexual Assault Nurse Examiner (SANE)
    • Other ____________________________
  • Other ____________________________

What most-closely describes your work environment?
  • Surgery/PACU
  • Medical/Surgical Department
  • Intensive Care Unit (Cardiac ICU)
- NICU
- Ambulatory Setting
- Emergency Department
- Non-Patient Care
- Other
APPENDIX C

COMPLETE UNABRIDGED RESULTS
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23 122 18.9%
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7 122 5.7%

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19 122 15.6%
### Mid-Range GEFT Scores

Males & Females

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Sum 68 122 55.7%

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model1 = lm(GEFT ~ Gender, data = TotalData)
> summary(model1)

Call:
lm(formula = GEFT ~ Gender, data = TotalData)

Residuals:

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Coefficients:

|                  | Estimate | Std. Error | t value | Pr(>|t|) |
|------------------|----------|------------|---------|---------|
| (Intercept)      | 12.015   | 1.864      | 6.446   | 2.51e-09*** |
| Gender           | -1.112   | 1.036      | -1.073  | 0.285   |

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 4.981 on 120 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.009511, Adjusted R-squared: 0.001257
F-statistic: 1.152 on 1 and 120 DF,  p-value: 0.2852

model2 = lm(Ship ~ Gender, data = TotalData)
> summary(model2)

Call:
lm(formula = Ship ~ Gender, data = TotalData)

Residuals:

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Coefficients:

|                | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | 18.6632  | 1.5885     | 11.749  | <2e-16 *** |
| Gender         | -1.5019  | 0.8828     | -1.701  | 0.0915 . |

---

Signif. codes:  0 ‘****’ 0.001 ‘***’ 0.01 ‘**’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 4.245 on 120 degrees of freedom
(1 observation deleted due to missingness)

Multiple R-squared: 0.02355, Adjusted R-squared: 0.01541
F-statistic: 2.894 on 1 and 120 DF,  p-value: 0.09148

Cohen’s D
GEFT – 0.22
CI 95%  -0.19, 0.63

Ship – 0.35
CI 95%  -0.06, 0.76

describe(TotalData)

<table>
<thead>
<tr>
<th>var</th>
<th>n</th>
<th>mean</th>
<th>sd</th>
<th>median</th>
<th>trimmed</th>
<th>mad</th>
<th>min</th>
<th>max</th>
<th>range</th>
<th>skew</th>
<th>kurtosis</th>
<th>se</th>
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<tbody>
<tr>
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<td>123</td>
<td>1.75</td>
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<td>1.81</td>
<td>0.00</td>
<td>1.2</td>
<td>1</td>
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<td>-0.73</td>
<td>0.04</td>
<td>-1.98</td>
<td>0.05</td>
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<td>2.44</td>
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<td>0.08</td>
<td>-0.52</td>
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<tr>
<td>YrsRN</td>
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<td>17.96</td>
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<td>17.29</td>
<td>10.38</td>
<td>146</td>
<td>45</td>
<td>105</td>
<td>0.57</td>
<td>0.94</td>
<td>-1.98</td>
<td>0.05</td>
</tr>
<tr>
<td>ProfCert</td>
<td>123</td>
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<td>0.00</td>
<td>6</td>
<td>6</td>
<td>1.50</td>
<td>2.84</td>
<td>0.10</td>
<td>-1.98</td>
<td>0.05</td>
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<tr>
<td>CritCare</td>
<td>123</td>
<td>0.46</td>
<td>0.50</td>
<td>0.44</td>
<td>0.00</td>
<td>0</td>
<td>1</td>
<td>0.18</td>
<td>-1.98</td>
<td>0.05</td>
<td>-1.98</td>
<td>0.05</td>
</tr>
</tbody>
</table>
model2 = lm(NsProf ~ Gender + YrsRN + CritCare + Ship + GEFT + ProfCert, data = TotalData)
> summary(model2)

Call:
  lm(formula = NsProf ~ Gender + YrsRN + CritCare + Ship + GEFT + ProfCert, data = TotalData)

Residuals:
    Min     1Q   Median     3Q    Max
-22.1379 -2.2533   0.4572   4.1180  14.2843

Coefficients:
            Estimate Std. Error t value  Pr(>|t|)
(Intercept)  30.6959    3.9638   7.744  5.54e-12 ***
Gender     -1.0503    1.4288  -0.735   0.4639
YrsRN        0.0866    0.0582   1.488   0.1395
CritCare    0.4918    1.2204   0.403   0.6877
Ship       -0.0758    0.1627  -0.466   0.6421
GEFT         0.2554    0.1405   1.818   0.0718 .
ProfCert    1.2152    0.5529   2.198   0.0301 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.075 on 108 degrees of freedom
(8 observations deleted due to missingness)
Multiple R-squared:  0.0989,    Adjusted R-squared:  0.04884
F-statistic: 1.976 on 6 and 108 DF,  p-value: 0.07537

cfint(model2, level = 0.95)
            2.5 %     97.5 %
(Intercept) 22.84  38.55  23.84  41.05
Gender     -3.88  1.79  -3.92  1.80
YrsRN      -0.23  0.25  -0.21  0.23
CritCare   -1.92  2.91  -1.92  2.90
Ship       -0.39  0.25  -0.40  0.25

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### Results from lm(beta(model2))

|          | Estimate | Std. Error | t value | Pr(>|t|) |
|----------|----------|------------|---------|----------|
| (Intercept) | 31.10673 | 3.98762    | 7.801   | 3.8e-12 *** |
| Gender    | -0.97839 | 1.43945    | -0.680  | 0.4981   |
| YrsRN     | 0.07567  | 0.05793    | 1.306   | 0.1942   |
| CritCare  | 0.52446  | 1.22328    | 0.429   | 0.6690   |
| Ship      | 0.07143  | 0.14346    | 0.498   | 0.6195   |
| ProfCert  | 1.05517  | 0.52707    | 2.002   | 0.0478 * |

---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.123 on 110 degrees of freedom
(7 observations deleted due to missingness)
Multiple R-squared: 0.06757, Adjusted R-squared: 0.02519
F-statistic: 1.594 on 5 and 110 DF, p-value: 0.1676

### Model

```r
model2 = lm(NsProf ~ Gender + YrsRN + CritCare + Ship + ProfCert, data = TotalData)
> summary(model2)
```

### Summary

Call:
```
formula = NsProf ~ Gender + YrsRN + CritCare + Ship + ProfCert,
data = TotalData
```

Residuals:
```
  Min     1Q Median     3Q    Max
-22.7190 -2.4493  0.5181  4.3084 14.8793
```

Coefficients:
```
  Estimate Std. Error t value Pr(>|t|)
(Intercept)  31.10673    3.98762  7.801 3.8e-12 ***
Gender      -0.97839    1.43945  -0.680   0.4981
YrsRN        0.07567    0.05793   1.306   0.1942
CritCare     0.52446    1.22328   0.429   0.6690
Ship         0.07143    0.14346   0.498   0.6195
ProfCert     1.05517    0.52707   2.002   0.0478 *
```

---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.123 on 110 degrees of freedom
(7 observations deleted due to missingness)
Multiple R-squared: 0.06757, Adjusted R-squared: 0.02519
F-statistic: 1.594 on 5 and 110 DF, p-value: 0.1676

Confidence intervals:
```
> confint(model2, level = 0.95)
2.5 %     97.5 %
(Intercept) 23.20421058 39.0092448
Gender      -3.83103763  1.8742485
YrsRN       -0.03913260  0.1904771
CritCare    -1.89978828  2.9487004
Ship        -0.21287995  0.3557409
ProfCert    0.01064035  2.0997091
```
> lm.beta(model2)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0.06860544</td>
<td>YrsRN</td>
<td>0.13046020</td>
<td>CritCare</td>
<td>0.04243895</td>
</tr>
<tr>
<td>Ship</td>
<td>0.04888565</td>
<td>ProfCert</td>
<td>0.18958015</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ns Knowledge – GEFT

model3 = lm(NsProf ~ Gender + YrsRN + CritCare + GEFT + ProfCert, data = TotalData)

> summary(model3)

Call:
  lm(formula = NsProf ~ Gender + YrsRN + CritCare + GEFT + ProfCert, data = TotalData)

Residuals:
  Min      1Q  Median      3Q     Max
-22.3615 -2.2209  0.5429  4.1619  14.6736

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 29.86885    3.19356   9.353 1.19e-15 ***
Gender      -0.96315    1.41329  -0.681   0.4970
YrsRN        0.08840    0.05644   1.566   0.1202
CritCare     0.41159    1.20904   0.340   0.7342
GEFT         0.20577    0.11976   1.718   0.0886 .
ProfCert     1.20742    0.54202   2.228   0.0279 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.04 on 110 degrees of freedom
(7 observations deleted due to missingness)
Multiple R-squared:  0.09392,    Adjusted R-squared:  0.05274
F-statistic: 2.281 on 5 and 110 DF,  p-value: 0.05147

> lm.beta(model3)

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0.06749675</td>
<td>YrsRN</td>
<td>0.15232735</td>
</tr>
<tr>
<td>CritCare</td>
<td>0.03328598</td>
<td>GEFT</td>
<td>0.16194206</td>
</tr>
<tr>
<td>ProfCert</td>
<td>0.20677670</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

> confint(model3, level = 0.95)

<table>
<thead>
<tr>
<th></th>
<th>2.5 %</th>
<th>97.5 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>23.53996784</td>
<td>36.197739</td>
</tr>
<tr>
<td>Gender</td>
<td>-3.76395679</td>
<td>1.837648</td>
</tr>
<tr>
<td>YrsRN</td>
<td>-0.02344788</td>
<td>0.200243</td>
</tr>
<tr>
<td>CritCare</td>
<td>-1.98445256</td>
<td>2.807630</td>
</tr>
</tbody>
</table>
Nurse Knowledge

model4 = lm(NsProf ~ YrsRN + CritCare + GEFT + ProfCert, data = TotalData)
> summary(model4)

Call:
lm(formula = NsProf ~ YrsRN + CritCare + GEFT + ProfCert, data = TotalData)

Residuals:
   Min      1Q  Median      3Q     Max
-22.7051 -2.4607  0.5967  4.2388  14.2100

Coefficients:  
                Estimate Std. Error t value Pr(>|t|)
(Intercept) 28.152383   1.958699  14.373  <2e-16 ***
YrsRN        0.082047   0.055528   1.478   0.1423
CritCare     0.709526   1.124505   0.631   0.5294
GEFT         0.207703   0.119432   1.739   0.0848 .
ProfCert     1.194714   0.540402   2.211   0.0291 *
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 . ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.025 on 111 degrees of freedom
(7 observations deleted due to missingness)
Multiple R-squared: 0.0901, Adjusted R-squared: 0.05731
F-statistic: 2.748 on 4 and 111 DF, p-value: 0.0318

> confint(model4, level = 0.95)
   2.5 %     97.5 %
(Intercept) 24.27108366 32.0336722
YrsRN       -0.02798200  0.1920910
CritCare    -1.51875856  2.9378241
GEFT        -0.02896921  0.4443602
ProfCert     0.12387992  2.2655385

> lm.beta(model4)
   YrsRN  CritCare      GEFT  ProfCert
    0.1413970 0.0573813 0.1634587 0.2045992
Nurse Knowledge

model5 = lm(NsProf ~ YrsRN + CritCare + Ship + ProfCert, data = TotalData)
> summary(model5)

Call:
lm(formula = NsProf ~ YrsRN + CritCare + Ship + ProfCert, data = TotalData)

Residuals:
   Min       1Q   Median       3Q      Max
-23.0748  -2.6421   0.5852   4.2991  14.4666

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 29.22248    2.85943  10.220  <2e-16 ***
YrsRN        0.07022    0.05723   1.227   0.2225
CritCare     0.82338    1.13872   0.723   0.4712
Ship         0.08083    0.14245   0.567   0.5716
ProfCert     1.03672    0.52510   1.974   0.0508 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.109 on 111 degrees of freedom
(7 observations deleted due to missingness)
Multiple R-squared:  0.06366,   Adjusted R-squared:  0.02991
F-statistic: 1.887 on 4 and 111 DF,  p-value: 0.1178

> lm.beta(model5)
    YrsRN  CritCare       Ship   ProfCert
0.12105193 0.06662802 0.05531544 0.18626508

> confint(model5, level = 0.95)
    2.5 %     97.5 %
(Intercept) 23.556321222 34.8886434
YrsRN       -0.043194614  0.1836248
CritCare    -1.433057871  3.0798220
Ship        -0.201447312  0.3630983
ProfCert    -0.003789251  2.0772363

GEFT and Gender

Females

describe(FeGEFT)
   var  n mean    sd median trimmed  mad min max range  skew kurtosis  se
Gender  1 92 2.00 0.00  2 2.0 0.00  2 0 NaN NaN 0.0
GEFT  2 91 9.79 4.76  10 9.9 5.93  0 18 -0.13 -0.81 0.5

Males

> describe(MaleGEFT)

        var  n mean   sd median trimmed  mad min max range  skew kurtosis   se
Gender   1 31  1.0 0.00      1    1.00 0.00   1   1     0   NaN      NaN 0.00
GEFT     2 31 10.9 5.61     11   11.16 7.41   1  18    17 -0.28    -1.32 1.01

summary(MaleGEFT)

        Gender   GEFT
Min. :1 Min. : 1.0
1st Qu.:1 1st Qu.: 6.0
Median :1 Median :11.0
Mean :1 Mean :10.9
3rd Qu.:1 3rd Qu.:16.0
Max. :1 Max. :18.0

> summary(FeGEFT)

        Gender   GEFT
Min. :2 Min. :0.000
1st Qu.:2 1st Qu.: 6.000
Median :2 Median :10.000
Mean :2 Mean :9.791
3rd Qu.:2 3rd Qu.:13.000
Max. :2 Max. :18.000
NA's :1

model2 = lm(NsProf ~ Gender + YrsRN + CritCare + Ship + GEFT + ProfCert, data =
TotalData)
> summary(model2)

Call:
lm(formula = NsProf ~ Gender + YrsRN + CritCare + Ship + GEFT +
    ProfCert, data = TotalData)

Residuals:
     Min  1Q Median  3Q Max
-22.1379 -2.2533  0.4572  4.1180 14.2843
Coefficients:

|                | Estimate  | Std. Error | t value | Pr(>|t|) |
|----------------|-----------|------------|---------|----------|
| (Intercept)    | 30.69585  | 3.96380    | 7.744   | 5.54e-12 *** |
| Gender         | -1.05033  | 1.42881    | -0.735  | 0.4639   |
| YrsRN          | 0.08664   | 0.05821    | 1.488   | 0.1395   |
| CritCare       | 0.49184   | 1.22044    | 0.403   | 0.6877   |
| Ship           | -0.07582  | 0.16266    | -0.466  | 0.6421   |
| GEFT           | 0.25543   | 0.14047    | 1.818   | 0.0718 . |
| ProfCert       | 1.21518   | 0.55285    | 2.198   | 0.0301 * |

---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.075 on 108 degrees of freedom
(8 observations deleted due to missingness)
Multiple R-squared:  0.0989,   Adjusted R-squared:  0.04884
F-statistic: 1.976 on 6 and 108 DF,  p-value: 0.07537

confint(model2, level = 0.95)

<table>
<thead>
<tr>
<th></th>
<th>2.5 %</th>
<th>97.5 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>22.83890356</td>
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</tr>
<tr>
<td>Gender</td>
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<td>1.7818076</td>
</tr>
<tr>
<td>YrsRN</td>
<td>-0.02874094</td>
<td>0.2020290</td>
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<tr>
<td>CritCare</td>
<td>-1.92728481</td>
<td>2.9109738</td>
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<tr>
<td>Ship</td>
<td>-0.39823848</td>
<td>0.2466047</td>
</tr>
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<td>GEFT</td>
<td>-0.02299918</td>
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<tr>
<td>ProfCert</td>
<td>0.11934469</td>
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</table>

lm.beta(model2)

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<tr>
<th></th>
<th>Gender</th>
<th>YrsRN</th>
<th>CritCare</th>
<th>Ship</th>
<th>GEFT</th>
<th>ProfCert</th>
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</thead>
<tbody>
<tr>
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<td>-0.07354619</td>
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<td>0.03963988</td>
<td>-0.05188952</td>
<td>0.19748704</td>
<td>0.20788059</td>
</tr>
</tbody>
</table>

model2 = lm(NsProf ~ Gender + YrsRN + CritCare + Ship + ProfCert, data = TotalData)
> summary(model2)

Call:
lm(formula = NsProf ~ Gender + YrsRN + CritCare + Ship + ProfCert, data = TotalData)

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
</table>

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Coefficients:

|                | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | 31.10673 | 3.98762    | 7.801   | 3.8e-12  *** |
| Gender         | -0.97839 | 1.43945    | -0.680  | 0.4981   |
| YrsRN          | 0.07567  | 0.05793    | 1.306   | 0.1942   |
| CritCare       | 0.52446  | 1.22328    | 0.429   | 0.6690   |
| Ship           | 0.07143  | 0.14346    | 0.498   | 0.6195   |
| ProfCert       | 1.05517  | 0.52707    | 2.002   | 0.0478   * |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.123 on 110 degrees of freedom
(7 observations deleted due to missingness)
Multiple R-squared: 0.06757, Adjusted R-squared: 0.02519
F-statistic: 1.594 on 5 and 110 DF, p-value: 0.1676

\[
\begin{align*}
\text{model3} & = \text{lm}(\text{NsProf} \sim \text{Gender} + \text{YrsRN} + \text{CritCare} + \text{GEFT} + \text{ProfCert}, \text{data} = \text{TotalData}) \\
& > \text{summary(model3)}
\end{align*}
\]

Call:
\[\text{lm(formula = NsProf} \sim \text{Gender} + \text{YrsRN} + \text{CritCare} + \text{GEFT} + \text{ProfCert}, \text{data} = \text{TotalData})\]

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22.3615</td>
<td>-2.2209</td>
<td>0.5429</td>
<td>4.1619</td>
<td>14.6736</td>
</tr>
</tbody>
</table>

Coefficients:

|                | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | 29.86885 | 3.19356    | 9.353   | 1.19e-15 *** |
Gender      -0.96315    1.41329  -0.681   0.4970
YrsRN        0.08840    0.05644   1.566   0.1202
CritCare     0.41159    1.20904  0.340    0.7342
GEFT         0.20577    0.11976   1.718   0.0886 .
ProfCert     1.20742    0.54202   2.228   0.0279 *

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.04 on 110 degrees of freedom
(7 observations deleted due to missingness)
Multiple R-squared:  0.09392, Adjusted R-squared:  0.05274
F-statistic: 2.281 on 5 and 110 DF,  p-value: 0.05147

> lm.beta(model3)

Gender       YrsRN    CritCare        GEFT    ProfCert
-0.06749675  0.15232735  0.03328598  0.16194206  0.20677670

> confint(model3, level = 0.95)

2.5 %    97.5 %
(Intercept) 23.53996784 36.197739
Gender      -3.76395679  1.837648
YrsRN       -0.02344788  0.200243
CritCare    -1.98445256  2.807630
GEFT        -0.03155930  0.443096
ProfCert     0.13325819  2.281590

Nurse Knowledge

model4 = lm(NsProf ~ YrsRN + CritCare + GEFT + ProfCert, data = TotalData)
>
> summary(model4)

Call:
  lm(formula = NsProf ~ YrsRN + CritCare + GEFT + ProfCert, data = TotalData)

Residuals:
     Min       1Q   Median       3Q      Max
-22.7051   -2.4607   0.5967    4.2388   14.2100

Coefficients:
             Estimate Std. Error   t value Pr(>|t|)
(Intercept)   28.15238    1.95870 14.373  <2e-16 ***
YrsRN         0.08205     0.05553  1.478     0.1423
CritCare      0.70953     1.12451  0.631     0.5294
|        | Estimate | Std. Error | t value | Pr(>|t|) |
|--------|----------|------------|---------|----------|
| (Intercept) | 29.22248 | 2.85943 | 10.220 | <2e-16 *** |
| YrsRN | 0.07022 | 0.05723 | 1.227 | 0.2225 |
| CritCare | 0.82338 | 1.13872 | 0.723 | 0.4712 |
| Ship | 0.08083 | 0.14245 | 0.567 | 0.5716 |
| ProfCert | 1.03672 | 0.52510 | 1.974 | 0.0508 . |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 6.109 on 111 degrees of freedom

(7 observations deleted due to missingness)

Multiple R-squared: 0.0901, Adjusted R-squared: 0.05731

F-statistic: 2.748 on 4 and 111 DF, p-value: 0.0318
(7 observations deleted due to missingness)
Multiple R-squared:  0.06366,  Adjusted R-squared:  0.02991
F-statistic: 1.887 on 4 and 111 DF,  p-value: 0.1178

> lm.beta(model5)
  YrsRN  CritCare     Ship  ProfCert
  0.12105193 0.06662802 0.05531544 0.18626508

> confint(model5, level = 0.95)

  2.5 %    97.5 %
(Intercept) 23.556321222 34.8886434
YrsRN     -0.043194614  0.1836248
CritCare  -1.433057871  3.0798220
Ship      -0.201447312  0.3630983
ProfCert  -0.003789251  2.0772363

describe(FeGEFT)

<table>
<thead>
<tr>
<th>var</th>
<th>n</th>
<th>mean</th>
<th>sd</th>
<th>median trimmed</th>
<th>mad</th>
<th>min</th>
<th>max</th>
<th>range</th>
<th>skew</th>
<th>kurtosis</th>
<th>se</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1</td>
<td>92</td>
<td>2.00</td>
<td>0.00</td>
<td>2.0</td>
<td>NaN</td>
<td>NaN</td>
<td>2</td>
<td>NaN</td>
<td>NaN</td>
<td>0.0</td>
</tr>
<tr>
<td>GEFT</td>
<td>2</td>
<td>91</td>
<td>9.79</td>
<td>4.76</td>
<td>10.9</td>
<td>0</td>
<td>18</td>
<td>18</td>
<td>0</td>
<td>-0.13</td>
<td>-0.81</td>
</tr>
</tbody>
</table>

Males

> describe(MaleGEFT)

<table>
<thead>
<tr>
<th>var</th>
<th>n</th>
<th>mean</th>
<th>sd</th>
<th>median trimmed</th>
<th>mad</th>
<th>min</th>
<th>max</th>
<th>range</th>
<th>skew</th>
<th>kurtosis</th>
<th>se</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1</td>
<td>31</td>
<td>1.00</td>
<td>0.00</td>
<td>1.0</td>
<td>NaN</td>
<td>NaN</td>
<td>1</td>
<td>NaN</td>
<td>NaN</td>
<td>0.00</td>
</tr>
<tr>
<td>GEFT</td>
<td>2</td>
<td>31</td>
<td>10.9</td>
<td>5.61</td>
<td>11.16</td>
<td>1</td>
<td>18</td>
<td>18</td>
<td>0</td>
<td>-0.28</td>
<td>-1.32</td>
</tr>
</tbody>
</table>

summary(MaleGEFT)

<table>
<thead>
<tr>
<th>Gender</th>
<th>GEFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.</td>
<td>1.0</td>
</tr>
<tr>
<td>1st Qu.</td>
<td>1.0</td>
</tr>
<tr>
<td>Median</td>
<td>11.0</td>
</tr>
<tr>
<td>Mean</td>
<td>10.9</td>
</tr>
<tr>
<td>3rd Qu.</td>
<td>16.0</td>
</tr>
<tr>
<td>Max.</td>
<td>18.0</td>
</tr>
</tbody>
</table>

> summary(FeGEFT)

<table>
<thead>
<tr>
<th>Gender</th>
<th>GEFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.</td>
<td>1.0</td>
</tr>
<tr>
<td>1st Qu.</td>
<td>6.0</td>
</tr>
<tr>
<td>Median</td>
<td>11.0</td>
</tr>
<tr>
<td>Mean</td>
<td>10.9</td>
</tr>
<tr>
<td>3rd Qu.</td>
<td>16.0</td>
</tr>
<tr>
<td>Max.</td>
<td>18.0</td>
</tr>
</tbody>
</table>
model1 = lm(ProfCert ~ Gender + Age + YrsRN + CritCare + NsProf, data = TotalData)
> summary(model1)

Call:
  lm(formula = ProfCert ~ Gender + Age + YrsRN + CritCare + NsProf, 
      data = TotalData)

Residuals:
     Min      1Q  Median      3Q     Max
-1.6855 -0.6731 -0.2352  0.4012  4.4062

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)     -1.57331    0.99094  -1.588   0.1152
Gender           0.20355    0.25477   0.799   0.4260
Age              0.03438    0.01932   1.780   0.0779 .
YrsRN            -0.01384    0.01863  -0.743   0.4591
CritCare         0.14856    0.21465   0.692   0.4903
NsProf           0.03654    0.01644   2.223   0.0283 *

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 . ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.078 on 111 degrees of freedom
6 observations deleted due to missingness
Multiple R-squared:  0.09855, Adjusted R-squared:  0.05794
F-statistic: 2.427 on 5 and 111 DF,  p-value: 0.0396

lm.beta(model1)

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Age</th>
<th>YrsRN</th>
<th>CritCare</th>
<th>NsProf</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.07944383</td>
<td>0.31186643</td>
<td>-0.13264569</td>
<td>0.06708066</td>
<td>0.20324641</td>
</tr>
</tbody>
</table>

> confint(model1, level = 0.95)

          2.5 %      97.5 %
(Intercept) -3.536919623 0.39029637
Gender        -0.301284531 0.70839200
Age             -0.003898324 0.07265873
YrsRN           -0.050757323 0.02307591
CritCare       -0.276785062 0.57390217
model2 = lm(ProfCert ~ Age + NsProf, data = TotalData)
> summary(model2)

Call:
  lm(formula = ProfCert ~ Age + NsProf, data = TotalData)

Residuals:
   Min     1Q Median     3Q    Max
-1.5572 -0.6006 -0.2527  0.4078  4.5680

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.83215  0.672730 -1.237  0.2186
  Age        0.02266  0.009905  2.288  0.0240 *
  NsProf     0.03533  0.016155  2.187  0.0308 *

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.07 on 114 degrees of freedom
(6 observations deleted due to missingness)
Multiple R-squared:  0.08891,   Adjusted R-squared:  0.07292
F-statistic: 5.562 on 2 and 114 DF,  p-value: 0.004956

> lm.beta(model2)
  Age  NsProf
0.2055346 0.1964812

> confint(model2, level = 0.95)

2.5 %     97.5 %
(Intercept) -2.164819390 0.50052600
  Age        0.003037082 0.04227926
  NsProf     0.003325738 0.06733121

lm.beta(model2)

confint(model2, level = 0.95)

model4 = lm(ProfCert ~ YrsRN + Gender + Age + CritCare + NsProf + Ship + GEFT, data = TotalData)
> summary(model4)
Call:
lm(formula = ProfCert ~ YrsRN + Gender + Age + CritCare + NsProf + Ship + GEFT, data = TotalData)

Residuals:
   Min     1Q   Median     3Q    Max
-1.8969 -0.5858  -0.1822  0.4099  4.4051

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -2.0092  1.0908  -1.842  0.0683 .
YrsRN       -0.0027  0.0184  -0.145  0.8851
Gender      0.2029  0.2455   0.827  0.4103
Age         0.0255  0.0192   1.331  0.1862
CritCare    0.1977  0.2064   0.958  0.3404
NsProf      0.0359  0.0159   2.251  0.0264 *
Ship        0.0489  0.0275   1.777  0.0784 .
GEFT       -0.0199  0.0241  -0.826  0.4104
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.031 on 107 degrees of freedom
(8 observations deleted due to missingness)
Multiple R-squared:  0.1217,   Adjusted R-squared:  0.0642
F-statistic: 2.117 on 7 and 107 DF,  p-value: 0.04776

> lm.beta(model4)
        YrsRN Gender Age CritCare NsProf Ship GEFT
-0.02681870  0.08306735 0.24148272  0.09313683  0.21031920  0.19567378 -0.09021042

> confint(model4, level = 0.95)
     2.5 %     97.5 %
(Intercept) -4.171624838 0.15317354
YrsRN      -0.039090750 0.03376841
Gender     -0.283774500 0.68965777
Age         -0.012486292 0.06345688
CritCare    -0.211553002 0.60693823
NsProf      0.004292693 0.06766586
Ship        -0.005658458 0.10347728
GEFT        -0.067844033 0.02792352

model4 = lm(ProfCert ~ YrsRN + Gender + Age + CritCare + NsProf, data = TotalData)
> summary(model4)
Call:
lm(formula = ProfCert ~ YrsRN + Gender + Age + CritCare + NsProf,
data = TotalData)

Residuals:
  Min 1Q Median  3Q  Max
-1.6855 -0.6731 -0.2352  0.4012  4.4062

Coefficients:
  Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.57331    0.99094  -1.588   0.1152
YrsRN       -0.01384    0.01863  -0.743   0.4591
Gender       0.20355    0.25477   0.799   0.4260
Age          0.03438    0.01932   1.780   0.0779 .
CritCare     0.14856    0.21465   0.692   0.4903
NsProf       0.03654    0.01644   2.223   0.0283 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.078 on 111 degrees of freedom
(6 observations deleted due to missingness)
Multiple R-squared:  0.09855,    Adjusted R-squared:  0.05794
F-statistic: 2.427 on 5 and 111 DF,  p-value: 0.0396

> lm.beta(model4)
          YrsRN   Gender         Age    CritCare      NsProf
-0.13264569  0.07944383  0.31186643  0.06708066  0.20324641

> confint(model4, level = 0.95)
          2.5 %     97.5 %
(Intercept) -3.536919623 0.39029637
YrsRN       -0.050757323 0.02307591
Gender      -0.301284531 0.70839200
Age         -0.003898324 0.07265873
CritCare    -0.276785062 0.57390217
NsProf      0.003962146 0.06912764

model4 = lm(ProcCert ~ YrsRN + Educ + Gender + Age + CritCare + NsProf + Ship + GEFT,
data = NewStudyData)
> summary(model4)
Call:
\texttt{lm(formula = ProcCert ~ YrsRN + Educ + Gender + Age + CritCare +
NsProf + Ship + GEFT, data = NewStudyData)}

Residuals:
\begin{tabular}{rrrrr}
  Min & 1Q & Median & 3Q & Max  \\
-1.9317 & -0.5655 & -0.1989 & 0.4084 & 4.2033  \\
\end{tabular}

Coefficients:
\begin{tabular}{rrrrrr}
  Estimate & Std. Error & t value & Pr(>|t|)  \\
(Intercept) & 0.11067 & 1.03005 & 0.107 & 0.9147  \\
YrsRN & 0.01269 & 0.01064 & 1.192 & 0.2365  \\
Educ & -0.01521 & 0.08602 & -0.177 & 0.8601  \\
Gender & -0.16483 & 0.25045 & -0.658 & 0.5122  \\
Age & -0.01462 & 0.01055 & -1.385 & 0.1695  \\
CritCare & -0.05261 & 0.21889 & -0.240 & 0.8106  \\
NsProf & 0.03829 & 0.01784 & 2.147 & 0.0346 *  \\
Ship & 0.06350 & 0.03062 & 2.074 & 0.0411 *  \\
GEFT & -0.03275 & 0.02780 & -1.178 & 0.2421  \\
\end{tabular}

---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.02 on 86 degrees of freedom
(28 observations deleted due to missingness)
Multiple R-squared: 0.1238, Adjusted R-squared: 0.04233
F-statistic: 1.519 on 8 and 86 DF, p-value: 0.1624

\begin{verbatim}
> lm.beta(model4)
  YrsRN  Educ  Gender  Age  CritCare  NsProf  Ship  GEFT
0.12894753 -0.01814479 -0.06907019 -0.14125591 -0.02529827  0.22729902  0.26357211 -0.15220040

> confint(model4, level = 0.95)
   2.5 %       97.5 %
(Intercept) -1.937007032 2.158346020
YrsRN -0.008468674 0.033844463
Educ -0.186204806 0.155791324
Gender -0.662712892 0.333056714
Age -0.035592551 0.006358147
CritCare -0.487738994 0.382522263
NsProf 0.002834153 0.073748748
Ship 0.002630272 0.124367029
GEFT -0.088010509 0.022519135
\end{verbatim}
model4 = lm(ProcCert ~ YrsRN + Educ + Gender + Age + NsProf + Ship + GEFT, data = NewStudyData)
> summary(model4)

Call:
lm(formula = ProcCert ~ YrsRN + Educ + Gender + Age + NsProf + Ship + GEFT, data = NewStudyData)

Residuals:
  Min  1Q Median  3Q Max
-1.9140 -0.5980 -0.1903  0.3847  4.2331

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.06472    1.00666   0.064   0.9489
YrsRN        0.01246    0.01054   1.182   0.2404
Educ        -0.01500    0.08555  -0.175   0.8612
Gender      -0.15061    0.24205  -0.622   0.5354
Age         -0.01478    0.01047  -1.412   0.1615
NsProf       0.03860    0.01769   2.182   0.0318 *
Ship         0.06384    0.03042   2.099   0.0387 *
GEFT        -0.03358    0.02743  -1.224   0.2243
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 . ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.015 on 87 degrees of freedom
(28 observations deleted due to missingness)
Multiple R-squared:  0.1232, Adjusted R-squared:  0.0527
F-statistic: 1.747 on 7 and 87 DF,  p-value: 0.1086

> lm.beta(model4)

YrsRN        Educ      Gender         Age      NsProf        Ship        GEFT
0.12666555 -0.01790063 -0.06311281 -0.14287028  0.22913526  0.26500406 -0.15606063

> confint(model4, level = 0.95)

         2.5 %      97.5 %
(Intercept) -1.936124683 2.065565878
YrsRN       -0.008493669 0.033420384
Educ        -0.185035475 0.155031234
Gender      -0.631705658 0.330482694
Age         -0.035569687 0.006028473
NsProf      0.003433716 0.073767859
Ship        0.003382228 0.124305034
GEFT        -0.088105747 0.020953327

>
model2 = lm(ProfCert ~ NsProf + Educ + YrsRN, data = AllData)
> summary(model2)

Call:
lm(formula = ProfCert ~ NsProf + Educ + YrsRN, data = AllData)

Residuals:
   Min     1Q Median     3Q    Max
-1.5597 -0.6128 -0.2424  0.3300  4.5383

Coefficients:
            Estimate Std. Error  t value  Pr(>|t|)
(Intercept) -0.225492   0.599112  -0.376     0.7073
NsProf       0.034963   0.016466   2.123     0.0359 *
Educ         0.058848   0.095107   0.619     0.5373
YrsRN        0.015109   0.009556   1.581     0.1166
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.085 on 113 degrees of freedom
(6 observations deleted due to missingness)
Multiple R-squared:  0.07161, Adjusted R-squared:  0.04696
F-statistic: 2.905 on 3 and 113 DF,  p-value: 0.03786

> lm.beta(model2)
   NsProf   Educ   YrsRN
0.1944816 0.05623644 0.14480382

> confint(model2, level = 0.95)
                  2.5 %     97.5 %
(Intercept) -1.412440079 0.96145679
NsProf      0.002341278 0.06758456
Educ        -0.129575208 0.24727111
YrsRN       -0.003822160 0.03404081

model2 = lm(Educ ~ ProfCert + NsProf + YrsRN + GEFT + Ship, data = AllDataEduc)
> summary(model2)

Call:
lm(formula = Educ ~ ProfCert + NsProf + YrsRN + GEFT + Ship, data = AllDataEduc)

Residuals:
Min       1Q   Median       3Q      Max
-1.29682 -0.32760 -0.03629  0.67472  1.13892

Coefficients:

|          | Estimate  | Std. Error | t value | Pr(>|t|) |
|----------|-----------|------------|---------|---------|
| (Intercept) |  2.4998021 |  0.4430133 |  5.643  | 1.34e-07 *** |
| ProfCert  |  0.0434170 |  0.0628704 |  0.691  | 0.4913 |
| NsProf   |  0.0020605 |  0.0107025 |  0.193  | 0.8477 |
| YrsRN    |  0.0003972 |  0.0064917 |  0.061  | 0.9513 |
| GEFT     |  0.0214634 |  0.0159041 |  1.350  | 0.1800 |
| Ship     | -0.0428175 |  0.0180777 | -2.369  | 0.0196 * |

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.6789 on 109 degrees of freedom
(8 observations deleted due to missingness)
Multiple R-squared: 0.05524, Adjusted R-squared: 0.01191
F-statistic: 1.275 on 5 and 109 DF, p-value: 0.28
| Variable | Estimate | Std. Error | t value | Pr(>|t|) |
|----------|----------|------------|---------|----------|
| YrsRN    | 0.018641 | 0.009674   | 1.927   | 0.0566   |
| GEFT     | -0.022070| 0.024205   | -0.912  | 0.3639   |
| Ship     | 0.050308 | 0.027702   | 1.816   | 0.0721   |

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.029 on 109 degrees of freedom  
(8 observations deleted due to missingness)  
Multiple R-squared: 0.1086,  Adjusted R-squared: 0.06774
F-statistic: 2.657 on 5 and 109 DF,  p-value: 0.02631

```r
> lm.beta(model2)

         Educ      NsProf       YrsRN        GEFT        Ship
0.10032061  0.20460880  0.18786239 -0.09974584  0.20127049
> confint(model2, level = 0.95)
                 2.5 %     97.5 %
(Intercept) -2.448556732 0.40508544
Educ        -0.084019513 0.28569302
NsProf       0.003547526 0.06645727
YrsRN       -0.000532802 0.03781531
GEFT        -0.070043429 0.02590324
Ship        -0.004596184 0.10521284
```

```r
> summary(AllData)

     Age   Gender  Educ  YrsRN ProfCert  CritCare  GEFT  Ship
Min. :25.00   Min. :1.000   Min. :1.000   Min. : 1.00   Min. :0.0000   Min. : 0.0000   Min. : 0.0000   Min. : 0.0000   Min. : 0.0000
1st Qu.:36.00  1st Qu.:1.500  1st Qu.:2.000  1st Qu.:10.00  1st Qu.:1.0000  1st Qu.:13.25  1st Qu.:10.00  1st Qu.:31.00
Median :44.00  Median :2.000  Median :2.000  Median :16.00  Median :1.0000  Median :16.00  Median :16.00  Median :34.00
Mean :44.47  Mean :1.748  Mean :2.447  Mean :17.96  Mean :1.3980  Mean :11.00  Mean :16.04  Mean :33.63
3rd Qu.:53.00  3rd Qu.:2.000  3rd Qu.:4.000  3rd Qu.:25.00  3rd Qu.:2.0000  3rd Qu.:37.00  3rd Qu.:19.00  3rd Qu.:47.00
Max. :66.00  Max. :2.000  Max. :4.000  Max. :46.00  Max. :6.0000  Max. :70.00  Max. :25.00  Max. :47.00

> describe(AllData)

   var  n   mean    sd  median trimmed   mad  min  max range   skew   kurt  se
```
model2 = lm(ProfCert ~ Educ + NsProf + YrsRN, data = AllData)
> summary(model2)

Call:
lm(formula = ProfCert ~ Educ + NsProf + YrsRN, data = AllData)

Residuals:
    Min      1Q  Median      3Q     Max
-1.5597 -0.6128 -0.2424  0.3300  4.5383

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)              -0.225492   0.599112  -0.376   0.7073
Educ                     0.058848   0.095107   0.619   0.5373
NsProf                   0.034963   0.016466   2.123   0.0359 *
YrsRN                    0.015109   0.009556   1.581   0.1166
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.085 on 113 degrees of freedom
(6 observations deleted due to missingness)
Multiple R-squared:  0.07161,  Adjusted R-squared:  0.04696
F-statistic: 2.905 on 3 and 113 DF,  p-value: 0.03786

> lm.beta(model2)
       Educ  NsProf   YrsRN
0.05623644 0.19444816 0.14480382

> confint(model2, level = 0.95)
     2.5 %      97.5 %
(Intercept) -1.412440079 0.96145679
Educ         -0.129575208 0.24727111
NsProf       0.002341278 0.06758456
\begin{verbatim}
YrsRN   -0.003822160 0.03404081

model2 = lm(Educ ~ ProfCert + NsProf + YrsRN , data = AllData)
> summary(model2)

Call:
  lm(formula = Educ ~ ProfCert + NsProf + YrsRN, data = AllData)

Residuals:
     Min      1Q  Median      3Q     Max
-1.6375 -0.5442 -0.3873  1.4403  1.7442

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.074273   0.558879   3.711 0.000321 ***
ProfCert     0.057380   0.092735   0.619 0.537321
NsProf      0.006257   0.016570   0.378 0.706418
YrsRN       0.004013   0.009532   0.421 0.674573

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.071 on 113 degrees of freedom
(6 observations deleted due to missingness)
Multiple R-squared:  0.008735,   Adjusted R-squared: -0.01758
F-statistic: 0.3319 on 3 and 113 DF,  p-value: 0.8023

model2 = lm(ProfCert ~ Educ + YrsRN , data = AllData)
> summary(model2)

Call:
  lm(formula = ProfCert ~ Educ + YrsRN, data = AllData)

Residuals:
     Min      1Q  Median      3Q     Max
-1.6838 -0.5160 -0.2772  0.4798  4.7619

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.074273   0.558879   3.711 0.000321 ***
ProfCert     0.057380   0.092735   0.619 0.537321
NsProf      0.006257   0.016570   0.378 0.706418
YrsRN       0.004013   0.009532   0.421 0.674573

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.071 on 113 degrees of freedom
(6 observations deleted due to missingness)
Multiple R-squared:  0.008735,   Adjusted R-squared: -0.01758
F-statistic: 0.3319 on 3 and 113 DF,  p-value: 0.8023
\end{verbatim}
model2 = lm(ProfCert ~ Educ + NsProf + YrsRN, data = AllData)
> summary(model2)

Call:
lm(formula = ProfCert ~ Educ + NsProf + YrsRN, data = AllData)

Residuals:
  Min      1Q  Median      3Q     Max
-1.5597 -0.6128 -0.2424  0.3300  4.5383

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.2255    0.5991   -0.38   0.7073
Educ          0.0588    0.0951    0.62   0.5373
NsProf        0.0349    0.0164    2.12   0.0359 *
YrsRN         0.0151    0.0096    1.58   0.1166

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.085 on 113 degrees of freedom
(6 observations deleted due to missingness)
Multiple R-squared:  0.07161,   Adjusted R-squared:  0.04696
F-statistic: 2.905 on 3 and 113 DF,  p-value: 0.03786

> lm.beta(model2)
        Educ   NsProf   YrsRN
0.05623644 0.19444816 0.14480382

> confint(model2, level = 0.95)
          2.5 %     97.5 %
(Intercept) -1.412440799 0.96145679
Educ        -0.129575208 0.24727111
NsProf       0.002341278 0.06758456
YrsRN       -0.003822160 0.03404081
```r
model2 = lm(Educ ~ ProfCert + NsProf + YrsRN, data = AllData)
> summary(model2)

Call:
lm(formula = Educ ~ ProfCert + NsProf + YrsRN, data = AllData)

Residuals:
   Min      1Q  Median      3Q     Max
-1.6375 -0.5442 -0.3873  1.4403  1.7442

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)
(Intercept)              2.074273   0.558879   3.711 0.000321 ***
ProfCert                 0.057380   0.092735   0.619 0.537321
NsProf                   0.006257   0.016570   0.378 0.706418
YrsRN                    0.004013   0.009532   0.421 0.674573

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.071 on 113 degrees of freedom
(6 observations deleted due to missingness)
Multiple R-squared:  0.008735,  Adjusted R-squared: -0.01758
F-statistic: 0.3319 on 3 and 113 DF,  p-value: 0.8023

> lm.beta(model2)
    ProfCert    NsProf      YrsRN
0.06004501 0.03641581 0.04024327

> confint(model2, level = 0.95)
          2.5 %     97.5 %
(Intercept)  0.96703226 3.18151404
ProfCert    -0.12634381 0.24110456
NsProf      -0.02657075 0.03908515
YrsRN       -0.01487203 0.02289758
```
APPENDIX D

EXTENDED LITERATURE REVIEW
Nursing Education

Three common avenues to obtain an RN license are a 2-year associate degree program (ADN), a 3-year diploma program, and a 4-year BSN (Lawrence, 2011). Miner (2012) challenges the nursing profession to abandon the multiple pathways in nursing education and join in adopting the BSN as the entry level education required for nursing practice. The states of New York and New Jersey have proposed all nurses, by 2020, have a minimum of a Bachelor of Science degree in nursing to enter the profession (Maneval & Teeter, 2010).

A BSN education, although not the cure for all that is expected of nurses in the future, does introduce nursing students to a wider range of competencies in areas such as quality improvement, leadership, public health, and health care policy (Institute of Medicine [IOM], 2010). An increase in the number of nurses with a BSN would establish a workforce positioned to achieve education at the master’s and doctoral levels (IOM, 2010). The number of doctoral trained nurses must be doubled by 2020 to meet the needs for nurse researchers, primary care providers, and nursing instructors (IOM, 2011, 2012). Currently, 13% of nurses have a graduate degree in nursing; however, less than 1% of nurses have doctoral degrees (IOM, 21012).

Changes in Nursing

Role Changes

Over the past 50 years, changes in nursing such as those related to job demands, technology, work environments, patient acuity, litigation, salaries, education, and uniforms have dramatically impacted the role of the professional nurse (Blanche, 2010). In today’s health care environment, nurses monitor complex physiological data, operate lifesaving equipment, administer high cost health care programs and coordinate the delivery of multiple patient
services (Weld & Bibb, 2009). The high demands of academic knowledge and clinical expertise are often unexpected to individuals new to the profession (Brodie et al., 2004).

Changes in Job Skills

Nurses must use critical thinking skills with assessment, interpretation, and decision making to provide patient care, ensuring patient safety at all times. Clinical knowledge is estimated to double every 18 months (van Terheyden, 2007). Medical practices, pharmaceuticals, regulations and standards of care require constant assimilation of new information. Health care professionals must stay in a continual mode of learning as the field of health care is constantly changing (Hodges, 2011).

As health care technology advances and patients require higher levels of care, nurses must incorporate new practices and workflows to meet the changes (Kalisch & Begeny, 2010). Using integrating technology to improve clinical nursing practice enhances the quality of patient care (Saba, 2001). Today’s nurse must use technology to support workflow as well as support the patient’s use of increased technology (Bond, 2009). The technology required by nurses may vary; however, the core skills of basic computer proficiency, information technology, and information systems for health care practice that comprise the foundations of nursing informatics are essential for all nurses (Bond, 2009).

Creation of EHRs (electronic health record) using CPOE (computerized physician order entry) and interfacing of various electronic applications has created a complex and dynamic work environment for nurses (IOM, 2011). Expansion of biometric devices such as automated insulin pumps and implantable cardiac defibrillators require nurses to continually expand the use of technology in patient care.
Skills required for professional nursing is complex and extensive. The practice of nursing care is discipline specific, but also requires multidisciplinary knowledge in such areas as respiratory therapy, pharmacy, rehabilitation, and surgery (Giuliano, Tyer-Viola, & Lopez, 2005). Nurses must be proactive problem solvers and collaborative interdisciplinary team members (Hodges, 2011). Foundational science and math knowledge are required for nurses in areas such as anatomy and physiology, pharmacology and human behavior. Registered nurses working today extensively utilize skills in assessment, critical thinking, and communication and must be able to act quickly and decisively.

The nurse is the last safety check in the chain of events from prescription to medication administration, before reaching the patient (Leufer & Cleary-Holdforth, 2013). Nurses must use basic math functions and algebraic equations to calculate doses of medications and determine intravenous (IV) drip rates (Maag, 2004). Research has shown spatial visualization abilities to be positively related with performance on math tasks, as well as tasks in science, technology, and engineering (Hinze et al., 2013).

Nurses are associated with quality performance metrics and are therefore essential members of every hospital quality team (Kohlbrenner, Whitelaw, & Cannaday, 2011). Nursing performance is more important today than ever before as communities can access hospital performance and outcome measures by accessing Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) scores (Leibert, 2011). The Joint Commission Leadership Standards identified RNs as the most important contributor of patient safety and quality (Kohlbrenner et al., 2011)
Many advances in medical care have resulted in greater numbers of hospitalized patients, more critically ill patients upon admission to hospitals, and aging patients as well as improved survival from critical events (Kuehn, 2007; Lynn & Redman, 2005). Increased patient acuity levels with shortened lengths of hospital stays create intensive and accelerated health care processes (Hirschkorn, West, Hill, Cleary, & Hewlett, 2010). Nurses complete an average of 100 tasks per shift, with an interruption every 3 minutes, often resulting in cognitive overload (Hendren, 2011). All of these improvements and changes rely on tremendous knowledge and a skill set that allows the nursing professional to deliver optimal care demanded in such situations.

The current nursing workforce contains a disproportionate number of females. While most disciplines within the health professional workforce have become more gender balanced, the same has not been true for nursing. The number of men who become nurses has grown in the last two decades however men account for only 7% of the current RN workforce (US Department of Health and Human Services, 2010). Stereotypes, role support, and academic acceptance are some challenges men encounter when entering the nursing profession (IOM, 2011). Moreover, there is little recognition of unique skills or abilities of males as nurses, and the turnover rate for male nurses is twice that of females (Hsu, Chen, Yu, & Lou, 2010). While more men are being drawn to nursing, especially as a second career, the field of nursing must continue to recruit men as their unique perspectives and skills are important to the profession and will help contribute additional diversity to the workforce (IOM, 2011). Given the disparity
between the number of males and females employed as professional nurses, gender differences in ability are important to determining skill acquisition/possession across the entire field of nursing.

Certifications

Licensing and Certification

RN licensure indicates entry-level competence to the nursing field where certification verifies specialty knowledge, skills, experience and clinical judgment (American Association of Critical-Care Nurses, 2013; American Board of Nursing Specialties, 2005). Certification reflects self-mastery with an emphasis on self-evaluation (Crist, Russell, & Farber, 2012). According to Wynd (2003), nursing professionalism is significantly related to years of nursing experience, higher educational degrees in nursing, professional organizational memberships and specialty certification.

Specialty certifications include, at a minimum, a practice component with required knowledge testing (Briggs, Brown, Kesten, & Heath, 2006; Grief, 2013). The American Nurses Credentialing Center (ANCC) is the nationally recognized agency to provide professional nursing credentialing programs to certify and recognize nurses in areas of specialty (ANCC, 2013). The majority of hospitals in the United States seek accreditation from the Joint Commission (Williams & Counts, 2013). Many hospitals apply for the Malcolm Baldrige National Quality Award, the American Association of Critical-Care Nurses Beacon Award for Excellence, and for Magnet recognition (Williams & Counts, 2013). All of these programs, whether accrediting, recognizing or awarding, include nursing certifications as an integral factor in demonstrating nursing excellence (Fleischman, Meyer, & Watson, 2011; Williams & Counts, 2013).
Professional Certification and Patient Outcomes

The connection between certified nurses and quality patient care is well established (Crist et al., 2012). Specialty nurse certification is increasing in value as more evidence suggests that certification is a factor in improving patient outcomes (Fleischman et al., 2011; Timmerman, 2008). RNs with a BSN degree and a specialty certification are associated with improved patient outcomes, decreased mortality, and decreased failure to rescue in general surgical patients (Kendall-Gallagher, Aiken, Sloane, & Cimiotti, 2011).

Competency or Proficiency

The National Council of State Boards of Nursing (NCSBN) requires all nurse licensing candidates to pass an examination that measures the competencies required to perform safe and effective patient care as a newly licensed entry-level nurse, namely the NCLEX-RN (National Council Licensure Examination for Registered Nurses), and graduate from an accredited school of nursing (National Council of State Boards of Nursing, 2013). Upon graduation from an accredited school of nursing and passing the NCLEX-RN, the student applies for a nursing license allowing the individual to practice nursing within the state where the requirements were met (Simon, McGinniss, & Krauss, 2013). The HESI (Health Education Systems, Inc.) Exit Exam, an external independent assessment of a student’s competency at a higher cognition level of application, analysis, and synthesis, is often administered to senior level nursing students to determine a student’s readiness to take the NCLEX-RN (Schooley & Kuhn, 2013).

Currently, in most states a nurse is considered proficient or competent upon initial licensing, with assumed proficiency or competency going forward unless otherwise discovered (Tilley, 2008). Tilley (2008) describes the confusion associated with competency and
proficiency as related to two different uses of the terms initial licensure and ongoing maintenance.

There has been little progress in the nursing profession towards the development of a general tool to evaluate overall nursing knowledge and skills outside of nursing schools (IOM, 2011; Long, Mitchell, Young, & Rickard, 2013). Definitions of nursing proficiency or competency are difficult to find as there is little consensus about a definition or the concept of a competency measurement (Tilley, 2008). Tilley (2008) outlined the defining attributes of competency as (a) application of skills in all domains for the practice role, (b) instruction that focuses on specific outcomes or competencies, (c) allowance for increasing levels of competency, (d) accountability of the learner, (e) practice-based learning, (f) self-assessment, and (g) individualized learning experiences. The NCSBN (2005) defines competency as “the application of knowledge and the interpersonal, decision-making, and psychomotor skills expected for the practice role, within the context of public health” (p. 81). Competency assessments should evaluate thinking in action, confidence in decision making, and information retrieval for the inclusion of best practices (Allen et al., 2008).

*Nursing Shortage*

Predictions

The nursing profession is experiencing a national workforce shortage of critical proportion (Juraschek, Zhang, Ranganathan & Lin, 2012). This shortage is predicted to worsen, with an expected national shortage of 300,000 to 1 million RNs in 2020, and continued shortages throughout the country through 2030 (Juraschek et al.). A report from the U.S. Department of Health and Human Services (2010) predicted a nursing shortage equating to a 36% shortage.
Aging Workforce

The aging RN workforce strongly impacts the projected nursing shortage (Juraschek et al., 2012). Nurses that were 50 years of age or older comprised 25% of the nursing workforce in 1980, 33% of the nursing workforce in 2000, and were accountable for 45% of the nursing workforce in 2008 (Juraschek et al.; US Department of Health and Human Services, 2010). A survey conducted in 2013 reported that 55% of the current RN workforces is age 50 or older (Budden, Zhong, Moulton, & Cimiotti, 2013). It is estimated that 55% of currently employed nurses plan to retire before 2020 (Hirschkorn et al., 2010).

Job Dissatisfaction

Social support from supervisors and coworkers, job demands, and self-efficacy were reported to be significantly related to job dissatisfaction, while demands and support from coworkers were related to intention to leave the profession (Peterson, Hall, O’Brien-Pallas, & Cockerill, 2011). Job dissatisfaction was a strong determinant of turnover among new nursing graduates, with interpersonal relationships having the strongest impact (Cho, Lee, Mark, & Yun, 2012). Nurses new to the profession are often disillusioned when what they learned nursing should be is different from the reality of nursing practice in their work place (Cho et al., 2012).

Nursing Faculty Shortage

There are many factors for the nursing shortage with a shortage of nursing educators being one of the factors (Rich & Nugent, 2010). In 2012, U.S. nursing schools declined almost 80,000 qualified applicants for baccalaureate and graduate nursing programs due to a lack of faculty, clinical sites, clinical preceptors and budget constraints (AACN, 2014). Higher
financial compensation in clinical settings is enticing current and potential nursing faculty away from the academic setting (AACN).

Addressing the Nursing Shortage

One step in addressing the predicted nursing shortage would be to ensure those entering the profession possess essential aptitudes for a career in nursing. In this manner, the profession of nursing might benefit from alignment with current strategies of early identification of individuals with potential for success, as is being done in science, technology, engineering, and math (STEM) fields.

Students often enter the field of nursing with common misconceptions, such as nursing is a subordinate occupation, requiring only common sense and little intellectual capacity (Brodie et al., 2004). Students are surprised, even overwhelmed, by the required high academic standards in nursing. The unexpected demands of academic knowledge and clinical expertise have been identified as a source of nursing student attrition (Brodie et al., 2004) Acquiring the required knowledge and skills often overwhelms students preparing for a nursing career. Harvey and McMurray (1997) reported that 81% of students dropping from a pre-nursing course cited a perceived discrepancy between the content of their course and their preconceived ideas of the nursing profession. Failure to recognize that nursing is based on science and requires a complex and specialized skill set with the ability to think critically and act decisively underlies much of that perceived discrepancy (Harvey & McMurray, 1997).
Spatial Ability

General Cognitive Ability - g

Charles Spearman introduced the first theory of intelligence in 1904, identifying general mental ability as a trait based on his findings that all mental test scores were positively correlated (Floyd, McGrew, Barry, Rafael, & Rogers, 2009; Jensen, 1987). Spearman proposed general intelligence, g, as the identified factor that accounted for correlations among cognitive ability tests (Carroll, 1997). General cognitive ability (g) is the capacity to work with cognitive complexity, more specifically, complex informational processing (Gottfredson, 1997; 2002). An application definition of general cognitive ability (g) is the aptitude to learn moderately complex material quickly and efficiently and the ability to prevent cognitive errors (Gottfredson, 2002). General cognitive ability has been identified as the primary predictor for occupational success in the United States (Kane & Brand, 2003).

Raymond Cattell suggested human intelligence is comprised of two complementary intelligence factors--crystallized and fluid intelligence (Horn & Cattell, 1966). Crystallized intelligence, gc, represents specific knowledge that one obtains from learning, education and experience; fluid intelligence, gf, represents the capacity to solve problems, think logically, and reason independent of acquired knowledge (Jensen, 1987). John Horn furthered Cattell’s research in 1965 by adding six broad factors, resulting in the Cattell-Horn Gf-Gc theory (Kane & Brand, 2003; McGrew, 2009).

Carroll’s research proposed a hierarchical model of intelligence, describing cognitive abilities in terms of a three-stratum model (Carroll, 1997; Kane & Brand, 2003). Stratum 1 is composed of a large number of narrow abilities, such as language development, reading, and spelling. Stratum II consists of 10 broad abilities, such as fluid intelligence, crystallized
intelligence, general memory and processing speed (Kane & Brand, 2003). The highest stratum, Stratum III, consists of only one single factor, \( g \), generalized intelligence (Carroll, 1997).

**Cattell-Horn-Carroll Theory**

The Cattell Horn Carroll (CHC) theory of intelligence was developed by merging the Cattell-Horn \( G_f-G_c \) model with Carroll’s three-tiered stratum model to form a broader hierarchical model of \( g \) (Floyd, Evans, & McGrew, 2003; McGrew, 2009). General cognitive ability, \( g \), is the highest level of the hierarchy at Stratum III (Bickley, Keith, & Wolfe, 1995; Parkin & Beaujean, 2012). Stratum II contains 10 broad CHC abilities with visual processing, \( G_v \), being one of the ten (Rozencwajg, Schaffer, & Lefebvre, 2010). Making use of simulated mental imagery to solve problems is the basis of visual processing (McGrew, 2013). Visual-spatial ability includes many specific perceptual abilities, being cognizant of complex visual patterns, being aware of where items are located in space, in addition to visualizing objects as they would appear from a different angle (Schneider & McGrew, 2012; 2013). According to McGrew (2009), \( G_v \) abilities are often measured by tasks that require retaining the spatial orientation of an object after the object has been moved or changed. Figure D.1 provides a visual illustration, comparing Carroll's three-stratum, Cattell–Horn's extended \( G_f-G_c \), and the integrated Cattell–Horn–Carroll models of human cognitive abilities (McGrew, 2009).
Figure D.1. Schematic representation and comparisons of Carroll's three-stratum, Cattell–Horn's extended Gf–Gc, and the integrated Cattell–Horn–Carroll models of human cognitive abilities (McGrew, 2009).

Stratum II contains 10 broad CHC abilities: (a) fluid intelligence, (b) quantitative knowledge, (c) crystallized intelligence, (d) reading and writing ability, (e) short-term memory, (f) visual processing, (g) auditory processing, (h) long-term retrieval, (i) processing speed, and (j) decision/reaction time/speed (Rozencwajg, et al., 2010). Over 100 narrow abilities are included in Stratum I and are subsumed under the broader abilities in Stratum II (Parkin & Beaujean, 2010).

The current study focused on the broad ability of visual processing, Gv. Higher Gv ability allows an individual to see more than the object by imagining the object from a different view after mental rotation, mentally taking a complex item apart and reassembling the item (Schneider & McGrew, 2013). Lower Gv levels decrease an individual’s ability to perform mental rotations causing the person to wait until an object is physically rotated to see the change
(Schneider & McGrew, 2013). McGrew (2013) explains that after the eyes have transmitted visual information, the visual system of the brain performs a number of basic computations, such as edge detection, light/dark perception, color-differentiation, and motion-detection. These activities are used by more high level processors to create more complex aspects of the image, such as spatial configuration (McGrew, 2013).

**Spatial Ability in STEM – to Include Nursing**

Over 50 years of research exists on the importance of using spatial ability, specifically in the realm of science, technology, engineering, and math (STEM), for selection and instruction in education (Wai, Lubinski, & Benbow, 2009). Spatial ability, often neglected in complex work environments, is a powerful systematic source of individual differences (Lubinski, 2010). Snow (1999) expressed concern about the absence of spatial ability in applied educational settings:

> There is good evidence that [spatial ability] relates to specialized achievements in fields such as architecture, dentistry, engineering, and medicine...Given this plus the longstanding anecdotal evidence on the role of visualization in scientific discovery... it is incredible that there has been so little programmatic research on admissions testing in this domain. (p. 136)

A recent study with over 4000 nursing students, compared admission criteria for nursing programs with a standardized RN Fundamentals assessment (Wolkowitz & Kelley, 2010). Wolkowitz and Kelley (2010) reported science coursework as a statistically significant predictor and the strongest predictor for nursing program success. Scores for biology and chemistry coursework were significant predictors for success with readiness practice exams for RN licensing (Simon, McGinniss & Krauss, 2013). As science is fundamental for nursing education and higher spatial ability levels are associated with success in math, nursing should consider
joining efforts with educational departments in evaluating spatial ability in efforts to identify potential candidates to enter professional nursing.

**Gender Differences in Spatial Ability**

Findings supporting gender differences in spatial ability are abundant; and, mental rotation testing is consistently more sensitive to gender differences than other spatial ability tasks (Brownlow, McPherson, & Acks, 2003; Ceci & Williams, 2010; Geary, Gilger, & Elliott-Miller, 1990; Geiser, Lehmann, & Eid, 2008; Jansen & Heil, 2010; Terlecki, Newcombe, & Little, 2008; Voyer et al., 1995; Voyer & Doyle, 2010). With the imbalance among the number of male and female nurses and the commonly accepted finding of males performing higher than females on mental rotation tests for spatial ability, looking at spatial ability in nurses could provide additional information to address gender differences and nursing shortages within the profession.

Several explanations for gender differences in spatial ability have been provided, such as socioeconomic status (SES), environmental, or biological factors (Levine, Vasilyeva, Lourenco, Newcombe, & Huttenlocher, 2005). Brain maturation, hormonal changes, personal beliefs and motivation have also been reported as possible explanations for gender differences in spatial abilities (Moe & Pazzaglia, 2006; Kozaki & Yasukouchi, 2009; Yilmaz, 2009).

Sex roles in play activities, parental expectations, and educational experiences all influence the development of a child (Yilmaz, 2009). Boys are more likely than girls to participate in spatial activities, such as building blocks, models, athletic sports, and video games in childhood (Baenninger & Newcombe, 1995; Cherney, 2008). Practice effects from participation in these spatial activities likely contribute to correlation with higher spatial ability test scores in males (Baenninger & Newcombe, 1995).
Gender differences in spatial ability may also result from different solution strategies. Mental rotation strategies are often categorized in two groups—analytic strategies and holistic strategies (Janssen & Geiser, 2010). Analytic strategies employ comparing specific details and using reasoning strategies, unlike holistic strategies that utilize mental transformations (Janssen & Geiser, 2010). According to Arendasy, Sommer and Gittler (2010), females are more likely to lose their internal mental representations or lose track during the transformational process. Holistic mental rotation strategies are reported to be more effective when compared to perspective change strategies, and females tend to utilize less effective perspective change strategies (Arendasy, Sommer, & Gittler, 2010). According to Janssen and Geisler (2010) individuals can be identified as rotators or non-rotators, dependent on the strategy they use for mental rotation testing.

Spatial Ability and Job Performance

General cognitive ability, $g$, is a significant component of individual differences in job performance associated with informational processing skills (Lubinski, 2000). Greater levels of $g$ are associated with higher levels of performance in all jobs and within all dimensions of performance (Gottfredson, 2002). Health care organizations are frequently described within the context of complexity, situations involving people working independently and collectively to manage an unpredictable work environment over time (Fairchild, 2010). Individuals with high general cognitive ability are needed in the nursing profession. As nursing requires strong information processing activities for successful patient care assessing individuals considering entering the nursing profession for general cognitive ability, specifically spatial visualization, might be beneficial.
COMPREHENSIVE REFERENCES


Arendasy, M. E., Sommer, M., & Gittler, G. (2010). Combining automatic item generation and experimental designs to investigate the contribution of cognitive components to the gender difference in mental rotation. *Intelligence, 38*(5), 506-512. doi:10.1016/j.intell.2010.06.006


