The authors review the historical development and organization of the profession of nurse anesthesia and the present requirements for admission to nurse anesthesia education programs. A literature review of the research on necessary skills and knowledge acquired by applicants from one year of acute/critical care nursing experience is discussed. Implications for future research and innovative education programs are addressed.

Key words: Acute/critical care experience, graduate education, nurse anesthesia education, nursing education, qualified nurse anesthesia applicants.

Introduction
Certified Registered Nurse Anesthetists (CRNAs) practice nursing in the context of anesthesia and intensive care, providing special care in anesthesia, analgesia, and resuscitation to patients. There is little scientific evidence of the specific skill sets and knowledge base necessary for qualified registered nurse applicants to nurse anesthesia education programs (NAEPs). This substantive issue is complicated further by the rapid transformations in healthcare delivery systems and health professional educational systems to meet population needs for anesthesia and resuscitation. Review of the literature suggested the need for further clarification of specific acute care clinical experiences that constitute the necessary skills set and knowledge base of qualified nurse applicants. Therefore, we began the process of developing a valid and reliable measuring instrument to identify relevant clinical experiences. A future article will explore the use and testing of the survey instrument in a large pilot study of a representative nationwide population. Identification of essential entry-level skills and knowledge necessary for successful student applicants to nurse anesthesia education programs could be of use to program directors as well as potential student applicants.

The purpose of this review is to examine the literature on the skills set and knowledge base necessary for qualified applicants of NAEPs. Necessary skills and knowledge are thought to be included in clinical experience requirements. Clinical experience, for purposes of this review, is conceptually defined as nursing activities performed in acute care settings.

Historical background
The specialty practice of nurse anesthesia has evolved over time into one of the most challenging areas of advanced practice nursing. In a fast-paced, interdisciplinary healthcare environment, CRNAs apply high-level professional judgment and precise technical skills in the ongoing assessment, management, and evaluation of patients and their families. The professional practice of nurse anesthesia requires critical thinking and independent judgment for administering anesthesia and providing other anesthesia-related services to patients in a wide variety of settings.

Education. Since 1887, professional nurse anesthetists have provided this specialized care.

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Although the earliest nurse anesthesia training program dates back to 1889, formal 6-month postgraduate courses in university and major community hospital settings were not established until 1909 through 1914. While early nurse anesthesia education was accomplished principally through on-the-job training, it was coupled with readings, discussions, laboratories, and peer instruction methods. Six-month postgraduate courses used lecture and supervised clinical experiences.

From 1915 to 1922, hospital-based NAEPs "began preparing graduate nurses as anesthetists, rather than trying to prepare them within basic nursing educational programs." At the time, no professional organization or standardized educational requirements existed.

Standardization of nurse anesthetist education programs was championed by Agatha Hodgins, CRNA, founder of the National Association of Nurse Anesthetists, as early as the 1930s. In addition, her interest in education was a significant force behind the development of the professional organization:

"You are doubtless aware that nurses with little or no education on the subject practicing anesthesia, is a serious cause of complex and disturbing difficulties constantly arising. This situation can only be cleared up by our ability to create a classification insuring protection to all concerned. Thus, briefly outlined, are the reasons leading to the organization." (P90)

The goal of standardization of education programs was driven by concerns about programs that were either limited to practical training or too short in duration. By 1936, a standardized curriculum for schools of nurse anesthesia, as recommended by the Educational Committee of the National Association of Nurse Anesthetists, was adopted. Among the recommendations were an educational program that included theoretical and practical experiences and course lengths that would be a minimum of 6 months "with one year advocated." (P101)

World War II brought increased demand for nurse anesthetists and the growth of emergency training programs. Increased need for nurse anesthetists resulted in accelerated training programs that grew shorter as the war advanced. At the same time, the National Association of Nurse Anesthetists endeavored to maintain the standards attained and pursued the development of programs for national examinations and school accreditation.

Nurse anesthesia was recognized as the first clinical specialty within nursing in 1946. The Journal of the American Association of Nurse Anesthetists reported a panel discussion in which Madeline McConnell, a director of nursing, observed that the nurse anesthetist profession is based on nursing educational requirements.

In 1950, nurse anesthetist standards of practice were advanced with the approval of plans for accreditation of schools of anesthesia. By 1952, the accreditation program for schools of nurse anesthesia was implemented and "only graduates of accredited schools would be eligible to take the qualifying examination." (P103)

In the 1960s and 1970s, civilian efforts to advance the educational structure of NAEPs were not met with enthusiasm, since many nurse applicants came from associate degree and diploma programs. On the other hand, a cooperative endeavor between the US Army and the College of Nursing, University of Hawaii, brought the first master of science degree program in nurse anesthesia in 1969. Ira P. Gunn, CRNA, was instrumental in its development, and Geraldene Felton, CRNA, PhD, (then Major, Army Nurse Corps) served as its program director (personal communication, I.P. Gunn, August 7, 1997). The program was discontinued after 4 or 5 classes of students graduated, but it served as a prototype for graduate education in this field (personal communication, I.P. Gunn, August 7, 1997). This graduate program preceded the development of baccalaureate programs in nurse anesthesia by a couple of years (personal communication, I.P. Gunn, August 7, 1997).

In the 1970s and 1980s, NAEPs continued advancing their educational standards with subsequent moves to graduate level educational programs. In 1978, the master of science degree in nurse anesthesia program was founded at California State University. The California State University program "has been the longest continuously running master's in a school or college of nursing" (personal communication, I.P. Gunn, August 7, 1997). By 1998, all NAEPs will offer graduate degrees as minimum entry level standards.

- **Professional organization.** Professional nurse anesthetists organized nationwide in 1931, forming the National Association of Nurse Anesthetists, later renamed the American Association of Nurse Anesthetists (AANA). An initial and continuing goal of the association has been the placement of well-educated people in the field of nurse anesthesia. With the founding of the AANA came many advances in the profession, including the initiation of the certification examination in 1945 and the accreditation program for schools of nurse anesthesia in 1952. Today, the AANA represents 96% (more than 25,000) of practicing CRNAs in the United States.

Requirements for initial CRNA status include:

- Licensure as a registered nurse.
Graduation from an accredited nurse anesthesia educational program.

Successful completion of the nurse anesthesia certification examination.

Additional requirements must be met to maintain recertification.

Analysis of the literature suggests NAEPs require the applicant's completion of basic nursing education, subsequent licensure as a registered nurse, and a minimum of 1 year of experience as a registered nurse for entry into an NAEP. But, what are the presumed prerequisite skills and knowledge acquired in that 1 year of experience?

Requirements for admission to NAEPs

Nurse anesthesia educational programs must comply with educational standards to meet quality requirements and maintain accreditation status. The Council on Accreditation of Nurse Anesthesia Educational Programs Standards include subsets of criteria. One such criterion is:

“Enroll only students who have a minimum of 1 year of experience as a registered professional nurse in which they have had the opportunity to develop as independent decision makers, and demonstrate psychomotor skills and the ability to use and interpret advanced monitoring techniques based on a knowledge of physiologic and pharmacologic principles.”

At the same time, AANA professional literature suggests that admission requirements to an NAEP include a “minimum of 1 year of acute care nursing experience,” Association pamphlets further elaborate on the requirements, calling for “a minimum of 1 year's acute care nursing experience, such as critical care, cardiac care, or emergency room nursing.” Additional literature supports these prerequisite experiences, suggesting at least 1 year of experience in an acute care setting or a year of critical care experience is required.

Why is 1 year seen as necessary? Discussion with Ira Gunn, CRNA, FAAN, a leader in the nursing education movement, provides insight.

“The proliferation of knowledge (biochemistry, physiology, pathophysiology, and pharmacology) and technology has resulted in an ever-increasing capability to prevent and/or diagnose and treat diseases, injuries, congenital defects, and disabilities in patients ranging from the essentially healthy to the moribund and in all age groups. As nursing moves into university settings, increasing requirements for academic courses in basic nursing education came at the expense of clinical experiences. Thus, many nurse anesthesia educators believed that nursing graduates should have a minimum of 1 year experience in an acute care setting to afford the new nurse opportunity to gain experience and confidence in independently applying her knowledge and critical thinking skills to patients whose needs were acute, rather than chronic, and whose physical conditions had the potential to be in a state of flux. This also permitted the young nurse opportunity to perfect the technical skills previously learned and acquire additional skills needed for caring for patients requiring acute or critical care. Particularly, those nurses who had experience in critical care settings, often came to the anesthesia program proficient in a variety of skills that were transferrable to anesthesia and, I believe, more confident in their assessment and clinical decision skills. Further, they came with an enhanced knowledge base which had moved beyond the theoretical to the reality of practice.

“The shifting emphasis on academic courses at the expense of clinical learning experiences within nursing has always been a significant influence in the setting of standards for nurse anesthesia education. The requirements for these programs included extending the length of educational programs to accommodate additional academic requirements rather than significantly reducing clinical education, as had happened in nursing education. Nurse anesthesia education has always incorporated the concept that the graduates of these programs must be prepared to function independent of supervision, since schools do not have control over where their graduates will practice.

“The focus on acute or critical care (regardless of the specialty in which it was acquired) was to focus on patients whose state of health was in flux, who required close monitorings and other assessment, and in which critical decision making was required more frequently than you would see in patients over the acute stage of their health problem. This would give the new nurse more opportunity to exercise her/his knowledge base and critical decision and technical skills” (personal communication, I.P. Gunn, August 29, 1997).

Accreditation criteria broadly define minimum experiential requirements of nurses for admission to an NAEP, including development of decision-making skills, demonstration of psychomotor skills, use and interpretation of advanced monitoring techniques, and a knowledge base of physiology and pharmacology. Other literature categorizes the necessary skills and knowledge as acute care experience and suggests the experience is obtained in certain settings (eg, critical care, cardiac care, and emergency room). The current literature review asks the question: Does the research literature identify the skills and knowledge acquired from 1 year of acute care/critical care experience?
Research on admission criteria. This review identified only 1 study of requirements and qualifications used to select students for admission to NAEPs. The descriptive study identified qualifications of nurses accepted to NAEPs for the 1992 to 1993 academic year. Many indicators were used to measure knowledge: Graduate Record Examination, grade point average (GPA), Miller Analogies Test, and completion of specific science courses. Years of critical care experience per individual student ranged from 2 months to 22 years (mean, 5 years). Critical care settings of applicants included surgical (54%), medical (18%), postanesthetic care unit (9%), emergency room (6%), neonatal (5%), operating room (4%), pediatric (2%), and other (2%). The “other” category included neurosurgical, burn, and trauma intensive care units, high-risk labor and delivery, and nurse practitioner. Respondents reported the top 3 factors considered most by the NAEP directors in the selection process were overall GPA, interview performance, and science GPA. Years of critical care experience ranked a close fourth.

Descriptive data reported by the Council on Accreditation document prerequisites to admission, as reported in annual surveys of NAEPs. Program directors reported that applicants meet admission requirements for GPA, admission tests (Graduate Record Examination, Miller Analogies Test), academic degrees, course work, and clinical experience. Experience in medical, surgical, or cardiac intensive care units, postanesthesia care units, and emergency rooms was acceptable for most programs responding.

An international descriptive study provided information regarding NAEPs in various countries. Training programs reported ranged from basic observational, tutorial, or assisted hospital/clinic training processes lasting 6 to 9 months to advanced academic degree programs lasting 3 years and 6 months. Qualified nurse applicants to NAEPs in Sweden were required to complete only 6 months of clinical practice as a registered nurse. Other countries required 2 or more years of clinical experience for applicants to NAEPs. The possible lack of homogeneity of conceptual definitions of “experience” and “critical care” and low response rates limited the generalizability of the study’s findings.

Descriptive studies provided information on the average characteristics of students accepted into 54% of graduate NAEPs (67% military, 42% other) and described the broad variety of “critical care” or acute care settings from which successful applicants came. Information on NAEPs internationally provided additional context for comparison. Yet, these surveys did not examine the specific skills and knowledge base acquired by successful applicants with work experience in various acute care settings.

Research on related topics. An analysis of professional practice activities has provided content validation for items on the National Certification Examination (NCE). Other studies have explored the relationship between NAEP characteristics and success of graduates on the NCE and identified preadmission, academic, and demographic predictors of success on the NCE.

A descriptive study examining the relationship between NAEP characteristics and NCE success rates found that such characteristics could not reliably predict success. Although none of the relationships studied were statistically significant, researchers suggested that future studies should consider the relationship between the number of years of nursing experience before entering NAEPs and NCE pass rates.

Years of nursing experience was a significant predictor of performance on the “preparation” subscore and “special procedures” subscore of the NCE (1987 to 1989) in another study. On the other hand, specific type of setting of clinical nursing background experience (ie, critical care, emergency room, recovery room, operating room, obstetrics/gynecology, and other) before entry into NAEPs was not predictive of success, suggesting that “the type of clinical nursing background is not a factor that influences performance.”

Similarly, a descriptive study suggested there was little difference in NCE performance of nurses from different experiential backgrounds (ie, critical care, recovery room, general, operating room, other). It is interesting to note that the majority of candidates constituting the sample for this study (1975 to 1978) came from clinical experience backgrounds other than critical care, operating room, recovery room, and general nursing. As the requirement for a minimum of 1 year experience prior to admission was not formalized until 1976, and programs were 2 years in length, it is likely that only the 1978 group met the requirement.

Related studies provide support for necessary academic content in education programs and identify significant characteristics of NAEPs and student applicants as they relate to successful performance on certification examinations. However, these studies provide little information about, and one might question the validity of, certification examination performance as a measure of essential skills and knowledge acquired from acute care nursing clinical experiences.

Practice and educational trends affecting the profession

Healthcare delivery systems are experiencing
revolutionary changes. The rapid proliferation of organized, integrated, managed care networks and capitated payment for enrolled populations tends to reduce inpatient lengths of stay and increase preventive and outpatient care.\textsuperscript{17} Federal funding for specialist medical education has been reduced.\textsuperscript{17,18} Managed care networks and Medicare’s prospective payment system mediate the demand for innovation and new technology.\textsuperscript{17} Overall, these forces have encouraged shifting to technologies for use in, and care provided in, outpatient settings, as well as an emphasis on generalist education of physicians.\textsuperscript{17} At the same time, these changes make it difficult to predict the number of nurse anesthetists needed in the future.\textsuperscript{18}

The current cost-containment environment could facilitate the increased use of CRNAs versus specialist physician anesthesiologists. Overall spending for medical education historically has exceeded that for nonphysician healthcare providers. A 1992 study conducted in Texas found that the average cost of educating a physician totaled approximately $650,000.\textsuperscript{19} At the same time the average cost of educating a CRNA was approximately $60,000.\textsuperscript{19}

The prospective payment system has resulted in increased acuity levels of hospitalized patients.\textsuperscript{20} A shortage of critical care nurses has been identified.\textsuperscript{20} These changes have converged to create an increased shortage of qualified NAEP applicants with critical care experience. Yet, patient care in hospitals has changed, with higher acuity patients now on medical-surgical units, who previously might have been in critical care units.

Transformations in healthcare delivery and financing systems have underscored the role of CRNAs and other healthcare practitioners and focused attention on their education. Recently, the Pew Health Professions Commission explored new approaches to healthcare workforce regulation. Raising questions of accountability and effectiveness, the task force called for review and reform of entry-to-practice requirements and standards to assure that such requirements are based on assessment of “the competence, skills, training, or knowledge of the professional.”\textsuperscript{21} Furthermore, they suggested that “rigid requirements for education and training . . . ignore comparable or innovational education, training, and work experience . . . and hamper(s) professional mobility within a profession.”\textsuperscript{21}

As healthcare delivery system changes occur, opportunities for development of innovative new education programs exist. If necessary skills and knowledge base requirements are identified, then the prerequisite 1 year of acute care experience might be satisfied through alternative methods.

**Clarification of requisite clinical experiences**

Inadequate numbers of applicants qualify for NAEPs, in part due to lack of critical care experience. At the same time, the acuity of hospitalized patients has risen, resulting in more critical patients on regular medical-surgical units. Historically, critical care experience may have entailed different activities in the 1960s and 1970s than it does in the late 1990s. Some of these activities have shifted from critical care to regular medical-surgical units, as client acuity levels have risen. Is it possible that the necessary skills and knowledge acquired through critical care clinical experiences might be acquired through alternative clinical experiences or through innovative educational programs?

Research studies have not yet identified a uniform set of skills and knowledge inherent in the traditional “1 year of critical care experience.” Therefore, the first step toward an innovative solution is to explore critical care experiences believed to include the skills and knowledge required for qualified applicants for entry into NAEPs. We have developed a research survey for this purpose.

Previous studies suggested that closer scrutiny of the construct of critical care experience and its relationship to performance on the NCE be considered.\textsuperscript{15} The premise of this review is that the construct should be closely examined for specific skill and knowledge content areas that reflect competence in applicants to NAEPs. Critical care is a broad construct that includes medical, surgical, and cardiac intensive care; step-down care units; emergency room and possibly recovery room; operating room; postanesthesia care units; and possibly other areas. The benefits of critical care experience may include development of critical thinking/problem solving skills, exposure to and experience with patients who have a variety of medical and nursing diagnoses, and development of confidence in one’s professional decision-making skills and autonomy.\textsuperscript{15}

The rationale for critical care nursing experience as an admission requirement is that it provides applicants with broad-based acute care problem-solving skills\textsuperscript{15} and allows inclusion of experience with and knowledge of advances in healthcare technologies. It is logical to assume that these problem-solving skills may develop from a skill set and basic knowledge content acquired in various clinical and educational settings. Research studies need to examine and explain the skills and knowledge acquired in 1 year’s acute/critical care experience that are necessary for competence in qualified applicants to NAEPs.
Innovative educational strategies

Analysis of the literature suggests that there is a need for “alternative educational pathways” for NAEPs as a result of the necessity for professionals to retool their skills and career paths several times in their lifetime, mid-career changes, and students who are employed and must continue to work. In addition, the dynamic changes in healthcare delivery systems call for innovative new educational programs to meet the public demand for nurse anesthetists. Therefore, innovative educational programs are appearing and new ones are likely to evolve. New alternatives may better meet the needs of nurses, potential students, and the public, thus enabling nurses with a broad variety of experiences to enter NAEPs. It is particularly important in this dynamic environment that educational programs broaden their frame of reference and create innovative solutions to meet the population’s healthcare needs in integrated healthcare delivery systems of the 21st century.

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ACKNOWLEDGMENT

We gratefully acknowledge the review of, and enlightening contributions to, the manuscript so graciously provided by Ira P. Gunn, CRNA, MLN, FAAN.