In 1990, Taunton et al. reviewed research published in the AANA Journal. They summarized and compared the research published during the 1975-1976 period with the research published during the 1985-1986 period. In a follow-up study, we compared the research published during the 1995-1996 period with the findings of Taunton et al. In addition, we searched for research reports in other nursing and medical journals that were authored or coauthored by Certified Registered Nurse Anesthetists (CRNAs). Based on our review, we provide recommendations for future directions for nurse anesthesia research.

Taunton et al. based their study on the work of Brown et al., who proposed 4 essential characteristics for the development of a scientific base for a practice discipline. The characteristics remain critical to nursing research, and we believe it is important to reiterate them in relationship to nurse anesthesia research. First, members of the specialty should conduct their own research. Second, the conduct of research by nurse anesthetists should be relevant to practice and focused on clinical problems of patients cared for by nurse anesthetists. Third, scientific research must be anchored in a theoretical framework appropriate to nurse anesthesia practice that can be refined and extended through replication. Fourth, nurse anesthesia research should be based on sound methodology with adequate attention to the psychometric properties of paper and pencil tools along with the accuracy and precision of mechanical instruments.

Two major questions were examined in the present study: How did the research during the 1995-1996 period compare with the research during the 1975-1976 and 1985-1986 periods as reported in the AANA Journal? Are the same themes as identified by Taunton et al. present in the research during the 1995-1996 period? In addition, we wanted to know if we could locate research authored or coauthored by CRNAs in other nursing and medical journals.

**Materials and methods**

The sample of the follow-up study was 38 complete research reports published in the 1995 (n = 19) and 1996 (n = 19) issues of the AANA Journal. These were selected for comparison with the findings of Taunton et al. for 1975 (n = 8), 1976 (n = 6), 1985 (n = 11), and 1986 (n = 7). As in the previous study, research abstracts were excluded because of insufficient detail to provide a complete analysis.

The categories identified by Taunton et al. to represent the 4 essential characteristics of research were used to classify the 1995-1996 studies. These categories also have been used to analyze trends in cardiovascular and neuroscience nursing research. An audit tool based on the categories from the earlier study was reviewed and approved by Dr. Taunton. The categories included professional credentials of the...
authors, general type and purpose of the research (clinical, mechanical, educational, or nurse characteristics), description of the sample, indicators of conceptual framework, research design (experimental, descriptive, methodological, or combination), timing (prospective, cross-sectional, or retrospective), sources of data, reliability and validity of measures, ethical issues addressed, statistics reported, and focus of the research.

Several steps were taken to ensure reliability. Similar to the original study, 25% of the sample articles were analyzed by 2 investigators (LC and JS) to facilitate intercoder reliability. Discrepancies were discussed and resolved until 90% agreement was obtained across categories. The 2 investigators then analyzed all articles independently. For each of the 38 reports, the classification on every category was reviewed for potential error by one of us (LC), and discrepancies again were resolved by mutual discussion and agreement among investigators.

Frequencies and percentages were used to summarize data across categories. (Totals do not always add up to 100% due to rounding.) We compared findings from the 1995-1996 period with the previous findings about the 1975-1976 and 1985-1986 periods.

Results and discussion
The 38 research reports identified constituted 43% of the 88 articles (as indexed in the Cumulative Index to Nursing and Allied Health Literature [CINAHL]) published in the AANA Journal during the 1995-1996 period, compared with 26% of the articles in both the 1975-1976 and 1985-1986 periods. These 38 articles represent a 111% increase over the 1985-1986 period (n = 18) and a 171% increase over the 1975-1976 period (n = 14). The AANA Journal does not put a quota upon or limit the number of research articles, rather the editorial board strives to achieve a balance of clinical and research publications that meets the needs of the varied readership (personal communication, Chuck Biddle, CRNA, PhD, AANA Journal editor in chief, January 21, 2001). Therefore, the increase in the number of research articles was interpreted, as in the study by Taunton et al,1 as a crude indication of change in the volume of research published in this particular journal.

Focus of research. As in the earlier study, the 1995-1996 researchers consistently focused on nurse anesthesia practice. Of the studies, 79% (30) were clinically or mechanically focused, which was similar to the 1980s (78%) but less than the 1970s (86%). Mechanical studies generally addressed characteristics of anesthesia equipment. The focus on clinical problems and concerns remained relatively stable across the 3 time periods.

Taunton at al1 identified 4 major themes in their analysis: (1) evaluation of specific anesthetics, (2) evaluation of new technology, (3) evaluation of specific anesthetic agents in patients with specific diagnoses, and (4) characteristics of nurse anesthetists. In the 1995-1996 articles, the same major themes were present, but we identified 2 additional themes. First, 11% (4) of the studies were focused on variables of educational programs. Second, investigators in 5 articles (13%) focused on patient safety.

Conceptual base of research. A broad interpretation of conceptual base was used in this study, taking into account both implicit and explicit conceptual frameworks. As in the study by Taunton et al,1 the presence of a literature review, conceptual perspective, or discussion of results in terms of previous research were viewed as indicators of a conceptual base but were not evaluated in detail. Examples of a conceptual perspective included the presence of specific hypotheses, research questions, or a narrative exploration or diagram of the proposed relationships between study variables. All of the articles analyzed from the 1995-1996 period demonstrated at least 1 indicator compared with 53% during the 1975-1976 period and 61% during the 1985-1986 period. Excluding case studies, a specific research hypothesis or question was stated in 52% (20) of the reports, compared with 40% in the 1980s and 19% in the 1970s.

Research methods. How have the methods in nurse anesthesia research changed during the 1995-1996 period compared with the 1980s and 1970s? As in the study by Taunton et al,1 the question was answered by looking at design, sampling, measures, and statistical analysis.

Design. The articles were classified according to their purpose—methodological, experimental, or descriptive. Methodological studies are those concerned with the development and testing of research instruments or procedures. No methodological articles were found in the 1995-1996 period. Case reports made up 45% of the total number of studies in the 1995-1996 period, compared with 53% of the total sample for the 1970s and 1980s. Experimental studies made up 21% of the sample (n = 8), which was similar to the number in the 1985-1986 period (n = 7).

Of the sample, 18 (47%) represented prospective studies, 7 (18%) were cross-sectional, and 13 (34%) were retrospective. In the earlier study, the total sample (1970s and 1980s) included 66% prospective, 3% cross-sectional, and 31% retrospective studies. During the 1970s, there were slightly more retrospective than
prospective studies, and during the 1980s, there were twice as many prospective as retrospective studies. Although the number of retrospective studies has remained relatively stable, there has been an increase in the number of cross-sectional studies. Several of the cross-sectional studies related to education.

As noted in the earlier article, nurse anesthesia had a higher proportion of case studies than was reported for the general nursing literature by Brown et al.² Generally the researchers reported on unusual patient conditions or situations and how anesthesia care was handled. Relatively rare clinical conditions or situations do not allow for other types of research designs that require large samples.

**Sampling.** Individuals comprised the sampling unit in 31 (82%) of the studies in the 1990s; machines and measurement tools were the sampling unit in 3 studies, nurse anesthesia programs in 2 studies, countries in 1 study, and journal articles in 1 study. The sample size ranged from 1 to 22,268, with 43% of the studies having a sample of 1. Of the studies, 50% had a sample size less than 30 compared with 45% during the 1970s and 1980s; 21% had a sample size between 30 and 60, which was similar to the 1970s and 1980s (28%); and 29% had a sample size greater than 60, which also was similar to the 1970s and 1980s (27%). The median sample size was 29 compared with 19 during the 1985-1986 period and 105 during the 1975-1976 period. The data were collected mainly in hospitals. With the largest sample (22,268), researchers examined existing CRNA membership and nationwide county rural-urban classification databases.

**Sources of data.** The primary sources of data used in the research reviewed are indicated in Table 1 for the 1975-1986, 1985-1986, and 1995-1996 periods. Physiological measures or observations were used in 67% (25) of the recent studies compared with 75% in the earlier study. The use of questionnaires and surveys increased in the 1990s to 26% (10) from 9% (1970s) and 6% (1980s). Taunton et al.¹ found that researchers often did not report on the validity and reliability of their data. During the 1995-1996 period, only 5 authors reported reliability and validity, with interrater reliability addressed in 2 studies and split-half reliability and content validity discussed in 2 studies. Many of the other studies involved clinical observations that traditionally have not been subject to extensive reliability and validity testing.

**Statistics and power analysis.** In the majority of the non-case study research reports, researchers used descriptive and simple inferential statistics (e.g., t test, χ²). In only 2 articles were more advanced inferential statistics used (specifically, logistic regression was used). In only 1 article was statistical power calculated. Power analysis would have been especially important when nonsignificant results were obtained and findings seemed inconclusive.⁵

**Ethical issues.** Reporting of information about ethical issues has increased since the study by Taunton et al.¹ with only 4 authors mentioning ethical issues in both the 1970s and 1980s. During the 1995-1996 period, submission to the institutional review board (IRB) was clearly stated in 12 studies (32%). Informed consent was mentioned in 8 studies and was considered probably not necessary in 27 studies.

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<tr>
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<tbody>
<tr>
<td>Questionnaire</td>
<td>9</td>
<td>6</td>
<td>10 (26)</td>
</tr>
<tr>
<td>Patient record</td>
<td>22</td>
<td>6</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Observation</td>
<td>19</td>
<td>22</td>
<td>22 (58)</td>
</tr>
<tr>
<td>Interview</td>
<td>9</td>
<td>9</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Physiological measure</td>
<td>28</td>
<td>47</td>
<td>3 (8)</td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
<td>10</td>
<td>2 (5)</td>
</tr>
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</table>

* Data are given as number (percentage).
1970s and 25% in the 1980s), which was expected due to the entry requirement in the specialty. Interestingly, during the 1995-1996 period, 21% (n = 8) of the studies included authors from more than one discipline. Despite this trend, all 3 of the 1990s articles authored by physicians had another physician as second author; none included a CRNA as author.

**Research reported in selected other journals.**
We thought it would be informative to review articles published by CRNAs in other professional journals. In an attempt to identify studies authored by CRNAs, we searched several databases (CINAHL and MEDLINE) using the keyword “CRNA.” This proved more difficult in the MEDLINE database than originally thought (see subsequent text). This search cannot be said to represent the total number of articles published in other journals by CRNAs during the 1995-1996 period, but only an examination of the articles we were able to locate.

**CINAHL.** By using the keyword CRNA in the CINAHL database, we located a total of 15 published research reports authored by CRNAs for the 1995-1996 period. Thirteen research articles were published in CRNA—The Clinical Forum for Nurse Anesthetists and 2 in Advanced Practice Nursing Quarterly. In addition, 1 dissertation reference was found. The dissertation was a descriptive study about factors contributing to the underrepresentation of minorities in anesthesia. No published article could be found based on the dissertation, so it was not included in the analysis. The articles found in CRNA—The Clinical Forum for Nurse Anesthetists were 5 case studies and 8 other research reports. The 2 articles in Advanced Practice Nursing Quarterly were an experimental study and a descriptive study.

Based on the 15 research articles found, the following analysis is provided. First authors for all articles were either CRNAs or nurse anesthesia students; only 1 article included physicians as coauthors. Convenience samples were used with sample sizes ranging from 1 to 127. Seven (47%) of the studies were prospective, 7 (47%) were retrospective, and 1 (7%) was cross-sectional. All studies but one were clinical. Conceptual orientation was present in all of the articles with review of the literature and discussion of results in terms of past research. The themes of the articles were similar to those in the AANA Journal, with 4 studies (27%) addressing the evaluation of specific anesthetics and 9 (60%) examining the evaluation of specific agents in patients with specific diagnoses. Two (13%) of the research articles were unusual cases that did not fall into the aforementioned categories, 1 (7%) addressed safety, and 1 (7%) was an educational study.

The primary source of data in 6 studies (40%) was patient records. Self-report was used in 3 studies (20%), observations in 3 studies (20%), biophysiological measures in 2 (13%), and survey in 1 study (7%). Approval of the IRB and receipt of informed consent were reported for all studies except for case studies and 1 retrospective records study. Statistics used generally were descriptive or simple inferential. Reliability and validity issues were discussed in 4 articles, including calibration of the instruments in 2 studies, interrater reliability of measurements in 1 study, and the use of the Visual Analogue Scale to measure pain in another study.

**Selected medical literature.** In the MEDLINE database, when CRNA was used as a key word, the research articles located were generally about CRNAs (ie, as part of a sample), but when we examined the articles, the authors did not seem to be CRNAs. Because it would be beyond our resources to manually search every medical journal, we followed the example of Catchpole⁶ to attempt to identify CRNA authors in the general anesthesia literature. In addition to the AANA Journal, she searched Anesthesiology and Anesthesia and Analgesia in preparing a review of nurse anesthesia care research. We manually searched the same medical journals mentioned and the Journal of Clinical Anesthesia, because of its clinical orientation, for the years 1995 and 1996 to see how many articles were authored or coauthored by a CRNA.

Only 13 research articles were located that were clearly coauthored by a CRNA (7 in Journal of Clinical Anesthesia, 5 in Anesthesia and Analgesia, and 1 in Anesthesiology). In all cases, the first author was a physician (MD or DO) and only 1 CRNA was coauthor for each article (the CRNA was the second author in 3, the third in 2, the fourth in 5, the fifth in 1, and the sixth in 2). All investigators reported clinical research except for one educationally oriented study. Conceptual orientation was indicated by review of the literature and discussion of results in terms of past research in all articles. Of the reports, 10 (77%) were of experimental studies, 2 (15%) were case studies, and 1 (8%) was a descriptive study. Samples were usually convenience, ranging in size from 1 to 260 with adults generally being the subjects (only 2 studies included children). Of the studies, 11 (85%) were prospective, and 2 (15%) were retrospective. Six (46%) of the studies were evaluations of specific anesthetics in patients with specific diagnoses, 3 (23%) were evaluations of specific anesthetics, and 2 (15%) involved new technology. The other 2 studies looked at the efficiency of central venous monitoring and medical waste programs (educational).
Measurement techniques included observation (4), biophysiological measures (1), patient records (3), questionnaire (1), and interviews (1). Reliability and validity issues were addressed in only 1 article, in which calibration, precision analysis, and quality control testing were outlined. In 8 of the articles, authors reported IRB approval and informed consent. Of the 5 that did not, 2 were case studies, 2 were retrospective patient records review, and 1 was a survey. The articles were similar in theme to those published in the AANA Journal, with the exception of nurse anesthesia educational programs and nurse anesthetist characteristics themes.

- **Summary of the research literature.** In Table 2 we have provided a brief summary comparison of the 66 studies reported in the AANA Journal, the CINAHL database, and the selected medical journals. Most of the studies focused on clinically relevant research. Overall the studies seem to be somewhat evenly divided among experimental, descriptive, and case report designs, although the majority of the studies reported in the medical journals reviewed were experimental compared with 21% (8/38) in the nursing literature. Authorship was an interesting finding, with the AANA Journal having 3 articles with physician first authors, but none of the medical literature having a CRNA as first author. Again, it is important to note that this summary represents only the articles we could locate.

**Conclusions and recommendations**

First, the amount of research reported in the AANA Journal has increased steadily since the 1975-1976 period. Examination of the AANA research articles and the literature that we were able to locate from other sources clearly revealed that nurse anesthetists are contributing to clinically relevant research. Second, the research in the AANA Journal has remained focused on clinical problems. The percentage of case studies has remained relatively constant, which probably reflects the clinical focus of the specialty. Third, when comparing findings of the past and the present studies, 2 new areas of research focus, education and patient safety, were identified. The interest in educational research may be related to the move to a master's degree for entry into practice. Interest in patient safety, in part, may have been stimulated by the 1986 decision by the AANA Board of Directors to accept the Harvard Standard of Anesthetic Monitoring and in 1989 to publish the AANA Patient Monitoring Standards. AANA published the guidelines to validate current professional practice and to foster research related to safety.7

The aforementioned findings are positive, but limitations remain. Specific theories need to be explored, particularly ones that the address the unique contributions of nurse anesthetists. Methodological studies that address the psychometric properties of instrumentation were not present in the 1990s, and few authors in the AANA Journal and in the other journals referenced even minimal reliability and validity of their tools.

In many of the studies, the investigators chose measurements in wide use in the clinical arena that have not been tested extensively for psychometric properties. However, for some of the instruments (ie, Verbal Analogue Scale for pain), published psychometric work is available that could have been reported. Information on the accuracy (similar to validity) and precision (similar to reliability) of physiological instruments often is available through the manufacturer, and in some cases instruments (ie, pulse oximetry) have been studied extensively for their precision and accuracy. Some experts also recommend estimating the reliability of instruments with each study, because reliability can vary from study to study.8

Given the lack of methodological research, nurse anesthesia researchers may want to focus more attention to measurement. Reporting reliability and validity issues is key to quality research reports.6 In addition,

**Table 2. Summary of all studies**

<table>
<thead>
<tr>
<th>Journals</th>
<th>AANA (n = 38)</th>
<th>CINAHL database (n = 15)</th>
<th>Selected medical journals (n = 13)</th>
<th>Total (n = 66)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical focus</td>
<td>30 (79)</td>
<td>14 (93)</td>
<td>12 (92)</td>
<td>56 (85)</td>
</tr>
<tr>
<td>Experimental design</td>
<td>9 (24)</td>
<td>5 (33)</td>
<td>10 (77)</td>
<td>24 (36)</td>
</tr>
<tr>
<td>Descriptive (non–case study)</td>
<td>12 (32)</td>
<td>5 (33)</td>
<td>1 (8)</td>
<td>18 (27)</td>
</tr>
<tr>
<td>Case studies</td>
<td>17 (45)</td>
<td>5 (33)</td>
<td>2 (15)</td>
<td>24 (36)</td>
</tr>
<tr>
<td>CRNA first authors</td>
<td>31 (82)</td>
<td>15 (100)</td>
<td>0 (0)</td>
<td>46 (70)</td>
</tr>
</tbody>
</table>

CINAHL indicates Cumulative Index to Nursing and Allied Health; CRNA, Certified Registered Nurse Anesthetist.

* Data are given as number (percentage).
methodological research to examine the psychometric properties of clinical tools can strengthen the tools for both research and clinical use. The effective use of power analysis and more sophisticated statistics also should be encouraged.

- **Locating CRNA research in other journals.** Locating research by CRNAs published in the medical literature other than the AANA Journal was difficult. It also should be noted that certain professional credentials, such as CRNA, are not always noted in basic science journals. For example, the authors are aware of a CRNA with a PhD in pharmacology whose published articles in the pharmacology literature do not indicate his status as a CRNA. Therefore, a database search using CRNA as a keyword or even a manual search will not locate these articles. One suggestion is that a database of research articles published by CRNAs be compiled. Perhaps the AANA membership survey could include a question about members’ publications during the past year. The information will help to establish the scientific orientation of the specialty and permit the AANA to highlight research done by CRNAs.

- **Research collaboration and multisite studies.** Increasingly, leading nursing researchers are emphasizing physiological as well as psychological responses to health problems. One of the strategies outlined by a biological task force of the National Center for Nursing Research in 1990 was to develop a cadre of nurses and nurse scientists with a background in the biological sciences. There are many research topics in which the practice of nurse anesthesia and other specialties overlaps and collaborative efforts could be successful, such as pain management, postoperative recovery, preoperative preparation, and conscious sedation.

Research collaboration with other disciplines and within nursing should be encouraged and is needed to solve complex healthcare problems. Collaboration between clinicians and colleagues in the basic science fields of pharmacology and physiology can help produce research that is clinically relevant. In addition, rapid changes in healthcare delivery systems have increased the need for clinical nursing research, and this includes nurse anesthesia practice research. For example, studying the trajectory of patients’ recovery, identifying services needed in new locations of care, and increasing the patient’s ability to handle care at home (ie, appropriate pain management) are all areas in which further research is needed. The present healthcare environment mandates multidisciplinary approaches to care, and this trend also suggests that opportunities for multidisciplinary research should be pursued.

Multisite studies are a logical step to conduct research that addresses clinical interventions that could affect practice. Multisite studies permit the inclusion of larger samples, thus increasing generalizability. Further development and collaboration also is needed in the areas of research utilization and evidence-based practice. Integrating research findings from many disciplines and applying them to practice problems takes skill, knowledge, and active collaboration.

- **Programs of research.** For the knowledge base to expand, there needs to be a cadre of senior researchers who have developed mature programs of research. Nurse anesthesia research has been criticized as noncumulative, meaning that research activities have not been directed in a systematic manner toward establishing a unique scientific foundation. Researchers should be encouraged to build on studies to extend previous work. Thus, there is a need for researchers who during a career build on their own and others’ previous work, as well as directing the research of graduate students. Graduate students can be encouraged to conduct research related to their mentor’s area of study in order to add to a particular knowledge base.

- **Research priorities and funding.** During the 1990s, many specialty organizations worked on establishing research priorities, and there was been work to develop a global perspective on these priorities. In reviewing the priorities of 9 specialty organizations, Hinshaw found that the top 5 priorities cited were:

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**Table 3. AANA Foundation research funding priorities**

<table>
<thead>
<tr>
<th>Tier 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Collect data that measure content, process, outcomes, and cultural diversities of Certified Registered Nurse Anesthetist (CRNA) practice on the quality of patient care.</td>
</tr>
<tr>
<td>2. Study issues in education and practice related to changing healthcare and economic environments.</td>
</tr>
<tr>
<td>3. Promote clinical research to advance the practice of nurse anesthesia.</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Tier 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Collect data that define and monitor CRNA employment and practice settings as well as projects workforce demographics.</td>
</tr>
<tr>
<td>2. Evaluate CRNA manpower and scope of practice in rural and underserved areas.</td>
</tr>
<tr>
<td>3. Expand the internal and external capability for collecting and assessing quality assurance and consumer satisfaction data.</td>
</tr>
</tbody>
</table>
(1) quality of care outcomes and their measurement, (2) impact and effectiveness of nursing interventions, (3) symptom assessment and management, (4) healthcare delivery systems, and (5) health promotion and risk reduction. Nurse anesthesia practice problems and issues fit well into these same categories.

There has been a concomitant increase in small research grants distributed by specialty organizations or their research foundations. Since it inception, the AANA Foundation has provided funding for nurse anesthesia research. The Foundation has established a funding priority of research topics for its grant program (Table 3). Providing small research grants has been a positive step in developing programs of research that address important issues for the specialty. The next step, though, is to work toward developing the research expertise within the specialty to compete for larger research grants such as from the National Institute for Nursing Research or other divisions of the National Institutes of Health. Addressing the important issues for the practice of anesthesia nursing will require a higher level of funding.

The new century is an exciting time for nurse anesthesia research. There are many challenges, but there are many opportunities as well. Adaptability and flexibility in taking advantage of the opportunities will be the keys to developing a unique scientific basis for nurse anesthesia practice.

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