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Using Data to Improve Quality and Outcomes in Perfusion Education: A Novel Idea?

Richmond M, Arnold B, Kurusz M. The relationship of duration of training to American Board of Cardiovascular Perfusion written certification examination scores. J Extra Corpor Technol. 1980;12:127–30.

During a recent stroll through the perfusion literature I happened upon the classic paper which is the subject of this article.

The Relationship of Duration of Training to American Board of Cardiovascular Perfusion Written Certification Examination (1)

This paper represents a significant puzzle piece in the advancement of our profession and was published at a critical time in the development of our profession's educational process. On reading it, I was immediately struck by both the contemporary timeliness of this subject material and the spirit of collaboration and professional community which must have existed circa 1980 to produce an article which so pointedly addressed a question for our entire profession. At the time of this publication, the young American Board of Cardiovascular Perfusion (ABCP) (founded in 1975) was diligently reporting from their database of test taker demographics and test outcomes to establish that there was statistically significant evidence to support an increase in the standards for perfusion education programs; that test scores were higher from schools with longer curriculum. At the time, the movement afoot in our community focused on the discontinuation of on-the-job-training programs. This movement can be compared to a discussion occurring in our profession right now which is calling for the entry level degree for all perfusion programs to be set at the master's degree level (2). Considering that 56% of the perfusion education programs in the United States award a bachelor's or a post-baccalaureate degree, this would be a significant change and would undoubtedly result in the termination of several programs if they failed to secure the prerequisite university affiliation to offer a graduate degree. Needless to say the suggestion is not without its opponents (3).

Although the overall goal of improved minimum educational standards is the same, the primary difference between the educational movement in the 1980s and the present day discussion is our access to outcome data. This classic paper by Richmond, Arnold, and Kurusz represents the full participation of the ABCP in the growth of our professional community through the open distribution of outcome data for educational programs. This stands in sharp contrast to the current state of the discussion regarding an entry level Master's degree for perfusion, which is, so far, based on thoughtful yet biased rhetoric. The demographic and outcome data for every perfusionist entering and re-entering the field is collected as a matter of procedure for all national certification test takers. The potential implications of rigorous statistical analysis of these data are obvious. While each program is currently provided outcome data for their students, the results are de-identified making it impossible for a program to validate the performance of program-assessment tools through comparison of their graduate's performance on program assessments to the same student's performance on the certification examinations. Furthermore, there is currently no greater analysis beyond each individual program. Generation and distribution of national benchmark performance profiles would help identify programs of excellence and facilitate goal setting for all perfusion education programs.

There is rarely any opposition to improving education. The debate generally focuses on how that should be done. Great improvements in clinical outcomes have been realized with the use of information obtained from clinical registries and mandated state reporting. In the 1980s, in my home state of New York, there was a great deal of skepticism over reporting of provider outcomes. Some believed that providing these data would limit access to care for the elderly and cause a shift of high-risk cases out of New York (nobody would operate on really sick people as it would ruin their stats and reputation). In 1998, Petersen and colleagues sought to determine if the prediction of the skeptics came true and found that not only was there no out migration of patients, nor access issues, States like New York and the Northern New England States that

examined results had an accelerated rate of improvement in outcomes (4). As we teach in school, every quality improvement process calls for careful analysis of data to identify the opportunity for improvement as well as continued data analysis to evaluate actions taken to effect the improvement. Maybe it is just time that we take the blinders off in perfusion education. Perhaps we could identify some best practices in education and realize improvements in student performance similar to the improvements in patient outcomes realized in New England. Furthermore, would it be farfetched to assume that better prepared clinician graduates may have a positive effect on a patient's outcome?

The current discussion regarding a master's degree for all perfusion programs is still very new. There is still time for a full analysis of the ABCP outcome data to be provided to the ACPE.* I'm sure this information will be informative and help lead our educational programs in the most productive direction.

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REFERENCES

1. Richmond M, Arnold B, Kurusz M. The relationship of duration of training to American Board of Cardiovascular Perfusion Written Certification Examination Scores. J Extra Corpor Technol. 1980;12:127–30.
2. Sistino JJ. The case for a single entry level into the perfusion profession by 2020. J Extra Corpor Technol. 2014;46:127–9.
3. Colligan M, Patel K. A single entry level into the perfusion profession is not the solution. J Extra Corpor Technol. 2014;46:324–5.
4. Peterson ED, DeLong ER, Jollis JG, Muhlbaier LH, Mark DB. The effects of New York's bypass surgery provider profiling on access to care and patient outcomes in the elderly. J Am Coll Cardiol. 1998;32:993–9.

*The Accreditation Committee for Perfusion Education (ACPE) is a representative body of directors appointed by professional organizations within the fields of Perfusion, Anesthesia, and Surgery: American Academy of Cardiovascular Perfusion (AACP), American Association for Thoracic Surgery (AATS), American Board of Cardiovascular Perfusion (ABCP), American Society of ExtraCorporeal Technology (AmSECT), Perfusion Program Director's Council (PPDC), Society of Cardiovascular Anesthesiologist (SCA), and Society of Thoracic Surgeons (STS). This body is responsible for setting standards and evaluating outcomes for perfusion education programs (www.acpe.org).

Guest Editors:

The Relationship of Duration of Training to American Board of Cardiovascular Perfusion Written Certification Examination Scores

Mark Richmond, ED.D.; Beth Arnold, PH.D.; and Mark Kurusz, C.C.P.

Introduction

The American Board of Cardiovascular Perfusion (ABCP) has as its primary purpose, and therefore its most essential function, protection of the public through the establishment and maintenance of standards in the field of cardiovascular perfusion. To achieve this objective, the ABCP has established qualifications for examination, procedures for recertification, and accreditation of cardiovascular perfusion training programs. Its requirements and procedures are reviewed and modified periodically as necessary.

As a part of its continuing effort to ensure a minimum standard of competence in the perfusion profession, the ABCP has an ongoing commitment to the comparative evaluation of methods of training and testing of competence for clinical perfusionists. Recent literature[1,2] strongly recommends a structured curriculum based on a combination of general academic training and systematic clinical experiences in an integrated teaching, application and reinforcement paradigm.

As the practice of perfusion has developed, so has the certification process. In July, 1972, the American Society of Extracorporeal Technology (AmSECT) administered the first certification examination for perfusionists. This effort was the culmination of five years of work by the AmSECT Certification and Education Committee. An examination was conducted in 1973 and 1974 on a "Grandfather" only basis in order to establish a knowledge data base. In 1974, with a suitable data base established, the examination was given the first time on a pass/fail basis. In 1975, after recognizing the desirability of separating the certification process from the professional society, AmSECT relinquished the duties of certification and recertification to the ABCP.

Shortly thereafter the ABCP, like nearly all other certifying agencies, determined that certification would have to ultimately involve a candidate's successful completion of an approved or accredited educational program. Therefore, the 1981 deadline was established by which certification is attainable for only those perfusionists who have undergone a formal, documentable and evaluatable training process. Since that decision there has been a rapid growth in the number of cardiovascular perfusion training programs.

To determine that the movement in this direction was indeed valid, the current study was conducted. The hypothesis to be tested was that the extent and duration of perfusion training reflects competence in perfusion technology; that is, that there will be a significant difference on ABCP examination scores between perfusionists based on duration of training programs.

Methods

Before reviewing the methodology and results of the study, a brief overview of terms used in conjunction with the study is in order.

ABCP: Refers to the American Board of Cardiovascular Perfusion, the certifying agency for practicing perfusionists; also referred to as the Board.

OJT: Refers to on-job-trained perfusionists who received their training either while employed and under the supervision of another perfusionist, or from a training program which has not been evaluated regarding its standards of training. This training usually lasts less than one year.

AP: Refers to an accredited program which has met specified standards of educational propriety, and which has demonstrated a capability of training perfusionists who will have a diversity of experience in perfusion

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TABLE I

Demographic Data of Perfusionists By Degree of Training

	Total Sample	OJT	AP	BS
N	513	317	165	31
Age	$\bar{X}$ 28.6 Min 20	29.8 21	26.8 20	26.4 22
	S.D. 4.7 Max 50	5.0 50	3.4 40	2.8 32
Sex	Male 367 (71.5%)	227 (71.5%)	113 (68.5%)	27 (87.1%)
	Female 146 (28.5%)	90 (28.5%)	52 (31.5%)	4 (12.9%)
Physiology	$\bar{X}$ 26.2	34.9	37.2	44.2
	S.D. 6.9	6.6	6.7	4.0
Anatomy and	$\bar{X}$ 35.2	34.2	35.8	42.1
Pathology	S.D. 5.8	5.4	5.6	4.7
Perfusion	$\bar{X}$ 36.1	35.3	36.1	43.3
Techniques	S.D. 5.2	5.4	5.2	3.4
Pharmacology	$\bar{X}$ 37.0	36.3	37.2	42.5
	S.D. 5.7	5.6	5.6	3.9
Total Battery	$\bar{X}$ 144.3	140.7	146.6	169.3
	S.D. 20.3	18.9	19.7	17.3

techniques. This training usually lasts one to two years.

BS: Refers to a training program which requires the completion of a full undergraduate curriculum, and into which is embedded a cardiovascular perfusion training program. This training usually lasts four years, and graduates are awarded a Bachelor of Science degree.

Data from all perfusionists certified by the ABCP since 1976 were categorized across the variables of age, sex, and type of training (OJT, AP, and BS). Additionally, dependent variables of subtest and total battery scores on the ABCP certification examination were acquired. All data came directly from certificees' records, housed in the national office of the ABCP. Only national office personnel were allowed access to the records, and no individual results were in any fashion used for this analysis.

A total of 513 perfusionists had complete, usable data. It was decided that only data from 1976 forward should be used, as that year was the first in which graduates from accredited schools sat for Board exams. Table 1 details the demographics of perfusionists by degree of training. One cautionary note should be inserted at this point and that is the number of perfusionists in the three major categories is widely disparate. Of the total sample of 513 perfusionists, over half (n = 317) were trained on the job. This constitutes 61.7% of the sample. The AP graduates constitute 32.3% of the sample (n = 165), while four-year BS program graduates constitute only 6% of the total sample (n = 31). While the chosen analytic procedure (analysis of variance) has been shown to be robust against violations of this type, disparate sample size is a problem of which the interpreter of research should be aware. Other factors of interest to be found in the data include the following:

1. While there was very little difference between the ages of AP and BS graduates, OJT perfusionists tended to be approximately 3 years older at the time of testing than were the other two groups.
2. There was a greater percentage of female certificees in the AP sample (31.5%) than in either the OJT sample (28.5%) or the BS sample (12.9%).
3. On the Board scores, inclusive of the total battery score and all subtests, a heirarchical arrangement was noted. In each case, OJT perfusionists scored lower than AP graduates, who in turn scored lower than did BS program graduates. These results were subjected to further analysis, which is reported in the following section of this paper.

Results

The appropriate statistical technique to test for differences among mean scores of more than two groups with one categorical (independent) variable is one-way analysis of variance. This technique compares mean scores of each group on the basis of the variance among test scores within each group and the variance amount test scores between all groups. For a more complete explanation of the technique, the reader is advised to consult Hays[3], Dayton[4], or Glass and Stanley[5]. Analysis and discussion of each examination

TABLE II

Analysis of Variance of Total Test Battery Scores By Duration of Training

Source	d.f.	S.S.	M.S.	F	p
Training	2	24284.10	12142.1	33.41	<.01
Error	509	184953.00	365.36		

Scheffe's Test

	Subset 1 OJT	Subset 2 AP	Subset 3 BS
$\bar{X}$	140.7	146.6	169.3

Grand Mean = 144.3

TABLE IV

Analysis of Variance of Anatomy and Pathology Subtest Scores By Duration of Training

Source	d.f.	S.S.	M.S.	F	p
Training	2	1823.56	911.78	30.88	<.01
Error	509	15027.36	29.52		

Scheffe's Test

	Subset 1 OJT	Subset 2 AP	Subset 3 BS
$\bar{X}$	34.2	35.8	42.1

Grand Mean = 35.2

subtest will be presented after presentation of the total battery results.

The first analysis, Total Battery, revealed differences as hypothesized; that is, that the duration of training is significantly related to Board examination scores. Graduates of BS programs scored significantly higher ($p < .01$) on the total test battery than did either of the two other groups. AP graduates scored significantly higher ($p < .01$) on the total test battery than did OJT perfusionists.

A brief summary of the contents of the analysis of variance table is provided here. A source table consists of the *degrees of freedom* (d.f.) associated with each component being analyzed. The *sum of squares* (S.S.) is a statistically derived number which is an index of the total amount of squared variance extant in each segment. The *mean square* (M.S.) is the relative amount of variance that exists in each segment. The *F-ratio* (F) is the ratio of the M.S. associated with treatment over the M.S. associated with error. *Probability* (p) is the estimated change in proportion form, that the results are other than those statistically indicated. The segments *Training* and *Error* refer, respectively, to the amount of variance accounted for by treatment (Training) and as yet unaccounted for (Error). Accounted for variance is variance in scores that is attributable to differences between groups (OJT, AP and BS programs). Error variance is an estimate of the variance in test scores which is attributable to differences within groups and as such minimizes the differences between groups.

Analysis of variance reveals only whether a significant difference exists among groups. It does not determine between which pairs of groups differences do or do not exist. In order to make that determination, a procedure known as Scheffe's test is normally employed. For purposes of this paper, Scheffe's test divides the groups into subsets within which no significant differences exist, but between which there is a significant difference.

Returning to Table 2, it can be seen that three subsets exist, indicating that all three groups differed significantly from each other. Examination of mean scores ($\bar{X}$) indicates the BS program graduates scored

TABLE III

Analysis of Variance of Physiology Subtest Scores By Duration of Training

Source	d.f.	S.S.	M.S.	F	p
Training	2	2675.92	1337.96	31.40	<.01
Error	509	21692.01	42.62		

Scheffe's Test

	Subset 1 OJT	Subset 2 AP	Subset 3 BS
$\bar{X}$	34.9	37.2	44.2

Grand Mean = 36.2

TABLE V

Analysis of Variance of Perfusion Techniques Subtest Scores by Duration of Training

Source	d.f.	S.S.	M.S.	F	p
Training	2	1799.86	899.93	37.62	<.01
Error	509	12173.55	23.96		

Scheffe's Test

	Subset 1		Subset 2
	OJT	AP	BS
$\bar{X}$	35.3	36.1	43.3

Grand Mean = 36.1

TABLE VI
Analysis of Variance of Pharmacology Subtest Scores by Duration of Training

Source	d.f.	S.S.	M.S.	F	p
Training	2	1098.25	549.2	18.24	<.01
Error	509	15319.70	30.09		

Scheffe's Test

	Subset 1		Subset 2
	OJT	AP	BS
$\overline{X}$	36.3	37.2	42.5
Grand Mean = 37.0			

significantly higher ($\overline{X}$ = 169.3) than did AP graduates ($\overline{X}$ = 146.6) who scored significantly higher than did OJT perfusionists ($\overline{X}$ = 140.7).

Tables 3 and 4 indicate the relationship that exists among the scores of groups of subtest 1 (Physiology) and subtest 2 (Anatomy and Pathology) on the ABCP examination. On both subtests, the same configuration existed as was evident on the Total Battery scores. BS program graduates scored significantly higher than did OJT perfusionists.

On subtests 3 (Perfusion Techniques) and 4 (Pharmacology), a somewhat different configuration is seen to emerge. Tables 5 and 6 indicate that BS program graduates scored significantly higher on both perfusion techniques and pharmacology than did either AP graduates or OJT perfusionists, while there were no significant differences in the scores of the latter two.

Conclusions

There is a consistent relationship between magnitude of examination scores and duration of training of perfusionists. These results speak to two very important assumptions which have been made in perfusion training programs and in the ABCP certification process. First, the accredited training programs appear to have validity; that is, graduates of those programs score consistently higher than do perfusionists who come from non-accredited programs or who are OJT. It is a conjecture that the difference between OJT and AP might be even stronger if only the last two years' Board scores were reviewed, as schools of perfusion are themselves undergoing growth as sound education practices and clinical training programs are established. Further, the OJT group contained perfusionists who had undergone training analogous to that of AP graduates but were in programs which were operating without the benefit of accreditation. Consequently, the OJT category contained a substantial number of perfusionists who had undergone formalized training programs.

Second, the ABCP examinations are capable of discriminating among perfusionists on the basis of their knowledge of perfusion and perfusion-related data. While this singular fact does not ensure higher quality perfusion practices or competence, all other factors being equal, enhanced knowledge of one's job should provide enhanced performance on the job in the clinical setting.

It is anticipated that follow-up studies to this initial investigation will be undertaken. Topics of interest would include, but not be limited to the following:

1. Analysis of scores from 1976 to present; to determine if, as suspected, ABCP examination scores are rising significantly each year.
2. Analysis of test performance to determine the interaction between prior experience and duration of training on ABCP examination scores.
3. Analysis to determine if differences exist on performance between different examination subtests.

References

1. Greenberg, N. S., Feifer, I.: A Structured Approach to the Integration of the Clinical and Didactic Components of Health Career Programs. *Journal of Allied Health* 9:59–62, 1980.
2. Agriesti-Johnson, C.: The Relationship Between Allied Health Practice and Academic Preparation Programs: An Integrating Curriculum Framework. *Journal of Allied Health* 9:119–124, 1980.
3. Hays, W. L.: *Statistics*. New York: Holt, Rinehart and Winston, 1963.
4. Dayton, C. M.: *The Design of Educational Experiments*. New York: McGraw-Hill Company, 1970.
5. Glass, G. V. & Stanley, J. C.: *Statistical Methods in Education and Psychology*. Englecliffs, N.J.: Prentice-Hall, Inc., 1970.