pregnancy outcome. Our findings showing improvements in the survival of low birth weight infants are not new. Nevertheless, they suggest the need to investigate more adequately efforts to regionalize perinatal services because survival rates improved across the State. Finally, the results suggest that perinatal care, in terms of prenatal as well as neonatal care, may be promising in improving outcomes in the poorest State in the United States. The implications of this finding for Mississippi and for other poor States are especially important in a time of reduced funding for public programs.

References

1. Health planner's handbook for MCH and CC programs. Information Sciences Research Institute, Vienna, VA, 1983.
2. Kessner, D. M., et al.: Infant death: an analysis by maternal risk and health care. Institute of Medicine, National Academy of Sciences, Washington, DC, 1973.
3. Shin, E. H.: Black-white differentials in infant mortality in the South, 1940–70. Demography 12: 1–19 (1975).
4. Armstrong, R. J.: A study of infant mortality from linked records by birth weight, period of gestation and other variables. Vital and Health Statistics, Series 20, No. 12. DHEW Publication No. (HSM) 72–1055. National Center for Health Statistics, Rockville, MD, 1973.
5. Chase, H., editor: A study of risks, medical care and infant mortality. Am J Public Health 63 (supp.): 1–56, September 1973.
6. Dott, A. B., and Fort, A. T.: The effect of maternal demographic factors on infant mortality rates. Am J Obstet Gynecol 123: 847–853 (1975).
7. MacMahon, B., Kovar, M. G., and Feldman, J. J.: Infant mortality rates: relationships with mother's reproductive history. Vital and Health Statistics, Series 22, No. 14. DHEW Publication No. (HSM) 72–1045. National Center for Health Statistics, Rockville, MD, 1973.
8. Varva, H. M., and Querc, J.: A study of infant mortality from linked records by age of mother, total birth order and other variables. Vital and Health Statistics, Series 20, No. 14. DHEW Publication No. (HRA) 74–1851. National Center for Health Statistics, Rockville, MD, 1973.
9. National Center for Health Statistics: Advance report, final natality statistics, 1975, 1976, 1977, 1978, and 1979. Monthly Vital Stat Rep vol. 25, No. 10, Dec. 30, 1976 for 1975; vol. 26, No. 12, Mar. 29, 1978 for 1976; vol. 27, No. 11, Feb. 5, 1979 for 1977; vol. 29, No. 1, Apr. 28, 1980 for 1978; and vol. 30, No. 6, Sept. 29, 1981 for 1979.
10. Shah, E. K., and Abbey, H.: Effects of some factors on neonatal and postneonatal mortality. Analysis by a binary variable multiple regression method. Milbank Mem Fund Q 49: 33–57 (1971).
11. Gortmaker, S. L.: The effects of prenatal care upon the health of the newborn. Am J Public Health 69: 653–660 (1979).
12. Ryan, G. M., Sweeny, P. J., and Solola, A. S.: Prenatal care and pregnancy outcome. Am J Obstet Gynecol 137: 876–881 (1980).
13. Fleiss, J. L.: Statistical methods for rates and proportions. John Wiley and Sons, New York, 1981, pp. 92–102.
14. Snedecor, G. W., and Cochran, W. G.: Statistical methods. Iowa State University Press, Ames, IA, 1972, pp. 240–248.
15. Kitagawa, E. M.: Components of a difference between two rates. J Am Stat Assoc 50: 1168–1194 (1955).
16. Kleinman, J. C., et al.: A comparison of 1960 and 1973–74 early neonatal mortality in selected states. Am J Epidemiol 108: 454–469 (1978).
17. Kim, Y. J., and Strobino, D. M.: Decomposition of the difference between two rates with hierarchical factors. Demography 21: 361–372 (1984).
18. Lee, K. S., et al.: Neonatal mortality: an analysis of the recent improvement in the United States. Am J Public Health 70: 15–22 (1980).
19. Morris N. M., Udry, J. R., and Chase, C. L.: Shifting age-parity distribution of births and the decrease in infant mortality. Am J Public Health 65: 359–362 (1975).
20. Wright, N. H.: Family planning and infant mortality rate decline in the United States. Am J Epidemiol 101: 182–187 (1975).
21. Annual report. Mississippi State Board of Health, 1979–80. Jackson, MS.
22. Goldenberg, R. L., et al.: The variability of viability: the effect of physician's perceptions of viability on the survival of very low birth weight infants. Am J Obstet Gynecol 143: 678–684 (1982).

Credentialing and Job Practice in Environmental Health: An Empirical Study

CATHERINE S. CLINE, PhD

Dr. Cline was Director of Research and Statistics at Professional Examination Service, New York, at the time this study was performed. She is currently Special Assistant to the Director of Examinations, New York City Department of Personnel, Rm 218, 220 Church St., New York, NY 10013.

The research described here was performed under contract 232-80-0020 from the Health Resources Administration (now Health Resources and Services Administration), Department of Health and Human Services.

Tearsheet requests to Dr. Cline.

Synopsis

To investigate the validity of the credentialing examination for entry-level practitioners in environmental health, 15 work measures, simulating or assessing important components of job practice, were developed. These work measures, along with the written examination, were administered to a sample of 128 entry-level practitioners drawn from 10 test sites throughout the country.

Composite work measures were constructed in which individual work measures were weighted according to their judged importance. The total composite work measure, based on all 15 individual measures, correlated .53 with the total written examination. Correlations between composite work measures and the written test scores were generally in the .3 to .5 range and significant at the .01 level. Seventy-three percent of the sample were consistently classified on both the written examination and the total work measure composite. That is, 73 percent of the sample passed both the examination and the work measures or failed both the examination and the work measures.

In comparison to similar studies, the magnitude of the coefficients reported here is acceptable to high. Results show that the examination is a valid, but not perfect, predictor of on-the-job skill in environmental health, and it should help to screen the public from the results of incompetent practice.

THE PROTECTION OF THE PUBLIC from incompetent practitioners is the primary mission of any credentialing agency. This mission is especially important in the health professions, where the results of incompetent practice may be disease, injury, or death.

Central to the credentialing process is usually a written examination designed to assess the mastery of knowledge essential to practice. Mastery of knowledge is assumed to translate into competence in practice, but the link between underlying knowledge and practical competence is not always empirically investigated. Investigation of the link is called test validation.

In recognition of the complexity and importance of credentialing in the health professions, the Division of Associated Health Professions (DAHP) of the Health Resources and Services Administration, Department of Health and Human Services, had sponsored a number of investigations into the credentialing process. Technical components in the DAHP model include a role delineation of the field, validation of the role delineation, and development of an examination (*1,2*). The final component is validation of the examination. One field which has followed the DAHP model is environmental health.

Environmental health practitioners provide services in a wide variety of areas, including, but not limited to, food protection, water and air quality, hazardous substances, solid waste management, vector control, water supply, shelter, and industrial hygiene.

General practitioners are often referred to as sanitarians; the credential generally conferred is that of registered sanitarian (*3*).

The work described here focuses primarily upon the validation of the registration examination for the general practitioner. This examination is used by 21 State licensing-certification agencies and also by the National Environmental Health Association (NEHA), the national professional association for environmental health personnel which credentials professionals in States that do not have licensing statutes. The examination is only one part of the credentialing process. Typically, applicants must satisfy a variety of educational and experiential requirements as well.

Role Delineation

A role delineation describes the responsibilities of positions within a given profession. It also defines appropriate content for credentialing tests. In 1975, the National Environmental Health Association was awarded a contract to develop and later verify a role delineation for the environmental health field. In any profession, the duties carried out by one person in one location or situation may vary from those of another person with the same job title. A role delineation should identify the common elements for any person filling a particular role and should state the elements in terms that adequately describe related jobs. The delineation also should describe knowledge, skills, and attributes (KSAs) needed to carry out job responsibilities.

For environmental health, KSAs were organized into five general domains or categories: disease and injury causation and control, data collection and interpretation, law and process, administration, and behavioral science. These five domains comprised the blueprint of knowledge, skills, and attributes upon which examination development was later based. Responsibilities for several position levels were delineated (*4,5*).

Test Development

After completion of the role delineation, a contract was awarded to Professional Examination Service (PES) to develop credentialing exam-

inations for two levels of practitioners, including the registration level. (The second level examination was for supervisory personnel.) In order to guide development of the test, an advisory committee was selected which determined the broad guidelines under which examination development proceeded.

Using the KSA as a basis, question development began. Through a variety of methods, approximately 1,200 questions were written. The 10-member advisory committee determined which KSA area each item assessed, and all items were field-tested on samples of students and practitioners at nine different sites. After the questions had been reviewed, edited, field-tested, and revised, the advisory committee met to select items for the final examination. Specifications for the registration examination were two-dimensional, paralleling the major responsibility areas and the KSA blueprint.

Test Validation

Test validation is the process of determining whether a test is valid (or appropriate) for its intended use. A highly valid credentialing test measures appropriate knowledge (content validity) and "predicts" job performance (predictive validity). The content validity of the environmental health examination was fairly well established by the test development procedures (*6*). To investigate the predictive validity of the examinations, a study was commissioned by DAHP to determine the correlation (statistical degree of association) between performance on the environmental health proficiency examinations and performance on the job. An advisory group was responsible for developing adequate work measures to assess performance on the job. The advisory group, or working committee, consisted of 12 environmental health professionals carefully chosen for geographic, specialty, and academic-practitioner representation.

Overview of the Study

To measure job performance, a series of work measures was developed that would systematically assess the responsibilities typical of the entry-level applicant for registration. Work measures were selected for each role delineation responsibility. A total of 15 work measures, described subsequently in table 1, were developed. The written examinations and the work measures were pretested in May 1981 to collect the data necessary to revise and refine them. Using the pretest data, the working committee refined the work measures and developed standardized ways of scoring performance. The final study data were collected from September to December 1981 at 10 test sites throughout the country. The work measures took 8 hours to administer, and the written test 4 hours. A total of 128 participants were administered both sets of measures.

'Environmental health practitioners provide services in a wide variety of areas, including, but not limited to, food protection, water and air quality, hazardous substances, solid waste management, vector control, water supply, shelter, and industrial hygiene.'

Sample

The 128 participants reported medians of 16.1 years of education and 2.7 years of work experience. All but eight persons reported possessing bachelor's degrees. Of the bachelor's degrees, 16 percent were in environmental health, while the rest were in other areas. Participants were required to have previous work experience in at least four major program areas in environmental health and to have previously performed two-thirds of the tasks assessed by the work performance measures.

Work Measures

Individual work measures are described in table 1. Each measure's coefficient alpha reliability is also given. To standardize the administration of the examination, examiners were trained in the use of the administration manual prior to the study. Scoring rules and observation checklists for each measure were developed. On observational measures, inter-judge reliability for three judges ranged from .46 to .91; the median was .67. Inter-scorer agreement for scored performance measures from two scorers ranged from .75 to 1.00; the median was .91.

Written Examination

The written examination was a 250-item, multiple-choice examination assessing knowledge and skills drawn from the role delineation KSA

blueprint. Five subscores, paralleling the KSA domains, are reported for this examination. These are disease and injury causation and control (DICC: 108 items); data collection and interpretation (data: 62 items); law and process (legal: 40 items); administration (admin: 18 items); and behavioral science (BehSc: 22 items). The KR20 reliability for the total examination is .95; subscore reliabilities range from .59 (admin) to .92 (DICC). KR20 is a measure of internal consistency which indicates the content homogeneity of the items within a score or subscore.

Results

Separately, each performance measure in this study assessed only a limited segment of practical competency in environmental health. To construct a global measure of environmental health competency, a composite variable was constructed in which all practical measures were entered and weighted according to the importance judgments given them by the working committee. In addition, several practical composite subscores were constructed in which smaller numbers of performance measures were grouped together, based upon the working committee's interpretation of factor analyses of all performance measures. The composite variables were then correlated with the total score on the written test to determine the relationships between them.

Table 2 presents the composition and weighting of the composite performance variables analyzed in this study. Composite performance was determined by weighting the individual performance measures according to the importance weights determined by the working committee. To control the differences in the means and the standard deviations among the individual performance modules, weights were at-

Table 1. Description of the performance measures

Name	*Description*	*Coefficient alpha*
REST DOC	Restaurant documentation: slides simulating restaurant violations are shown. Examinee classifies, documents, and recommends corrections for the violations.	.55
REST VIOL	Restaurant violations: slides showing restaurant conditions are shown. Examinee classifies violations on FDA checklist.	.64
SAM POT	Sampling potable water: direct observation of collection of water samples for bacteriological analysis.	.68
SAM DO	Sampling: direct observation of water sample collection (from tap) for dissolved oxygen analysis.	.68
SAM FORMS	Sample forms: Completion of laboratory forms to include with water samples.	.89
SP TEC	Swimming pool technique: direct observation of use of test kits to determine pH and chlorine residuals of swimming pool water.	.71
SP READ	Swimming pool readings: accuracy of swimming pool pH and chlorine readings. Appropriateness of recommendations.	.56
EPI	Epidemiology: presented with a set of data, an epidemiologic curve, and background information, examinee constructs an attack rate table, determines disease agent, and recommends preventative measures.	.92
ROD	Rodent complaint: examinee listens to a rodent complaint and records it. Slides are shown to establish the complaint, and examinee records the results of this investigation and recommends abatement procedures.	.73
SEPTIC	Septic tank permit: examinee reviews a septic tank installation plan to see if it conforms to a given set of regulations.	.70
WAR	Warrant application: given complaint and investigation records, as well as several sets of regulations, examinee chooses the appropriate warrant form and completes it in accordance with appropriate regulations.	.74
INB	Inbasket: examinee reads through memos, phone messages, laboratory reports, inspection and investigation records and decides priorities for action.	.90
LIGHT TEC	Light meter technique: direct observation of examinee's use of light meter.	.73
LIGHT READ	Light readings: accuracy of light readings checked against baselines.	.50
LABEL	Pesticide label: examinee identifies key elements of a standard pesticide label.	.36

tached to standard scores on the performance measures rather than to raw scores.

The total composite score is the most inclusive of overall competency in environmental health. The restaurant composite and the sampling-field test composite are based upon the modules suggested by their names. The other composite contains performance modules which did not fit in with the other modules, either statistically or substantively. It is possible that the other composite may reflect ability in data interpretation, since the SEPTIC, EPI, and WAR modules involve interpretation of collected data according to regulations or standard principles. It is also possible that the other variable may reflect quantitative (mathematical) ability, since the SEPTIC and EPI modules require arithmetical calculations.

Table 3 presents the intercorrelation matrix of the composite performance variables and the written test scores. Total composite performance correlates .53 with total score. This means that 28.09 percent of the practical test variance can be accounted for by total written test performance, and that there is a significant relationship between performance in environmental health practice, as measured by the performance modules, and total score on the written test.

In interpreting the magnitude of a validity coefficient—the correlation between test score and some criterion measure thought to be predicted by the test—attention must be paid to results found in similar studies. A generally accepted standard for a "good" validity coefficient is .4 (*7*). Cronbach (*8*) states that "it is unusual for a validity coefficient to rise above .60." By these criteria, the coefficients reported for total written test scores in table 3 are good to unusually high. The coefficients for the written test subscores are sometimes somewhat lower than for the total test score. The subscores of the written tests are themselves substantially intercorrelated. It would be surprising to see differential patterns of validity coefficients, when the data indicate there is little difference in patterns of performance among the written test subscores.

An analysis was performed to determine the percentage of persons passing or failing both the work measure and the written examination. Passing points had previously been set on the work measures and on the written examination, using a variation of the Angoff technique. This is a criterion-referenced technique which asks judges to estimate the percentage of minimally competent practitioners who should be able to respond correctly to each item of an examination. On the practical examinations, judges were asked to estimate the percent-

Table 2. Construction of the composite criterion variables

Composite criterion variable	*Performance measures in variable and weights*
Total composite	All performance measures
Restaurant composite	REST DOC **15** REST VIOL **10**
Sampling-field test composite	SAM POT **10** SAM DO **2.5** SAM FORMS **2.5** SP READ **10** SP TEC **5** LIGHT READ **1.5** LIGHT TEC **1** LABEL **2.5**
Other composite	SEPTIC **10**, EPI **10**, WAR **5**, RODENT **10**, INB **5**

NOTE: computational formulas for composite variables involved summing weighted standard scores for each performance measure and dividing by the sum of the weights.

Table 3. Intercorrelation of the composite variables and written test scores[1]

Variables and test scores	*Composites*				*Written*					
	Total	*Rest*	*FT-S*	*Other*	*Total*	*Data*	*DICC*	*Legal*	*Admin*	*BehSc*
Composite variables										
Total	...									
Restaurant	...	...								
Field test-sampling	...	.27	...							
Other	...	.54	.29	...						
Written test										
Total	.53	.34	.35	.56	...					
Data	.57	.34	.44	.51	...	...				
DICC	.44	.27	.29	.47	...	.74	...			
Legal	.38	.28	.22	.46	...	.78	.65	...		
Administrative	.34	.29	.13(ns)	.39	...	.68	.65	.66	...	
Behavioral science	.22	.29	.04(ns)	.35	...	.59	.60	.62	.66	...

[1]N= 101 to 128; missing data treated by pairwise deletion.
NOTE: All values are significant at the .01 level, except for the two marked ns.

Table 4. Numbers in the sample in each of the pass-fail classifications on the comprehensive work measure and national examination

Work measure composite	National examination	
	Fail	Pass
Pass	6	58
Fail	15	21

age of minimally competent practitioners who should be able to perform correctly each step of the practical examination. On the written examination, judges responded directly to the examination items. These percentages were then averaged across judges and items (steps) to arrive at the passing score.

Table 4 shows that there was a 73-percent correct classification of 100 persons taking both the written and all of the practical examinations. (Some attrition had occurred in the 128-person sample, due to missing data on one of more of the performance measures.) Correct classification would mean that both the practical and written examinations were passed or both failed. This percentage seems satisfactory, and it reflects the significant correlation between the written examination and the work performance measures.

Since passing points for the written and practical examinations were arrived at independently, and without explicit consideration of the proportion of the sample that would pass or fail each examination, a larger proportion of the sample "failed" the practical than "failed" the written. The differing pass-fail marginal distributions explain the seemingly large percentage of all persons who failed the practical, but passed the written. Were the passing point on the work performance measures lowered to fail the same proportion of examinees as the written, the number of persons in the lower right-hand quadrant would also decrease.

Conclusions

There is a significant, but not perfect, level of correlation between the written examination and the practical job-related examination which should be indicative of job success.

The procedures used to develop and validate the written credentialing examination in environmental health should assure registration agencies that they have valid and legally defensible examinations with which to register or credential environmental health personnel.

References

1. Conant, R.A.: Credentialing concept. J Environ Health 41: 88–98 (1978).
2. Quatrano, L., and Conant, R.: Continuing competency for health professionals: caveat emptor. J Environ Health 44: 124–130 (1981).
3. Richardson, S.E., Jr., and Stuart, K.: Sunset laws and sanitarian registration. J Environ Health 41: 105–107 (1978).
4. Report on the role delineation project for practitioners in environmental health. Contract HRA 231–75–0211 with the National Environmental Health Association, Denver, CO, 1977.
5. Identification of the role performed by the sanitarian as a health professional. Final report. Contract HRA 231–77–0030 with the National Environmental Health Association, Denver, CO, 1978.
6. Examination development for environmental health personnel. Final report. Contract HRA 232–78–0146 with the Professional Examination Service, New York, 1980.
7. Ghiselli, E.E.: The validity of occupational aptitude tests. John Wiley & Sons, New York, 1966.
8. Cronbach, L.J.: Essentials of psychological testing. Ed 3, Harper & Row, New York, 1970, p. 135.

Collaborative Studies Program on Maternal and Child Health in New York State, 1981–83

ROSEMARY BARBER-MADDEN, EdD
LINDA RANDOLPH, MD, MPH

Dr. Barber-Madden is the Project Director of the MCH Collaborative Studies Program. She is also the Director of the Maternal and Child Health Program, and an Assistant Clinical Professor of Public Health, Center for Population and Family Health, Columbia University School of Public Health. Dr. Randolph is the Director of the Office of Public Health, New York State Health Department. She is also an Assistant Clinical Professor, Center for Population and Family Health, Columbia University School of Public Health.

This is an abbreviated version of a paper presented at the Joint Meetings of the Association of Teachers of Maternal and Child Health and the Association of Directors of Maternal and Child Health and Crippled Children's Services, held in Washington, D.C., on March 20, 1984.

The MCH Collaborative Studies Program is supported jointly by the New York State Health Department and the Columbia University School of Public Health.

Tearsheet requests to Rosemary Barber-Madden, EdD, Center for Population and Family Health, 60 Haven Avenue, New York, NY 10032.