Finding our way from the heart to the head

Ralph J. Petrucci, EdD

Dr Petrucci

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We have all had this experience. The patient sits before us accompanied by a family member during a preoperative office visit, denying any cognitive problems after a significant cardiac event. The gestures from the family member in the background of the office indicate something quite different. "Oh no, I'm doing fine," the patient says, despite occupational, financial, social, and sexual dysfunction. However, when we ask about the children and grandchildren, the room suddenly becomes humid. So, what is all the concern about any relationship between the head and the heart? According to our patient, there is not any.

If we are to explain this cardiocognitive connection, much will depend on further exploration of physiologic parameters and not just new surgical techniques. Neuropsychology can further the contribution to cardiothoracic surgery in this area. Balancing variable selection, design, statistical manipulation, and assessment of the relevant outcome is a tough accomplishment. The current article by Taggart and colleagues¹ does just that, isolating a variable, blood gas levels, to assess the relationship between preoperative and postoperative cognitive dysfunction.

Use of parametric statistics over incident reports, frequency, or descriptive statistics alone carries more power in assessing clinical outcome and applicability. Parametric analyses with an established confidence level at a *P* value of less than .05 or less than .01 will assist interpretation. Most medical research accepts results at a *P* value of less than .05. The use of standardized scores, *z* scores, allows researchers to compare measures over time.²⁻⁴

Investigators usually establish an interpretation of clinically meaningful change a priori. The use of standardized scores, patient self-reports, and collateral data from family members or significant others will help to convey clinically meaningful information. Studies do establish a 1 to 1.5 SD of change as significant.⁵ Others accept a 20% difference within 20% of the tests administered and with given control group comparisons. A 20% of 20% formula works well if the battery is comprehensive.⁶ With abbreviated batteries, we risk the overacceptance of minimal change. A 2-SD change strengthens conclusions.

If we reject the null hypothesis when it should actually be accepted, we are risking a type I error. Conversely, if we accept the null hypothesis and it should be rejected, we are risking a type II error. An acceptable confidence level established before the research study governs the acceptance or rejection of the null hypothesis. It is most important to gear the project design to prevent a type I error. Establishing strict confidence levels, controlling for confounding variables, and obtaining a large heterogeneous sample size strengthens the cardiocognitive connection.

The growing interest in neurobehavioral implications associated with cardiac illness and neuroprotective procedures over the past decade has expanded the need for cognitive testing before and after cardiovascular surgery.^{7,8} Recommendations for the inclusion of neuropsychological testing with cardiovascular research have been established.^{5,9-11} These recommendations include the following: (1) perform preoperative and postoperative cognitive testing; (2) avoid immediate postoperative measures because of the influence of physiologic and pharmacologic effects; and (3) analyze individual differences in performance rather than group differences. Although these recommendations have been accepted, differences still exist from center to center in the selection of cognitive measures, the appropriate timing of

From MCP Hahnemann University, Philadelphia, Pa.

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Address for reprints: Ralph J. Petrucci, EdD, MCP Hahnemann University, Hospital North Tower, 203 N Broad St, Mail Stop 115, Philadelphia, PA 19102-1192 (E-mail: Ralph.Petrucci@drexel.edu).

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postoperative testing, the variables being controlled, and the clinical definition and acceptable level of significance.

Advances in cardiac technology and techniques have overshadowed a concern for cognitive functioning and its effect on daily life. A reliable and consistent methodology must be established to understand the effect of cognitive functioning on daily life. For most research, nothing beats a good, tight preprocedure-postprocedure design with a large subject pool, but for current purposes, this is impractical and not always useful. Where ethics and procedures allow, double blinding and randomization equalizes individual differences and increases generalizability. Studies controlling for comorbid medical conditions and neurologic history will allow us to isolate the effect of the cardiac procedure on cognitive functioning. The strength of cardiothoracic neurobehavioral studies lies in establishing controls for physical and neurologic conditions.

There are a number of external design concerns when considering drawing up a neuropsychological protocol. The first are the physical limitations and restrictions of the deconditioned cardiac patients. Patient deconditioning affects timed tests, motor skills, and processing speed. Patient performance will be affected by variables such as function of hemodynamic status, use of anesthetic and psychotropic agents, metabolic rates, infusion lines, and level of awareness. Postoperative upper extremity motor speed will be disrupted after the insertion and removal of infusion lines.

Second, the testing timetable, or when cognitive testing occurs before and after procedures, is an important consideration. Centers should establish a standard time for baseline testing. Postoperative testing results obtained too early within the recuperative phase can be misleading. For example, comparing reexamination results between patients undergoing off-pump or on-pump bypass the first week after surgical intervention with comorbid medical conditions might reflect a wider range of cognitive differences. A reexamination schedule compared with baseline testing comparison at discharge, 6 months, and 12 months offers adequate recovery and physical stabilization.⁵ Extending the follow-up will increase the lost-to-follow-up percentage and the risk of other pathophysiologic changes, especially in elderly patients.

Third, the inability to control for testing conditions is another threat to the design. Most commonly, these are bedside versus laboratory, inpatient versus outpatient, early versus late in the hospitalization, patients having several procedures versus those having no previous procedures while in the hospital, and with versus without achievement of metabolic stabilization.

A brief neuropsychological review of 45 to 60 minutes either at bedside, in the neuropsychology laboratory, or both is realistic given competition for the patient's time. The testing is conducted by a neuropsychologist or a technician

supervised by a neuropsychologist. The testing of cognitive domains includes standardized internationally acceptable measures in which established norms for specific medical control groups exist. Because patients can be their own control subjects and are retested over time, test-retest reliability needs to be acceptable. A selection of the tests emphasizing specificity, sensitivity, availability of alternative or parallel test forms, and a balanced review of cognitive domains represents the core battery for administration. These common cognitive domains include the following: attention-concentration, auditory and visual memory, motor, visual-spatial, abstract-executive, processing speed, and language functions. Collateral information from the family or significant others regarding the activities of daily living strengthens outcome perspectives.

A selection of the cognitive domains and sampling of measures includes the following: Attention/Concentration-Wechsler Memory Scale-R/III^{12,13}; Information and Orientation; Wechsler Adult Intelligence Test-R/III^{14,15}; Digit Span and Digit Symbol; Trail Making A and B¹⁶; Auditory and Visual Memory-Wechsler Memory Scale-R/III, Auditory and visual sections with delay; Benton Visual Retention Test¹⁷; Rey Auditory-Verbal Learning Test¹⁸; California Verbal Learning Test¹⁹; Hopkins Verbal Learning Test²⁰; Motor-Finger Tapping and Grip Strength¹⁶; Grooved Pegboard Test²¹; Visual/Spatial-Rey Complex Figure Test²²; Wechsler Adult Intelligence Test-R/III, Block Design; Clock Drawing²³; Abstract/Executive—The Stoop Test²⁴; Booklet Category Test²⁵; Processing Speed-Wechsler Adult Intelligence Test-R/III, Digit Symbol, Symbol Search; Trail Making A and B; Language subtests of Boston Diagnostic Aphasia Examination²⁶; Boston Naming Test²⁷; Controlled Oral Word Association Test²⁸; and Collateral Information-Sickness Impact Profile.²⁹

Is there a difference between clinically meaningful and statistically meaningful? In medical populations we often get statistically significant data but somehow miss information that is clinically useful. This can be more easily explained with the examples of pre-examinations and postexaminations. Two patients who score in the impaired range in memory functioning on post-testing might present different clinical challenges. For one patient, the deficits might be of long-standing duration evident on the pretest. This patient and his or her family have compensated and need no additional help with care. In the other patient the new-onset cognitive problems will drastically affect his or her follow-up performance in areas like self-care, family care, or return to work.

Finding our way from the heart to the head to assist patient understanding can be accomplished by staying focused on physiologic parameters, tightening the methods, and using a balanced cognitive domain review. Including collateral family perspectives will strengthen the outcome.

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