Studying reliability using identical handheld lactate analyzers

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Stewart MT, Stavrianeas S. Studying reliability using identical handheld lactate analyzers. Adv Physiol Educ 32: 165–166, 2008; doi:10.1152/advan.90106.2008.—Accusport analyzers were used to generate lactate performance curves in an investigative laboratory activity emphasizing the importance of reliable instrumentation. Both the calibration and testing phases of the exercise provided students with a hands-on opportunity to use laboratory-grade instrumentation while allowing for meaningful connections to be made between data collection and analysis. Pairs of student teams tested individual aerobically trained participants exercising to voluntary exhaustion on a cycle ergometer. The analysis of four volunteers’ postexercise blood samples revealed lactate data that, although highly correlated, showed small but statistically significant differences between devices. This laboratory activity provides a useful platform for introducing students to the reliability of instrumentation, in particular noting its relevance to designs employing repeated measures.

Project KALEIDOSCOPE (11) guidelines identify several attributes of strong undergraduate science programs, in particular noting that curricula of successful programs are more often “experimental” and “steeped in investigation” with case-based laboratory exercises figuring prominently into the investigative learning experience (5, 13, 14). In recent years, science educators have developed a variety of innovative and engaging classroom activities to target specific learning objectives designed to expose students to the intricacies of laboratory research (3, 6). However, although close inspection of the physiology laboratory literature reveals a number of useful activities of this kind (i.e., see Ref. 7 and the examples therein), there is a clear absence of exercises for teaching students important experimental concepts such as reliability. Given the recent American Physiological Society initiative on more frequent and appropriate use of statistical techniques (2), the time is right for physiology educators to incorporate such elements into their laboratory courses.

A number of studies have found that the use of an Accusport analyzer for the measurement of blood lactate during exercise is a reliable alternative to standard enzyme-based spectrophotometric methods (8, 9, 12). These handheld analyzers compare favorably when measuring the magnitude of the lactate response to specific exercise intensity as well as for tracking day-to-day variations (1, 4, 15). Not surprisingly, however, one concern raised repeatedly regarding the use of these devices has been that different blood lactate analyzers and even different analyzers of the same model (e.g., comparisons between two Accusport analyzers) yield different absolute lactate values (1, 10). Herein, we describe an inexpensive, engaging laboratory exercise to highlight the importance of establishing the reliability of research instrumentation.

The activity begins by having students form teams of two and assigning each pair of students a lactate analyzer for data collection. Standard lactate concentrations (5 and 30 mmol/l) purchased from the same supplier as the analyzers are used for calibration. Students produce several dilutions (1, 2.5, 7.5, 10, 15, and 20 mmol/l), and each team generates a standard curve similar to that shown in Fig. 1. Following calibration, four students serve as participants and take turns performing an exercise bout of progressively increasing intensity to voluntary exhaustion on a cycle ergometer (initial load: 100 W, with increments of 25 W every 2 min). Assessment teams work separately but concurrently to measure a given participant’s blood lactate levels (i.e., a total of 2 teams/participant, each with an analyzer, testing the right or left hand of the cyclist). At the end of every 2-min stage, each team collects a 25-μl blood sample from the volunteer’s respective ring finger using identical premarked microcapillary tubes. The blood from each capillary tube is then transferred directly onto a lactate strip, processed by the Accusport analyzer in accordance with the procedure described above, and recorded. The time span from blood draw to analyzer is <20 s. Using Microsoft Excel, teams then use their recorded results to generate lactate concentration curves like those shown in Fig. 2.

Comparisons of the four pairs of lactate curves are then computed, with students testing for similarity between pairs using Pearson’s correlation coefficient (r). In our laboratory, the four sets of lactate curves yielded very high correlations (0.996 < r < 0.998). However, t-tests (α = 0.05) for potential differences between the two devices revealed small but statistically significant differences in blood lactate levels (average difference of 0.31 mmol/l, P < 0.01). The outcomes provide a useful context for group discussion of the importance of using the same device for data collections on the same individual and, more generally, for highlighting the fact that because all

Fig. 1. A sample lactate standard curve generated by applying standard lactate solutions (1, 2.5, 5, 7.5, 10, 15, 20, and 30 mmol/l) on a test strip and analyzed using an Accusport® analyzer.
experimental designs are vulnerable to error, investigators must establish appropriate controls early in the design phase. The final component of the laboratory activity requires students to conduct a database search of the literature for purposes of verifying that the blood lactate curves they generated are consistent with data reported by others.

Taken together, the data collection exercise and the fact that students generated results that agreed with previously published values served to bolster the students’ confidence in their emerging research skills while at the same time broadening their exposure to the scientific process. An informal, ad hoc discussion of the activity following its completion indicated strong student support and appreciation for the simplicity and hands-on nature of the exercise. Moreover, several students reported that this investigative activity greatly enhanced their understanding of design and analysis-related issues, in particular that instrumentation reliability itself, although often alluded to in other sciences-based laboratory courses, was rarely modeled as simply and meaningfully as in the present exercise.

REFERENCES