Handling of and Direct Sampling from Primary Barcode-Labeled Pediatric Tubes on Vitros Clinical Chemistry Analyzers Integrated into an enGen Work Cell, Ayse Y. Demir, Wouter W. van Solinge, and Hans Kemperman (Department of Laboratory Medicine, University Medical Center Utrecht, The Netherlands; * address to correspondence to this author at: Department of Laboratory Medicine, University Medical Center Utrecht, HP G.03.550, PO 85500, 3508 GA Utrecht, The Netherlands; fax 31-30-2505418, e-mail h.kemperman@azu.nl)

Handling and directly sampling from primary barcode-labeled pediatric tubes is a challenge for laboratories receiving substantial numbers of samples from pediatric patients (1). To prevent iatrogenic anemia from frequent blood draws, preanalytical as well as analytical systems should be capable of handling small sample volumes collected in pediatric tubes (2). However, most analyzers and robotic systems have been developed for standard 5- to 7-mL test tubes and cannot handle small pediatric tubes. This incompatibility leads to manual processing of pediatric samples and transfer of samples to micro cups even in large automated laboratories. Manual handling of specimens and transfer of samples are laborious and may lead to errors in both the preanalytical and analytical phases.

In most hospitals, blood of pediatric patients is collected in small pediatric tubes by heel puncture, in contrast to adult patients from whom blood is collected by venipuncture in 5- to 7-mL evacuated tubes. Although most instruments require that the barcode label be applied vertically for reading, regular barcode labels do not conveniently fit on small pediatric tubes (2). Because of the reduced size of the tubes, separate buckets are needed for centrifugation, and often the barcode labels, which are too large for the small tubes, interfere with proper fitting in the buckets; they can also get damaged and no longer be readable (1). Furthermore, standard analyzer sample racks and trays do not support the dimensions of pediatric tubes. The same holds for tube carriers used by various work cells and track systems.

In our clinical chemistry department, we receive ~2500 test tubes daily from various departments of the University Medical Center in Utrecht, The Netherlands. Among these tubes, ~500 pediatric tubes are derived from the pediatric hospital that is part of our organization. Until recently, these tubes were analyzed in a separate satellite laboratory in the pediatric hospital. For efficiency reasons, chemistry tests previously performed in the pediatric hospital, ~250 tubes per day, were moved to our central laboratory, in which two Vitros 950 and one Vitros 250 dry chemistry analyzers (Ortho Clinical Diagnostics) are integrated into an enGen™ work cell (Thermo Electron Corporation). This work cell includes an entry/exit module where samples can be loaded and unloaded. A robotic arm picks up the tubes from sample blocks placed in 1 of the 3 entry drawers and puts each tube in an individual carrier. The barcode is read, and the information is written to a chip in the base of the carrier. The computer uses the requested tests and the status of the different analyzers to calculate an optimal route for each tube through the work cell to the analyzers. Tubes with a cap are first routed to the decapper. After completion of all requested tests, the tubes are sent to the entry/exit module again, where the tubes are placed in barcode-labeled storage racks. These storage racks can be placed directly in the refrigerator. If a tube is needed, for example for additional tests, the data manager will identify at which position in which block the tube is located.

To be able to handle pediatric tubes through the whole preanalytical and analytical phase in a way similar to that for the standard 5- to 7-mL tubes, our laboratory has made the following adjustments. Before blood drawing at the pediatric hospital, 500-μL Capiject lithium-heparin pediatric gel tubes (Terumo Capiject System; Omnilabo) are prefixed in Microtainer tube extenders (Becton Dickinson; Fig. 1A), which make handling of the tubes during blood drawing easier. More importantly, the tube extenders make possible uniformity in size of both pediatric and adult specimens. As a result, the regular barcode labels can be placed in the usual vertical position on the primary pediatric tubes and be transported in standard racks (Fig. 1B). The pediatric tubes are centrifuged together with the standard tubes in the same buckets and centrifuge. Because the sample probe senses the liquid height and starts sampling just below the surface, the Vitros analyzers can deal with variable liquid heights in different sample tubes. However, to enable pipetting directly from these primary barcode-labeled pediatric tubes, the speed at which the sample probe is lowered had to be increased because the fluid height drops more rapidly in these tubes during aspiration as a result of the smaller inner diameter.
This is accomplished by giving pediatric tubes an electronic flag based on a sample identifier that is unique for pediatric samples. Alternatively, an electronic flag could be added by defining a separate entry drawer for pediatric samples in the entry/exit module. The pediatric tubes are loaded in the entry/exit module in the standard sample blocks and are decapped without modifications of the decapper. In emergency situations, manually decapped pediatric tubes are loaded directly in the analyzer by placement in the sample tray, where pediatric samples are distinguished from standard-sized tubes through the use of different tube adapters.

Sampling errors attributable to the reduced inner diameter of the pediatric tubes have not occurred. The minimum fill volume for pediatric tubes is, of course, dependent on the type and number of requested tests and the hematocrit, which is often high in neonates. Because the sample volume needed for assays on the Vitros dry-chemistry analyzers is 5.5–11 μL per test and the mean dead volume in pediatric tubes is ~50 μL, short-sample failures are not seen in daily practice with normally filled (500 μL of whole blood) pediatric tubes.

Before the adjustments described above were made, pediatric tubes were handled separately from standard-sized tubes throughout the preanalytical and analytical phases. Samples had to be centrifuged in separate buckets, and after centrifugation, plasma was manually transferred to micro cups. Because these micro cups did not contain a barcode label, the sample identifier had to be entered in the analyzer manually with the position on the sample tray. In addition to being laborious, this process also led to wrong results attributable to mistakes in sample identification (1, 2). After the relatively simple modifications described here, the Vitros chemistry analyzers integrated in an enGen work cell were capable of handling and directly sampling from primary barcode-labeled pediatric tubes. Errors attributable to manual pipetting and sample transfer were thus eliminated. In addition, because of the ability to handle both standard 5- to 7-mL tubes and pediatric tubes interchangeably in both the preanalytical and analytical phases, turnaround times of both adult and pediatric samples have not changed after integration of the pediatric chemistry tests in the central laboratory.

References

DOI: 10.1373/clinchem.2005.048637