Letters to the Editor

Smartphones Can Monitor Medical Center Pneumatic Tube Systems

To the Editor:

The pneumatic tube system (PTS) has become a common means of transportation of specimens in medical centers. Although the PTS provides convenience and speed of transport, hemolysis of blood specimens and preanalytical variation have been related to excessive acceleration forces and prolonged time/distance traveled in the PTS (1–5). As a result, regular assessment of 3-axis acceleration (i.e., forces) in PTSs has been recommended in an article in this journal (5). An editorial related to that article suggested that products designed for PTS assessment may become commercially available and capable of recording g-forces in PTSs (2). To date, however, we have found no products that are available in the US designed to record forces in the PTS used in our health system (Swisslog).

Many modern smartphones are equipped with an accelerometer that

References

measures acceleration forces. The devices also contain a chronometer, and they are nearly ubiquitous and are portable, and small enough to fit in a PTS carrier, suggesting that they might be useful for monitoring forces and time associated with travel of samples through a PTS.

To explore this possibility, we used a relatively old cell phone (iPhone 5) and a readily available data logger app (Sensor Kinetics Pro). The smartphone was wrapped in bubble wrap, placed in a carrier, and sent through the hospital PTS. The data logger app collected data on 3-axis acceleration vs time in transit. As shown in Fig. 1, the smartphone experienced shocks with peak acceleration forces exceeding 8g (78 m/s²). These forces are similar to the forces of up to 10g reported by Streichert et al. in their PTS when it was at a high-speed setting (5). Streichert et al. documented that such forces are associated with sample hemolysis. The smartphones that we sent through the PTS were not damaged during transport, and the results were reproducible when the smartphone was sent through the PTS repeatedly (not shown).

The iPhones, like most smartphones, also have audiovisual recording capabilities and a light source. We used these capabilities to visualize the effect of acceleration forces on blood samples during transit through the PTS. One smartphone was used to make an audiovisual recording of blood in a filled heparinized sample tube, and a second smartphone illuminated the tube in the carrier. As can be seen in the resulting smartphone video (see the online Supplemental Video link that accompanies the online version of this article at http://www.clinchem.org/content/vol62/issue6), the sample experienced marked turbulence, resulting in a foamy or frothy appearance of the blood sample, with large and small air pockets. The foamy appearance of the sample was readily appreciated upon direct visual inspection immediately after transport of the sample, but dissipated within a few minutes.

These findings suggest that smartphones can be used to quickly and economically monitor the PTS variables of force and time that have been shown to affect the integrity of patient specimens. Although we used an iPhone 5, other types of smartphones have similar capabilities and presumably could be used; this possibility will require documentation. Due to the convenience and efficiency of this approach, it has several possible applications in medical centers that use PTs: (a) a medical center may use this approach to establish PTS acceptability criteria or recommend thresholds not to be exceeded to ensure sample integrity during transport; (b) this approach can be used to investigate a presumptive problematic PTS route; (c) because PTS routes are often installed, and may be modified during medical center renovations, this approach can be used to quickly assess or reassess route performance and consistency; and (d) this approach may be especially useful for more-frequent monitoring of PTS routes that service specific patient populations (such as oncology or hematology patients) whose blood samples may be more susceptible to cellular damage during transport.

Smartphones appear to provide the capabilities needed to monitor medical center PTs, with the benefits of being cost effective, convenient, and widely available.

Author Contributions: All authors confirmed they have contributed to the intellectual content of this paper and have met the following 3 requirements: (a) significant contributions to the conception and design, acquisition of data, or analysis and interpretation of data; (b) drafting Fig. 1. Three-axis acceleration vs time plot of data collected by a smartphone (iPhone 5) using a data logger app (Sensor Kinetics Pro) while traveling through a pneumatic tube system from a patient-care area to the clinical laboratory.
Is the 2-h Sample Really Necessary in the Oral Glucose Tolerance Test in Pregnant Females?

To the Editor:

We read with interest the recent article by Daly et al. on the impact of implementing preanalytical laboratory standards on the diagnosis of gestational diabetes mellitus and found the comment “efficiencies may be achieved by omitting the 2-h OGGT sample” (1) especially interesting because our laboratory performs approximately 5000 oral glucose tolerance tests (OGTT)1 annually on pregnant females, and the elimination of the 2-h sample would increase patient safety and convenience by elimination of superfluous phlebotomy and reduction in waiting room time.

To evaluate this potential efficiency, 75-g OGTT tests were performed following a positive 50-g gestational diabetes screen and patients were asked to fast for a minimum of 8 h before performing the OGTT. Samples were collected in BD Serum Separator tubes, allowed to clot for 30 min, and then centrifuged for 10 min at approximately 1200g. Each sample in the OGTT was processed independently and the serum was not removed from the separator gel. Glucose analysis was performed in a central laboratory using a hexokinase method on a Siemens Advia 1800. Analytical imprecision at 2 levels of control was below 2% for the period of the study.

Using the Viewics Health Insighter program, data were extracted for all OGTT tests performed on pregnant females (a different test code from OGTT tests performed on males and nonpregnant females) from the MySys Laboratory Information System for the period April 1, 2014, to February 16, 2016. Forty-two of the 10 815 OGTT tests found were not included in the study because of missing data (mostly the 2-h result) leaving a cohort of 10 773 patients. The data were analyzed for the number of OGTT tests classified as positive using the 2013 Canadian Diabetes Association (CDA) guidelines criteria (2) (fasting glucose ≥5.3 mmol/L, 1 h ≥10.6 mmol/L, 2 h ≥9.0 mmol/L) and the American Diabetes Association (ADA) guidelines criteria (3) (fasting glucose ≥5.1 mmol/L, 1 h ≥10.0 mmol/L, 2 h ≥8.5 mmol/L) and are summarized in Table 1. Using the ADA guidelines we found a positivity rate of 37.4%, which compares favorably with the research protocol used in the Daly et al. study (1), which had a positivity rate of 38.1%.

Using the CDA criteria, 850 patients were diagnosed with gestational diabetes based solely on the 2 h result, accounting for 31% of all positive OGTT tests. Similar findings were observed using the ADA

References


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Table 1. Summary of OGTT classified as positive according to the 2013 CDA (2) and ADA guidelines criteria (3).

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<th>CDA criteria</th>
<th>ADA criteria</th>
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<tbody>
<tr>
<td>Number of pregnancy OGTTs</td>
<td>10 773</td>
<td>10 773</td>
</tr>
<tr>
<td>Total number positive</td>
<td>2776</td>
<td>4033</td>
</tr>
<tr>
<td>Total diagnosed by 2-h result only</td>
<td>850</td>
<td>994</td>
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<tr>
<td>% of positives diagnosed by 2-h result only</td>
<td>31</td>
<td>25</td>
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1 Nonstandard abbreviations: OGTT, oral glucose tolerance test; CDA, Canadian Diabetes Association; ADA, American Diabetes Association.

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