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Letter to the Editor

Multicenter evaluation of bacterial contamination of glucose test strips☆

Dear Editor,

In the U.S., healthcare-associated infections lengthen the average hospital stay by up to 19 days and increase costs by approximately $43,000 per hospitalization [1]. The prevalence of blood contamination of hospital glucose meters has been reported to be 30.2 ± 17.5%; an increase in the number of operators increases the odds of contamination [2]. Blood glucose monitoring devices have been associated with nosocomial transmission of bloodborne pathogens such as hepatitis B virus when the devices were used on multiple patients without proper cleaning and disinfection [3]. The investigations conducted by health authorities focused on the reusable finger-lancing devices and glucose meters. They did not examine the test strip supplies. Like glucose meters, test strips packaged in a vial for multiple uses may also be vulnerable to contamination. Besides the lancing device, the test strip, rather than the meter, is the component of the blood glucose monitoring system that directly contacts the patient's fingerstick puncture site. Therefore, the potential for cross contamination from test strips is no less than from the meter.

Bacterial contamination of glucose test strips in partially used vials was reported recently at a teaching hospital in France [4]. In that study, 38 of 148 Nova StatStrip Xpress strips (25.7%) tested positive for bacteria. Since this finding was based on one type of test strips at a single center, we were interested in evaluating three other brands of glucose test strips with two different modes of packaging at multiple hospitals to assess the prevalence of bacterial contamination of test strips in active use at various patient care areas.

Of the 5 hospitals that donated glucose test strips for this study, 2 provided Roche Accu-Chek Comfort Curve strips (50 strips per multi-use vial), another 2 provided LifeScan SureStepPro strips (25 strips per multi-use vial), and 1 provided Abbott Precision Xceed Pro strips (100 strips sealed in individual foil packets per carton). Opened vials of Roche and LifeScan strips and opened cartons of Abbott strips were retrieved from active use in various patient care areas, including both the intensive care unit (ICU) and non-ICU, from these hospitals. New, unopened containers (vials or cartons) were also obtained from each hospital and tested for comparison. Once removed from patient care areas, the containers of strips were processed in a central microbiology lab. The exterior surface of each strip container was thoroughly wiped with 70% isopropyl alcohol prior to placing them in a biosafety cabinet. Depending on the number of strips received in the opened vial, up to 6 strips per vial were tested. Using aseptic technique, each strip was vortexed in 10 ml of 0.85% saline and filtered with a 0.45 μm membrane under vacuum. After washing with 100 ml of peptone A solution twice, the membrane was placed on a tryptic soy agar plate and incubated aerobically at 30–35 °C for up to 3 days or anaerobically on blood agar at 35 °C for at least 3 days. The same procedure was followed minus test strips for negative control samples. After incubation of the agar plates, colony count, colony morphology assessment, and Gram stain were performed. Representative colonies were stored at −70 ± 10 °C in tryptic soy broth with 20% glycerol until identification of bacterial species using a 16S ribosomal DNA-based bacterial identification method matched against validated libraries for ≥500 base pairs [5].

Of the strips that were packaged in vials, a total of 40 opened vials (30 Roche vials and 10 LifeScan vials) from 40 patient care areas of 4 hospitals were received for testing. From these vials, 192 strips were individually cultured and 66 (34%) strips yielded positive cultures, 48/144 (33%) aerobic and 18/48 (38%) anaerobic. The bacterial species identified in these cultures are shown in Table 1. Of these 40 vials, 26 (65%) contained strips that yielded positive cultures, 21/40 (53%) aerobic and 16/40 (40%) anaerobic. We used a logistic regression model with culture condition, opened or unopened vials, and hospital as covariates to model the number of contaminated strips per vial and the number of contaminated vials, using the Williams method [6] to correct for overdispersion in the analysis of the number of strips. We found a statistically significant difference between opened and unopened vials, both in terms of the proportion of strips contaminated ($p = 0.0273$) and the proportion of vials contaminated ($p = 0.0350$).

A total of 118 individually packaged Abbott strips from opened containers were received from four patient care areas of an urban teaching hospital. Of 100 strips tested, 3 (3%) yielded positive cultures of minimally pathogenic microorganisms at a low bioburden of 1 colony forming unit per strip (CFU/strip); 3/75 (4%) aerobic and 0/25 (0%) anaerobic.

Strips from new, unopened containers were also tested from each hospital. Only 3 of these 72 control strips (4%) yielded positive cultures of *Staphylococcus epidermidis* and *Propionibacterium acnes* at 1–2 CFU/strip. All 3 of these strips came from 1 of 4 Roche vials tested. No bacteria grew from cultures of 20 strips from 2 new LifeScan vials and 20 strips from a new Abbott carton.

Both brands of glucose test strips packaged in vials showed a high prevalence of bacterial contamination when the opened vials were retrieved from active use in various hospital patient care areas. Seven of 10 (70%) opened LifeScan vials had strips contaminated with bacteria; 29/56 (52%) strips had positive aerobic or anaerobic cultures. Eighteen of 30 (60%) opened Roche vials has contaminated strips; 37/136 (27%) strips had positive aerobic or anaerobic cultures. The prevalence of strips from opened vials with positive aerobic cultures (48/144 or 33%) in this study is consistent with the 25.7% reported by Vanhaeren et al. on the Nova strips. In our study, strips in opened vials were contaminated with a broad range of bacteria, from skin flora to *Enterococcus faecium* and *Staphylococcus aureus*. New, unopened vials of strips had a very low prevalence of bacterial contamination.

Glucose test strips packaged in vials are available in 25, 50 or 100 strips per vial. In point-of-care testing, each vial is typically accessed many times by multiple testing personnel under non-sterile conditions over several days to retrieve test strips for use on patients. In addition,

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Table 1
Bacterial contamination of glucose test strips.

Hospital, type, number of beds	Test strip	Number of patient care areas sampled	Number of opened vials tested	Culture condition	Strips with positive culture (%)	Vials with bacterial contaminated strips	Bacteria identified, CFU/strip
A, county teaching hospital, 570	LifeScan SureStepPro	5	5	Aerobic	14/27 (52%)	4/5 (80%)	*Micrococcus luteus*, 1–2 *Staphylococcus aureus*, 1 *Staphylococcus epidermidis*, 1–32 *Staphylococcus warneri*, >200 *Streptomyces spp.*, 1
				Anaerobic	6/9 (67%)	4/5 (80%)	*Enterococcus faecium*, 2 *Propionibacterium acnes*, 5–54 *Staphylococcus capitis*, 7 *Staphylococcus epidermidis*, 3–6
B, community hospital, 230	LifeScan SureStepPro	5	5	Aerobic	8/15 (53%)	3/5 (60%)	*Bacillus krulwichiae*, 2 *Micrococcus luteus*, 1 *Staphylococcus epidermidis*, 1–10 *Staphylococcus warneri*, 1
				Anaerobic	1/5 (20%)	1/5 (20%)	*Psychrobacter immobilis*, 1
C, community hospital, 165	Roche Accu-Chek Comfort Curve	25	25	Aerobic	16/75 (21%)	11/25 (44%)	*Bacillus cereus*, 1–3 *Bacillus fastidiosus*, 1 *Bacillus sphaericus*, 1 *Corynebacterium propinquum*, 1 *Kocuria varians*, 1 *Micrococcus luteus*, 1 *Paenibacillus spp.*, 1 *Staphylococcus capitis*, 1 *Staphylococcus epidermidis*, 3 *Staphylococcus haemolyticus*, 1 *Staphylococcus hominis*, 1–4
				Anaerobic	11/25 (44%)	11/25 (44%)	*Actinomyces meyeri*, 1 *Propionibacterium acnes*, 2–5 *Staphylococcus auricularis*, 2–3 *Staphylococcus capitis*, 1 *Staphylococcus epidermidis*, 1–109 *Streptococcus oralis*, 1
D, university hospital, 943	Roche Accu-Chek Comfort Curve	5	5	Aerobic	10/27 (37%)	3/5 (60%)	*Enterobacter cloacae*, 1–10 *Micrococcus luteus*, 1–4 *Staphylococcus epidermidis*, 1 *Staphylococcus haemolyticus*, 1 *Staphylococcus saprophyticus*, 1–2
				Anaerobic	0/9 (0%)	0/5 (0%)	–
E, university hospital, 700	Abbott Precision Xceed Pro	4	n/a	Aerobic	3/75 (4%)	n/a	*Brevibacterium halotolerans*, 1 *Bacillus spp.*, 1
				Anaerobic	0/25 (0%)	n/a	–

Spp. = no definitive match for bacterial species in the identification procedure.

some testing personnel may return unused test strips to open vials. Pathogens such as *Clostridium difficile*, methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE) and *Acinetobacter baumannii* can survive on medical devices or environmental surfaces for many days [7]. Vials of test strips may thus act as a reservoir of fomites for the transmission of organisms important to infection control practices.

Of the individually packaged Abbott strips from opened containers, the prevalence of positive bacterial cultures was 3%, comparable to the prevalence of bacterial growth in strips from new, unopened vials. Since glucose test strips are not manufactured and sold as sterile products, it is not surprising to find a small percentage of strips with minimally pathogenic bacteria from the manufacturing environment.

In conclusion, test strips packaged in vials can become contaminated with bacteria during routine use in the hospital. We identified a range of skin and enteric flora in this study. One limitation of this study is our relatively small sample size (192 strips from opened vials were tested), compared to more than 500,000 glucose test strips used every year by many hospitals. This may have limited our probability of finding common nosocomial pathogens such as MRSA and VRE. However, our results do confirm that bacterial contamination of test strips from open vials is common, and suggest that these vials can serve as fomites for patient-to-patient transmission of potentially pathogenic bacteria and organisms important to infection control practices. Testing personnel should handle test strip vials with clean gloves, designate each vial of test strips to a single patient and discard any remaining strips upon patient discharge from the hospital to minimize the risk of patient-to-patient transmission of potentially pathogenic organisms. This would be consistent with the CDC recommendation that "Unused supplies and medications taken to a patient's bedside during fingerstick monitoring or insulin administration should not be used for another patient because of possible inadvertent contamination" [8]. Alternatively, individually packaged test strips may be used to minimize the risk of cross contamination.

References

[1] Lucado J, Paez K, Andrews R, Steiner C. Adult hospital stays with infections due to medical care, 2007. HCUP Statistical Brief, #94. Rockville, MD: Agency for Healthcare Research and Quality; August 2010. http://www.hcup-us.ahrq.gov/reports/statbriefs/sb94.pdf (assessed 18 May 2012).
[2] Louie RF, Lau MJ, Lee JH, Tang Z, Kost GJ. Multicenter study of the prevalence of blood contamination on point-of-care glucose meters and recommendations for controlling contamination. Point Care 2005;4:158–63.
[3] Thompson ND, Schaefer MK. "Never events": hepatitis B outbreaks and patient notifications resulting from unsafe practices during assisted monitoring of blood glucose, 2009–2010. J Diabetes Sci Technol 2011;5:1396–402.
[4] Vanhaeren S, Duport C, Magneney M, et al. Bacterial contamination of glucose test strips: not to be neglected. Am J Infect Control 2011;39:611–3.
[5] Woo P, Ng K, Lau S, et al. Usefulness of the MicroSeq 500 16S ribosomal DNA-based bacterial identification system for identification of clinically significant bacterial isolates with ambiguous biochemical profiles. J Clin Microbiol 2003;41:1996–2001.
[6] Williams DA. Extra-binomial variation in logistic linear models. Appl Stat 1982;31:144–8.

[7] Arias KM. Contamination and cross contamination on hospital surfaces and medical equipment. Initiatives in Safe patient Care. http://www.initiatives-patientsafety.org/Initiatives4.pdf (accessed 18 May 2012).
[8] CDC Diabetes and viral hepatitis: important information on glucose monitoring. http://www.cdc.gov/hepatitis/Settings/GlucoseMonitoring.htm (assessed 18 May 2012).

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