Use of the Rapid BinaxNOW Malaria Test in a 24-Hour Laboratory Associated with Accurate Detection and Decreased Malaria Testing Turnaround Times in a Pediatric Setting Where Malaria Is Not Endemic

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The impact of implementing the BinaxNow malaria test was evaluated. From 288 tests, 34 malaria cases were detected. Laboratory turnaround time decreased from 9.8 to 1.7 h for report of any Plasmodium spp., 10.2 to 1.6 h for P. falciparum, and 8.6 to 1.1 h for any result.

Therapeutic delay has been associated with increased risk of mortality in Plasmodium falciparum malaria (1). Timely administration of antimalarial therapy is, in turn, dependent on swift clinical identification of persons at risk, prompt specimen acquisition, and rapid testing turnaround time (TAT). The BinaxNOW malaria test (RDT; Alere Scarborough, Inc., Scarborough, ME) is a U.S. Food and Drug Administration-approved immunochromatographic assay that detects P. falciparum-specific histidine-rich protein 2 (HRP-2) and aldolase, a pan-Plasmodium enzyme, within 20 min. We investigated its performance in a pediatric population in a nonendemic setting and its impact on malaria testing turnaround times.

All specimens received for malaria testing from 1 January 2006 to 31 December 2011, inclusive, were considered for inclusion. Only the first specimen submitted, per patient, was analyzed. We recorded the date and time of specimen receipt and first report of any result (the presence of Plasmodium falciparum or a non-falciparum species or the absence of Plasmodium spp.), RDT and thick and thin Giemsa smear results, and shift (day shift versus evening or night shift) and staffing status (standard weekday versus holiday or weekend) at the time of specimen receipt. Medical records of all cases were reviewed to determine if they met the Centers for Disease Control and Prevention’s criteria for severe malaria (one or more of the following criteria: impaired consciousness/coma, severe normocytic anemia [hemoglobin of <7 g/dl], renal failure, acute respiratory distress syndrome, hypotension, disseminated intravascular coagulation, spontaneous bleeding, acidosis, hemoglobinuria, jaundice, repeated generalized convulsions, and/or parasitemia of ≥5%) (2).

A protocol involving RDT followed by thick and thin Giemsa smear microscopy was implemented on 1 August 2007. Prior to this, we relied solely on thick and thin smears for malaria diagnosis. Testing was performed on venous blood anticoagulated in EDTA. RDT was performed according to the manufacturer’s instructions. Two thin and two thick Giemsa smears were prepared from every blood specimen, and positive smears were reviewed by two technologists. Throughout, the policy was for thick and thin smears to be prepared and read as soon as a technologist with the necessary skills started his or her shift. RDT was performed immediately upon specimen receipt, and results were reported as ‘preliminary’ and finalized when blood smear results were reported. All technologists performed RDT, but only microbiology technologists prepared and read blood smears.

A total of 288 specimens (67 pre-RDT, 221 post-RDT) qualified for analysis. There were 34 confirmed cases of malaria with positive RDT and blood smears. Blood smears were positive in nine of the 67 patients tested pre-RDT (seven P. falciparum, one P. vivax, one P. ovale). After introduction of RDT, 27 of the 221 patients tested were RDT positive. Blood smears yielded 19 cases of P. falciparum malaria, three P. vivax cases, two P. ovale cases, and one mixed case with P. falciparum and P. ovale. Of the 27 P. falciparum cases with parasites seen on blood smears, 16 had <1% parasitemia. The remaining 11 cases had 1.2, 2.2, 6.1, 6.3, 6.5, 6.9, 10.1, 15.0, 17.0, 20.4, and 35% parasitemia. In two cases, RDT tested positive for P. falciparum but no parasites were seen on blood smears. Both cases presented febrile and defervesced with atovaquone-proguanil therapy. Neither had an alternative diagnosis to explain the fever. One case arrived in the United States from a refugee camp in Thailand 3 months prior to presentation. Two subsequent sets of thick and thin smears showed no evidence of Plasmodium species. The second case had a travel history to Nigeria 3 weeks prior to presentation during which she reportedly took malaria prophylaxis. Compliance was not documented. A subsequent blood smear was negative for Plasmodium spp. Both cases were analyzed as false positives.

Nine cases with P. falciparum malaria met CDC criteria for severe malaria, and all had parasitemia levels of >5%. Five cases met other criteria for severe malaria (hypotension, hemoglobin levels of <7 g/dl).

Using Giemsa smears as the gold standard, the sensitivity (SN), specificity (AP), positive predictive value (PPV), and negative predictive value (NPV) of RDT were 100%, 99%, 92%, and 100%, respectively, for the detection of any Plasmodium spp. and 100%, 99%, 91%, and 100% for P. falciparum. RDT detected 5/5 cases of...
TABLE 1 Univariate and multivariate analysis results of the characteristics of malaria testing pre- and postimplementation of the BinaxNOW malaria test (RDT)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Result</th>
<th>Pre-RDT</th>
<th>Post-RDT</th>
<th>P value (unadjusted)</th>
<th>P value (adjusted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean TAT (h) to a positive report</td>
<td>a</td>
<td>9.8 (2.4)</td>
<td>1.7 (0.43)</td>
<td>&lt;0.001</td>
<td>NA</td>
</tr>
<tr>
<td>Mean TAT (h) to a P. falciparum report</td>
<td>a</td>
<td>10.2 (2.8)</td>
<td>1.6 (0.52)</td>
<td>&lt;0.001</td>
<td>NA</td>
</tr>
<tr>
<td>Mean TAT (h) to any report</td>
<td>b</td>
<td>8.6 (0.84)</td>
<td>1.1 (0.14)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>% tests received on day shift</td>
<td>c</td>
<td>50</td>
<td>58</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>% tests received when fully staffed</td>
<td>d</td>
<td>77</td>
<td>76</td>
<td>0.90</td>
<td></td>
</tr>
</tbody>
</table>

a Turnaround time to a positive report: the time elapsed from specimen receipt in the microbiology laboratory to the first report of P. falciparum or non-P. falciparum malaria.
b Turnaround time to any report: the time elapsed between specimen receipt in the microbiology laboratory to the report of any result, positive or negative.
c "Day shift" was defined as 08:00 to 15:59; evening shift, 16:00 to 23:59; night shift, midnight to 06:59.
d "Fully staffed" was defined as any workday that was not Saturday or Sunday (i.e., a weekend) or a hospital-designated holiday.

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We have no conflicts of interests to declare.

K.O.-S. contributed to the conception and design of this study, data collection, and data analysis and drafted and edited the manuscript. D.L.B.-S. contributed to the conception and design of this study and data analysis and edited the manuscript.

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