Evaluation of BBL CHROMagar O157 versus Sorbitol-MacConkey Medium for Routine Detection of Escherichia coli O157 in a Centralized Regional Clinical Microbiology Laboratory

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Received 23 February 2007/Returned for modification 16 April 2007/Accepted 10 July 2007

Escherichia coli O157:H7 strains are the most prevalent group of Shiga toxin (Stx)-producing E. coli (STEC) worldwide (4, 11, 13, 23, 25). This serotype causes a broad range of conditions, from mild, nonbloody diarrhea to severe hemorrhagic colitis, hemolytic uremic syndrome, and death (3, 12, 16, 21, 23, 25). Transmission frequently occurs through ingestion of raw or undercooked beef, but other contaminated foods and water have also been implicated, and person-to-person transmission also occurs (1, 4, 7, 16, 19–21, 24, 25, 26).

Our centralized regional clinical microbiology laboratory routinely tests all stool cultures for E. coli O157, using its inability to ferment sorbitol on sorbitol-MacConkey (SMAC) agar (PML Microbiologics), a medium where sorbitol is substituted for the lactose in the standard MacConkey formulation (11, 14, 22). However, E. coli O157 infections may be missed on SMAC because some strains ferment sorbitol and cannot be differentiated from normal intestinal flora (2, 11). Chromogenic agar was recently marketed for improved detection of E. coli O157. Colonies of E. coli O157:H7 growing on BBL CHROMagar O157 (CHROM) (Becton Dickinson) produce a mauve color due to chromogenic substrates in the medium, thus allowing presumptive identification from the primary isolation plate and differentiation from other organisms (5). This study compared the performance and diagnostic efficacy of these two types of selective and differential solid media for the routine detection of E. coli O157 during the summer months when infections are most prevalent in our region.

Calgary Laboratory Services (CLS) is a large integrated medical laboratory company that provides clinical services to the Calgary Health Region (CHR), one of the largest integrated healthcare regions in Canada (population, 1.2 million). Clinical microbiology services for hospitalized and ambulatory patients are delivered 24 h a day, 7 days a week, through a centralized laboratory located in the community (9). The CHR has a high prevalence of infection with enteric bacteria, including E. coli O157 (population-based prevalence of 9:100,000), because southern Alberta is a major agricultural area (15, 16). Children have the highest prevalence of E. coli O157:H7 infection in our region (7, 15, 16).

From 15 June to 5 September 2006, stool specimens for culture were collected into a sterile screw-cap container, transported to CLS, and inoculated onto SMAC and CHROM agars within 4 to 6 h after collection. Plates were incubated aerobically for 18 to 24 h at 35°C and read by independent technologists. On average, 10 colorless NSF colonies were picked off the SMAC plate, and all mauve colonies were picked off the CHROM plate. Colonies confirmed with either medium to be E. coli by standard biochemical reactions and positive for O157 by latex particle agglutination (Oxoid) were identified as E. coli O157. Antibiotic susceptibility testing was performed but not routinely reported according to CSLI guidelines (10). The numbers of colony picks, indole reactions, and O157 serotyping tests for SMAC versus those for CHROM plates were recorded. Economic comparisons for each medium included labor costs based on the current salary scale for medical laboratory technologists (MLTs), and material costs (for media and regents) included applicable taxes. Data were entered into Microsoft Office Excel 2003 (Microsoft Corporation, Seattle, WA) and analyzed using standard statistical methods.

Results for 27/3,116 (0.9%) stool cultures from 27 patients were positive for E. coli O157. All strains of E. coli O157 grew abundantly and were easily distinguished on CHROM as typ-

<table>
<thead>
<tr>
<th>TABLE 1. Performance of CHROM compared to that of SMAC media</th>
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<tbody>
<tr>
<td>CHROM result</td>
</tr>
<tr>
<td>Positive</td>
</tr>
<tr>
<td>Positive</td>
</tr>
<tr>
<td>Negative</td>
</tr>
<tr>
<td>Total</td>
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</tbody>
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*Sensitivity = 26/27 (96.3%), specificity = 3,089/3,090 (99.96%), positive predictive value = 26/27 (100%), negative predictive value = 3,089/3,089 (100%), prevalence = 27/3,116 (0.86%), accuracy = 3,115/3,116 (99.97%).
ical mauve colonies. Table 1 shows the performance data for CHROM versus those for SMAC. CHROM missed one E. coli O157 infection, but four were missed by SMAC. CHROM missed a repeat culture detected by SMAC from a previously positive patient on both media. No false-positive cultures occurred on either medium. CHROM had a higher sensitivity (96.30%) and negative predictive value (100%) than SMAC but a specificity (100%) and positive predictive value (100%) similar to those for SMAC.

Nine hundred stool cultures required further analysis. The diagnostic efficiency of CHROM was much better than that of SMAC, with a 75% decrease in the number of colony picks (i.e., less false-positive growth on CHROM and better differentiation of O157 due to the mauve indicator), a 52% decrease in indole reactions, and a 43% decrease in O157 serotyping tests. Totals of 771 non-sorbitol-fermenting versus 196 mauve colony picks, 358 versus 185 indole reactions, and 273 versus 156 O157 serotyping tests were done from SMAC versus CHROM, respectively. Overall, the false-positive rate for colony picks for SMAC (65%) was substantially higher than that for CHROM (20%).

Table 2 lists the component costs of performing stool cultures for E. coli O157 detection using either medium. Labor costs for CHROM decreased by 21% (equivalent to saving 0.2 full-time equivalents [FTE]) during the study, while material costs decreased 64% because fewer biochemical tests were done (i.e., indole reactions and serotyping tests), even though chromogenic medium is more expensive. Implementation of CHROM is projected to decrease annual material costs in our regional microbiology operation by ~$11,000 and save the equivalent of 1.0 FTE in MLT labor (~$65,000).

This study is the first clinical evaluation of CHROM for the routine detection of E. coli O157. The improved diagnostic performance and efficiency of CHROM would allow more appropriate management of E. coli O157 cases and outbreaks (18, 25). Limited clinical studies have evaluated other types of chromogenic media for detection of enteric pathogens, including Salmonella and E. coli O157 (6, 8, 17). Another chromogenic O157 medium (O157 H7 ID-F; bioMérieux SA, Marcy-l’Etoile, France) recently showed suitable performance for isolation of E. coli O157 and other STEC strains (6). The ability of CHROM to detect non-O157 STEC strains was not evaluated, since these serotypes are not routinely tested for in our region.

CHROM improved diagnostic efficiency by dramatically reducing the number of false-positive colony picks by MLTs, thus reducing the numbers of unnecessary biochemical and O157 serotyping tests performed. Use of CHROM would therefore be cost-effective in our laboratory even though this medium is more expensive than SMAC. The significant projected annual resource savings (~$76,000) could be utilized to perform other laboratory procedures. Proportional savings based on annual stool culture test volume would occur in other laboratory settings with high prevalences of E. coli O157. Although the annual savings were extrapolated from implementation of CHROM during the main season for E. coli O157:H7 incidence, this extrapolation would result in only a minor overestimation of total savings since stool test volumes remained constant throughout the year. Further studies should confirm these findings in a larger number of cases and determine the performance of CHROM for diagnosis of non-O157 STEC infections.

This study was funded by a grant from BD Diagnostic Systems (study no. 06C3-008-CHROM-CLS) (Becton Dickinson, Sparks, MD). CLS Finance reviewed costing.

### REFERENCES


### TABLE 2. Comparison of CLS study costs for using SMAC versus costs for CHROM for stool cultures

<table>
<thead>
<tr>
<th>Medium</th>
<th>Cost of medium (cost per plate)</th>
<th>Cost of other materials</th>
<th>Total MLT time (FTE)</th>
<th>No. of patients during study</th>
<th>Total study cost</th>
<th>Total annual cost</th>
<th>Total annual labor</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMAC</td>
<td>$872.48 ($0.30)</td>
<td>$1,223.25</td>
<td>0.53 (220.8 h)</td>
<td>3,116</td>
<td>$10,744.12</td>
<td>$51,571.78</td>
<td>2.54</td>
</tr>
<tr>
<td>CHROM</td>
<td>$5,297.20 ($1.70)</td>
<td>$445.04</td>
<td>0.32 (70.1 h)</td>
<td>3,116</td>
<td>$8,501.77</td>
<td>$40,807.94</td>
<td>1.54</td>
</tr>
</tbody>
</table>

* a The immediate effects of change to CHROM are as follows: cost of medium, $4,424.72 increase; cost of other materials, $778.21 decrease; total MLT time, 0.2-FTE decrease; total study cost, $2,242.35 decrease; total annual cost, $10,763.84 decrease; and total annual labor, 1.0-FTE (~$65,000) decrease.

b MLTs and laboratory assistants.

c Total costs include the Canadian Goods and Services tax but not shipping and handling.

d Projected annual resource savings extrapolated from the labor/material savings during the study period.


