Comparison of Media for Direct Isolation and Transport of Shigellae from Fecal Specimens

GEORGE K. MORRIS, JUDITH A. KOEHLER, EUGENE J. GANGAROSA, AND ROBERT G. SHARRAR

Epidemiology Program, National Communicable Disease Center, Atlanta, Georgia 30333

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Xylose-lysine-deoxycholate (XLD) agar, SS agar, and MacConkey agar for isolating shigellae from fecal specimens were compared. XLD agar was superior to both SS agar and MacConkey agar for isolating Shigella sonnei, and both XLD and SS agar were superior to MacConkey agar for isolating S. flexneri. Direct plating of the fecal specimens in the field resulted in a greater yield of shigellae as compared to transporting specimens to the laboratory either in holding media or enrichment broth. Buffered glycerol saline was superior to other transport media evaluated, yielding 83% of shigella isolates when plated within 48 hr as compared to direct plating. The combination of XLD agar and SS agar is recommended for direct isolation of shigellae, and, whenever possible, these solid media should be taken to the bedside and inoculated directly.

Many media have been recommended for the transport, enrichment, and isolation of shigellae. We evaluated three commonly used plating media for direct isolation and five transport or enrichment media to determine the optimal method for recovery of shigellae from fecal specimens.

MATERIALS AND METHODS

The clinical material for this study consisted of 4,228 fecal specimens, mostly in the form of rectal swabs, collected in the 5-year period 1965 to 1969. Of these 4,228 fecal specimens, 2,068 were plated on xylose-lysine-deoxycholate (XLD) and SS agars, and the remaining 2,160 were plated on XLD, SS, and MacConkey agars. Samples were collected as part of surveys for shigellosis in mental hospitals, in monkey colonies at the National Communicable Disease Center, and during epidemiologic investigations of outbreaks of acute shigellosis around the United States. A rectal swab was taken by gently inserting it beyond the rectal sphincter muscle. In the few cases that fresh stools were received, the swab was inserted into the stool, and the media were inoculated as with rectal swabs. Plating media were seeded immediately by rotating the swab on an area of the agar surface approximately 1 inch in diameter. The swab was rotated after each inoculation so that an unused side of the swab was exposed to each plate. The sequence in which the various media were plated with the swab was rotated so that all solid media were equally represented in being plated first, second, etc. Also, in some cases, multiple swabs were taken to inoculate transport or enrichment media. The following transport and enrichment media were utilized during the course of this study: buffered glycerol saline (3), Cary-Blair medium (2), silica gel (Protek-Sorb, Poly foil bag, Grace Davison Chemical, Baltimore, Md.), Gram-negative (GN) broth (5), and specimen preservative (SP) broth (4). After specimens in transport and enrichment media were received in the laboratory, they were plated on media similar to that used in the field for direct plating. Swabs in silica gel were rehydrated in Brain Heart Infusion broth for 2 hr at 37 C prior to inoculating the plating media. After inoculation, plates were streaked with a sterile loop and were incubated at 37 C for 20 to 24 hr.

After incubation, all colonies suspected of being shigellae were picked and inoculated into Triple Sugar Iron agar (Difco; TSI). All cultures showing TSI reactions suspicious of shigellae were typed serologically. These cultures, along with those negative serologically, were examined with the following biochemical tests: indole; methyl red; Voges-Proskauer; lysine, arginine, and ornithine decarboxylases (Moeller method); Christensen's citrate agar; Christensen's urea agar; motility; lactose, mannitol, and glucose fermentation broths (3); and acetate (9). Confirmation of selected isolates and the serological subgrouping were performed by the Enteric Bacteriology Laboratories, National Communicable Disease Center.

XLD agar was made from basic ingredients (8) in the early phases of the study, but, when commercial medium became available, the XL agar base (BBL) was used and heat-labile ingredients were added after autoclaving. SS agar (Difco) and MacConkey agar (Difco) were prepared from commercial dehydrated preparations.

RESULTS

Of the 4,228 fecal specimens studied, 2,068 specimens were plated on XLD and SS agars. Shigellae were isolated from 230 of these speci-
Table 1. Recovery of shigellae on XLD and SS agars from fecal specimens

| Media combination          | Method of plating |            |            |            |
|----------------------------|-------------------|------------|------------|------------|
|                            | Direct            | Indirecta | Total      |            |
| XLD + SS                   | 71                | 15         | 86         |            |
| XLD alone                  | 54                | 32         | 86         |            |
| SS alone                   | 44                | 14         | 58         |            |
| Total on XLD               | 125               | 47         | 172        |            |
| Total on SS                | 115               | 29         | 144        |            |
| Total on both media        | 169               | 61         | 230        |            |
| Total specimens examined   | 986               | 1,082      | 2,068      |            |

a Specimens received in transport media or enrichment broth.

Table 2. Distribution of shigellae from 2,068 fecal specimens on two plating media (XLD and SS agars)

| Media | S. dysenteriae | S. flexneri | S. sonnei |
|-------|---------------|-------------|-----------|
|       | No. | Per cent | No. | Per cent | No. | Per cent |
| XLD alone | 2   | 66.7      | 46  | 31.5      | 38  | 46.9     |
| SS alone   | 0   | 0         | 49  | 33.6      | 9   | 11.1     |
| Both SS and XLD | 1 | 33.3 | 51  | 34.9      | 34  | 42.0     |

a S. dysenteriae 2.

Table 3. Recovery of shigellae on XLD, SS, and MacConkey agars from fecal specimens

| Media combination                        | Method of plating |            |            |            |
|------------------------------------------|-------------------|------------|------------|------------|
|                                          | Direct            | Indirecta  | Total      |            |
| XLD + SS + MacConkey                    | 31                | 3          | 34         |            |
| SS + MacConkey                          | 3                 | 3          | 3          |            |
| XLD + MacConkey                         | 6                 | 1          | 7          |            |
| SS + XLD                                | 34                | 3          | 37         |            |
| MacConkey alone                         | 6                 | 2          | 8          |            |
| SS alone                                | 23                | 0          | 23         |            |
| XLD alone                               | 22                | 7          | 29         |            |
| Total on MacConkey                      | 46                | 6          | 52         |            |
| Total on SS                             | 91                | 6          | 97         |            |
| Total on XLD                            | 93                | 14         | 107        |            |
| Total all media                         | 125               | 16         | 141        |            |
| Total specimens examined                | 1,563             | 597        | 2,160      |            |

Table 4. Distribution of shigellae on three plating media (XLD, SS, and MacConkey agars)

| Shigella species | Media | S. flexneri | S. sonnei |
|------------------|-------|-------------|-----------|
|                  | No.   | Per cent    | No.       | Per cent  |
| MacConkey alone  | 4     | 4.3         | 4         | 8.2       |
| SS alone         | 21    | 22.8        | 2         | 4.1       |
| XLD alone        | 15    | 16.3        | 14        | 28.6      |
| SS and XLD       | 23    | 25.0        | 14        | 28.6      |
| XLD and MacConkey| 2     | 2.2         | 5         | 10.2      |
| SS and MacConkey | 3     | 3.3         | 0         | 0         |
| XLD, SS, and MacConkey | 24 | 26.1 | 10 | 20.4 |
| Total isolations with XLD                 | 64 | 69.6 | 43 | 87.8 |
| Total isolations with SS                   | 71 | 77.2 | 26 | 53.1 |
| Total isolations with MacConkey            | 33 | 35.9 | 19 | 38.8 |

lated on SS alone. However, a distinct superiority of XLD over SS was noted when the two plating media were inoculated indirectly, i.e., after being held in transport or enrichment media. In the latter case, 32 specimens were positive on XLD alone and only 14 were positive on SS alone.

The distribution of the Shigella species on the two plating media was determined (Table 2). In the case of Shigella flexneri, the two media were approximately equal, but XLD agar was far superior to SS agar for isolating S. sonnei (38 isolates on XLD alone, but only 9 isolates on SS alone). Isolations of S. dysenteriae were too few to evaluate.

The 2,160 fecal specimens plated on XLD, SS, and MacConkey agars yielded 141 shigellae isolates (Table 3). When samples were plated directly, XLD and SS were individually superior to MacConkey (93, 91, and 46 isolates, respectively), but there was little difference between XLD and SS. With those samples, plated indirectly, with holding or enrichment media, XLD was superior to both SS and MacConkey agars (14, 6, and 6 isolates, respectively), but there was no difference between SS and MacConkey.

The species distribution (Table 4) indicated that, for the isolation of S. flexneri, XLD and SS agars are superior to MacConkey agar, but there was no apparent difference between XLD and SS agars. For isolation of S. sonnei, XLD was superior to both SS and MacConkey agars, but there was no apparent difference between SS and MacConkey agars.

Some specimens were inoculated into holding and enrichment media, and the analysis of those specimens (Table 1). XLD agar appeared to be slightly superior to SS agar when the specimens were plated directly; 54 isolates of Shigella were obtained on XLD alone, whereas only 44 were iso-
TABLE 5. Efficiency of various media used to transport fecal specimens for the isolation of shigellae

| Transport or enrichment media | Days media held before plating | No. fecal specimens examined | No. S. shigella isolated by direct plating of fecal specimen | No. S. shigella isolated when specimens plated from transport media | Per cent positive compared to direct plating |
|-------------------------------|--------------------------------|-----------------------------|-------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------|
| Buffered glycerol saline      | 1–2                            | 36                          | 18                                                         | 15                                                              | 83.0                                         |
|                               | 3–6                            | 271                         | 50                                                         | 24                                                              | 48.0                                         |
|                               | 7–10                           | 203                         | 45                                                         | 17                                                              | 37.8                                         |
| Cary-Blair                    | 1–2                            | 298                         | 68                                                         | 18                                                              | 27.5                                         |
|                               | 3–6                            | 148                         | 35                                                         | 8                                                               | 22.8                                         |
|                               | 7–10                           | 295                         | 27                                                         | 8                                                               | 29.6                                         |
| GN broth                      | 1–2                            | 298                         | 66                                                         | 8                                                               | 12.1                                         |
|                               | 3–6                            | 125                         | 28                                                         | 2                                                               | 7.1                                          |
|                               | 7–10                           | 24                          | 8                                                         | 0                                                               | 0                                            |
| Silica gel                    | 3                              | 18                          | 8                                                         | 3                                                               | 38.0                                         |
| SP broth                      | 7–10                           | 148                         | 14                                                         | 1                                                               | 7.1                                          |

samples for which results of direct plating were also available are shown (Table 5). Buffered glycerol saline was superior to either Cary-Blair medium or GN broth at each time period, and GN broth was the poorest when compared to the results of direct plating. The efficiency of both buffered glycerol saline and GN broth decreases with time. The efficiency of the Cary-Blair medium was intermediate to buffered glycerol saline and GN broth, and the effectiveness of Cary-Blair medium did not deteriorate with time in this study.

The isolation of shigellae from 18 human rectal swabs by plating directly to XLD and SS was compared to plating indirectly after transport at room temperature in silica gel for 3 days. Eight shigellae were isolated by the direct method, whereas only three were isolated by the indirect method. Of 148 human fecal specimens, 14 yielded shigellae when plated directly, but only one of these yielded shigellae when held in SP broth for 7 to 10 days prior to plating.

DISCUSSION

The efficiencies of XLD and SS agars were similar when the fecal specimens were plated directly, but XLD agar was superior when the specimens were plated indirectly with transport or enrichment media. The efficiency of MacConkey agar was similar whether plated directly or indirectly. However, there were fewer isolates from Mac Conkey agar than from either XLD or SS agars when the specimens were plated directly. On indirect plating, the efficiency of MacConkey agar was comparable to SS agar and inferior to XLD agar. Neither MacConkey nor XLD was noted to show any advantage for the isolation of either S. flexneri or S. sonnei. SS agar, however, was more effective for isolating S. flexneri than S. sonnei. The low number of S. sonnei isolated on SS agar may be influenced by the large number of specimens of carrier-state individuals cultured in the monkey colony and mental hospitals in this study. Although S. sonnei I is isolated more frequently from acute cases, S. sonnei II is more commonly isolated from carriers (1). SS agar has been shown to be inhibitory for S. sonnei II but not for S. sonnei I (10).

The transport and enrichment media yielded shigellae less frequently than fresh fecal specimens inoculated directly on solid media. Buffered glycerol saline was the best of the five media evaluated, whereas GN broth, designed as an enrichment medium rather than holding medium, was the poorest. The recovery of shigellae from buffered glycerol saline and GN broth progressively decreased with time, after the rectal swabs were taken. Cary-Blair medium was intermediate to buffered glycerol saline and GN broth for isolating shigellae, and its effectiveness in maintaining shigellae did not decrease with time.

At least two solid media are recommended for direct isolation because lot-to-lot variation of individual commercial media has been reported (6, 7).

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