A simple and direct method of turnaround time audit in a microbiology laboratory

P G Murphy, E Crothers

Abstract
A method of specimen turnaround time audit, directly controlled by laboratory staff, was applied to a bacteriology service to assess service efficiency and identify delays and other deficiencies, so that resources could be optimised. The method provided a complete collection of turnaround time data and was easy to use. Delays of both administrative and technical natures were identified, and with minimal reorganisation the mean turnaround time was improved.

Laboratory audit, although normally a continuous activity, often includes periodic specific indepth analyses, one of which may be turnaround time analysis, which permits assessment not only of technical efficiency but also of the entire pathological service. It also assesses a measurement of service which is often seen as the main item of quality by certain laboratory users.

The recent report of a simple method of auditing turnaround times in a microbiology laboratory has prompted us to report briefly our own method, which is also simple to perform and achieves higher completion rates by being under more direct laboratory control.

Methods
A form was designed detailing 11 datum time points for each specimen analysed and 11 accompanying cumulative times (figure). Eight areas of laboratory activity were investigated: miscellaneous (such as swabs, pus, etc); blood culture; sputum; faeces; urine; serology; mycobacteriology (direct microscopy); and food hygiene. Specimens were recorded for each area of laboratory work over a seven day period. Two types of positive bias were introduced to correct for small sampling and ensure that all specimen types and sources would be included: a source bias was introduced by randomly selecting specimens to obtain equal numbers from each of general practice, on-site hospital, and off-site hospital sources. Similarly, a sample bias was introduced by selecting specimens with turnaround times expected to be best, median, and worst—for example, specimens arriving just in time for, or just missing, a batched analysis, or non-emergency specimens arriving out of hours. Forms were completed by MLSO staff as work was carried out. The other data which were external to the laboratory control (form items 1, 2, and 11) were collected by telephone enquiries made to the laboratory users, such as clinical staff on hospital wards and general practice surgeries. Median turnaround time values were computed rather than mean values or standard deviations, as turnaround time data are not normally distributed but skewed towards larger values and mean values are longer than median values.

Results
A form completion rate of 95% was achieved by this method which allowed 108 specimens from eight areas of work, over seven days, to be analysed. The entire procedure was completed in two weeks with very little disruption to normal working. Cumulative turnaround times were analysed by laboratory turnaround time (4-7) and total turnaround time (1-11) (table). Those specimens with turnaround times above the mean were targeted for detailed scrutiny. Only minor improvements were made in laboratory protocol. The major potential for improvements in turnaround time were identified outside the laboratory and were corrected by administrative reorganisation, which mainly involved specimen collection and delivery of reports.

<table>
<thead>
<tr>
<th>Specimen Type</th>
<th>Median cumulative laboratory time (range)</th>
<th>Median cumulative total time (range)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miscellaneous</td>
<td>46 (19-25-97-25)</td>
<td>94 (46-8-190)</td>
<td>19</td>
</tr>
<tr>
<td>Sputum</td>
<td>23-7 (11-2-57)</td>
<td>43-7 (30-100)</td>
<td>19</td>
</tr>
<tr>
<td>Blood culture</td>
<td>144 (27-168)</td>
<td>192 (186-240)</td>
<td>12</td>
</tr>
<tr>
<td>Faeces</td>
<td>45 (41-5-66)</td>
<td>96 (66-75-122)</td>
<td>12</td>
</tr>
<tr>
<td>Urine</td>
<td>21-7 (9-5-46-5)</td>
<td>33-5 (16-128)</td>
<td>15</td>
</tr>
<tr>
<td>Serology</td>
<td>25 (22-177)</td>
<td>74-6 (19-5-127)</td>
<td>6</td>
</tr>
<tr>
<td>Mycobacteriology (microscopy)</td>
<td>26-3 (21-6-96-7)</td>
<td>120 (46-148)</td>
<td>12</td>
</tr>
<tr>
<td>Food hygiene</td>
<td>92 (24-211)</td>
<td>172 (76-372)</td>
<td>13</td>
</tr>
</tbody>
</table>

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Form for turnaround time data collection to be completed by the MLSO processing the specimen.

BACTERIOLOGY AUDIT
SPECIMEN TURNAROUND TIMES (TAT)

NATURE OF SPECIMEN:
WARD / DEPT / SOURCE:
SAMPLE BIAS: BEST/MEDIAN/WORST
SOURCE BIAS: GP / HOSPITAL / OUTSIDE HOSPITAL
ON CALL: YES / NO

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Cumulative TAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Specimen request made</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Specimen left ward/source</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Specimen received in lab. dispatch</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Specimen received in lab.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>If/when telephone report made</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>If/when interim report made</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Final report available</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Final report authorised</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Final report left lab.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Final report left office</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Final report reached ward</td>
<td></td>
</tr>
</tbody>
</table>

Comments

Discussion
The main advantage of this method is the direct laboratory control of data entry and lack of reliance on the participation of ward staff and porters. A compliance of virtually 100% can therefore be achieved. The method also allows the user flexibility to design a one week study period as reported here, or a more prolonged assessment as reported by Rogers et al.1

Certain areas were less appropriate to turn-round time analysis due to the small numbers of positive results (mycobacteriology and blood cultures) and lack of urgency outside the laboratory (food hygiene microbiology). Those specimens requiring referral to another laboratory were excluded. Although laboratory turnaround time endpoints were taken as final report available (datum point 7), very often an interim report was of greater clinical importance.

The data were helpful in identifying inefficient aspects of the laboratory service and helped in the correction of deficiencies and improvements not only in laboratory practice but also in specimen and report delivery.

Careful scrutiny was required of the large amount of turnaround time data generated. This was particularly so in analysing delays which were outside the scope of laboratory control. Several improvements have arisen as a result of the audit and are examples of closing the audit loop.2 Two examples are listed as follows.

(a) Most general practice reports were posted and received the next day. However, the worst delay in this category occurred in a practice in very close proximity to the laboratory which relied on the practice porters liaising with the laboratory porters at a half way site in the hospital. Poor cooperation was identified at this point leading to delays of up to several days. These reports are now posted and preliminary checking has shown that delivery occurs the next day. Indeed, on closer examination a further delay was avoided in
Evaluation of modified passive haemagglutination assay for Vi antibody estimation in *Salmonella typhi* infections

G Kang, G Sridharan, M V Jesudason, T J John

Abstract

A simple passive haemagglutination assay (PHA) was developed to detect Vi antibodies, to improve the diagnosis of typhoid fever by small laboratories. The Vi capsular antigen of *Salmonella typhi* was extracted by alternate alcohol and acetone precipitation. Formalin fixed, sheep red blood cells treated with chromium chloride were sensitised with this Vi antigen and antibodies detected and measured by PHA. The test had a sensitivity of 83-3% among 30 cases of typhoid fever confirmed by culture. The specificity of the test was 94%, making it suitable for use in laboratories without facilities for IFAT or ELISA.

Typhoid fever continues to be a major problem in tropical developing countries. The facilities available for a confirmative microbiological diagnosis are often inadequate in such areas. Simple, economical, and reliable methods for diagnosis are therefore imperative. The conventional Widal test serves a useful but modest purpose. Many immunological tests such as indirect fluorescence antibody test (IFAT) and enzyme linked immunosorbent assay (ELISA) have been devised to detect Vi antibody in the serum of patients with typhoid fever and typhoid carriers.1 2 The passive haemagglutination assays (PHA) have been used for antibody detection in typhoid carriers.3 Those reported have relied on heat extracted Vi antigen or antigen prepared by ethanol-cetavlon precipitation.4 This report describes a modified method of Vi antigen preparation and evaluation of the PHA both in cases of typhoid fever and typhoid carriers.

Methods

Vi antigen was prepared from *S typhi* (ST) (NCTC 8382) grown on Mueller Hinton agar for 18 hours. The saline harvest of the organisms was heated at 100°C for one hour and centrifuged. The supernatant was treated with 2-5 volumes of absolute ethanol and proteins precipitated out. Centrifuged supernatant was treated with 3 volumes of acetone and the Vi polysaccharide was precipitated out and vacuum dried. Sheep red blood cells (SRBC) were fixed in formalin according to Coizmas’s method.5 Formalin (50 ml) was dialysed into 200 ml 12-5% (SRBC) in phosphate buffered saline (pH 7-4) (0-13 M) (PBS) for three hours and then formalin released into the SRBC suspension. This mixture was placed on a rotator overnight at room temperature. The coarse particles were removed and the SRBC suspension washed and stored at 4°C. A 4% suspension of SRBC was treated with chromium chloride (CrCl₃ · 6H₂O) at a concentration of 40 µg/ml for 15 minutes at 37°C with frequent mixing. After three washes in PBS, pH 7-4 (0-15 M), 2 ml of a 10% suspension of treated cells were mixed with 1 ml of Vi antigen solution (2 mg/ml) and incubated at 37°C for two hours with continuous mixing. The cells sensitised with Vi antigen were made into a 1% suspension in PBS, pH 7-4, containing 0-2% bovine serum albumin (BSA). A 1% suspension of unsensitised cells treated with chromium chloride was also prepared to serve as controls. All sera were absorbed with SRBC
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doi: 10.1136/jcp.45.8.738

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