The use of performance metrics to monitor the impact of CPOE on pathology laboratory services

Andrew GEORGIOUa,1, Wendy MORSEb, Wyndham TIMMINSb, Sangeeta RAYc, Johanna I. WESTBROOKa

a Health Informatics Research & Evaluation Unit, Faculty of Health Sciences, The University of Sydney, 1825, Australia
b Sydney South West Area Health Service Pathology Liverpool, 1871, Australia
c Discipline of International Business, The University of Sydney, 2006 Australia

Abstract. Organisational communication perspectives provide a framework for examining the impact of new Computerised Physician Order Entry (CPOE) systems on health care organisations. The aim of this study was to utilise performance metrics (volume of telephone/fax calls and the management of unfulfilled test requests) as a way of monitoring the impact of a new CPOE system on the communication (synchronous and asynchronous) interface in the Central Specimen Reception (CSR) area of a pathology laboratory service. The total number of outgoing and incoming calls rose considerably after the implementation of the new system. The number of unfulfilled test requests initially increased in the implementation period and thereafter fell to below pre-implementation levels. There were significant differences in the relative proportion of duplicate (69% - 35%) and rescheduled requests (4% - 24%) between the pre- and post-periods. Performance metrics, can be relevant for measuring and monitoring changes in communication processes. This is important with CPOE systems whose introduction can have unexpected consequences requiring early detection and action.

Keywords. Computer order entry, Evaluation studies, Hospital information systems, Laboratories, Pathology

Introduction

CPOE systems automate the clinical ordering process [1], and through the incorporation of clinical decision support and database linkage have the potential to contribute to improving the efficiency and quality of health care delivery [2]. However, their introduction into hospitals can also result in major changes to work practices.
particularly in the way that hospital departments communicate and work with each other [3]. To date there has been little research into the impact of these systems on laboratory functioning. The existing research in this area has tended to focus on the pre-analytical (doctor’s decision to order) and post-analytical (delivery and application of test results) stages of the pathology ordering process, with little attention to ward-laboratory communication patterns and work patterns [4].

Information processing and communications are critical features of most activities within an organisation. Careful and systematic monitoring of how CPOE systems are used and their contribution to these processes can help to maximise system effectiveness [5]. The aim of this study was to utilise two performance metrics (volume of telephone; and fax calls and the management of unfulfilled test requests) as a means of monitoring the impact of a new CPOE system on the communication (synchronous and asynchronous) interface in the Central Specimen Reception (CSR) area of a pathology laboratory service after the changeover to a new results reporting system followed by electronic ordering two months later.

1. Material and Methods

1.1. Research Setting

The study was undertaken in the CSR department (consisting of around 20 staff) of a pathology laboratory service located in a large (640-bed) hospital in Sydney, Australia. On 22 November 2005, the Cerner Millennium Pathnet system replaced the previous laboratory information system. This was the precursor to the introduction in January 2006 of the Power Chart (version 2004.01) electronic ordering system which included some basic decision support features including prompts for essential patient information and notification of duplicate test requests.

1.2. Procedures

1.2.1. Telephone communications

Hospital communication data logs listing the number of incoming and outgoing calls for each of the existing CSR phones and fax machines were accessed. These summaries were grouped into five quarters beginning in June – August 2005 and ending June – August 2006 to compare the number of calls over the period.

1.2.2. Unfulfilled test requests

In the pre-CPOE period, CSR blood collectors visited wards to access the hand written requests. They matched the hand written request with the patient, and then proceeded with the specimen collection. On occasions where a collection was unable to be taken, and after consultation with the responsible clinician, the request was either put aside for collection on a future round or a notation was made on the request form and then returned to CSR as an unfulfilled request. An unfulfilled request is therefore one where a blood specimen was not taken and the request cancelled. Unfulfilled requests can occur for a number of reasons; it could be a duplicate test request inadvertently made for the same patient by different clinicians; it may have been cancelled by the clinician;
This procedure changed with the implementation of the new system on 22 November 2005. The department introduced a form to record the details of the episode including patient identification, ward, and date, and the reason for not collecting a specimen. The form provided the following choices: 1) Difficult collection; 2) Patient refused; 3) Patient unavailable; 4) Patient aggressive; 5) Patient not fasting; 6) Other. The forms also required the collectors to record whether the collection was rescheduled or cancelled. The information from these forms was then used to either cancel or reschedule the test request in the electronic system. These forms, along with all unfulfilled requests forms prior to 22 November 2005, were made available to the research team to audit for the period September 2005 to March 2006. Data were collated and cross validated by two researchers. Data about the total number of test requests per month were obtained from the pathology information service.

1.2.3. Analysis

The total and average number of incoming and outgoing calls per telephone/fax line were analysed by three-month (quarterly) periods. The proportion of unfulfilled requests to the total number of tests over each month, and of telephone calls for each quarter were also calculated. To aid the longitudinal overview of these data, the month of November (unfulfilled requests) and the Sep-Nov quarter (phone calls) were included as part of the pre-implementation period. However the Chi-square tests comparing types of unfulfilled requests during the pre- and post- periods used 22 November 2005 as the delineator date.

2. Results

2.1. Telephone communication

Table 1 shows the number of outgoing and incoming calls per quarter alongside their proportion to the total number of test requests for each period. It also provides the average number of calls per telephone/fax line. The number of calls (incoming and outgoing) for each quarter doubled in the Mar-May 06 periods and remained high in the Jun-Aug 06 period. The average number of incoming calls over the study period changed considerably but with high standard deviation (SD) values. In contrast the averages for outgoing calls did not vary as much and the SD values were lower.

2.2. Unfulfilled test requests

There were 4794 unfulfilled test requests for the period September 2005 to March 2006. Table 2 shows that the number of unfulfilled test requests rose sharply from 356 in the pre-implementation month of September 2005, to a peak of 1543 in December 2005, and then fell to 143 in March 2006. There was a similar trend in the proportion of unfulfilled test requests to total test requests, rising from 0.008 in September 2005 to 0.04 in December 2005 and then decreasing to 0.003 in March 2006. The number of cancelled and rescheduled requests was also compared over the pre- and post-implementation periods. In the pre-implementation period rescheduled requests
amassed to 4% (n=26) of all unfulfilled requests. This proportion rose to 24% (n=969) post-implementation. Cancelled requests fell from 96% (n=672) of the total pre-implementation number to 76% (n=3127) in the post-implementation period ($\chi^2 = 144.1; \text{df} 1; p<0.0001$). There was also a significant decrease in the proportion of duplicate requests from 69% (n=484) to 35% (n=1448) ($\chi^2 = 286.4; \text{df} 1; p<0.0001$).

Table 1 Total and mean (with SD) of calls per telephone/fax of incoming/outgoing phone calls and the proportion of total requests (pre-implementation quarters shaded)

<table>
<thead>
<tr>
<th>Month</th>
<th>No. total requests</th>
<th>No. outgoing calls (Proportion to total requests)</th>
<th>Mean (SD)</th>
<th>No. incoming calls (Proportion to total requests)</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jun-Aug 05</td>
<td>121290</td>
<td>2037 (0.02)</td>
<td>169.8 (95.7)</td>
<td>1268 (0.01)</td>
<td>105.7 (56.2)</td>
</tr>
<tr>
<td>Sep-Nov 05</td>
<td>121372</td>
<td>2872 (0.02)</td>
<td>119.7 (68.2)</td>
<td>4054 (0.02)</td>
<td>168.9 (407.6)</td>
</tr>
<tr>
<td>Dec-Feb 06</td>
<td>111703</td>
<td>3061 (0.03)</td>
<td>145.8 (81.5)</td>
<td>4871 (0.04)</td>
<td>232.0 (477.6)</td>
</tr>
<tr>
<td>Mar-May 06</td>
<td>118290</td>
<td>6078 (0.05)</td>
<td>155.9 (96.1)</td>
<td>10683 (0.09)</td>
<td>273.9 (554.8)</td>
</tr>
<tr>
<td>Jun-Aug 06</td>
<td>125334</td>
<td>5850 (0.05)</td>
<td>121.9 (87.5)</td>
<td>10678 (0.09)</td>
<td>222.5 (490.1)</td>
</tr>
</tbody>
</table>

Table 2 No. unfulfilled requests as a proportion of total requests (pre-implementation months shaded)

<table>
<thead>
<tr>
<th>Month</th>
<th>No. unfulfilled requests</th>
<th>No. total requests</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep-05</td>
<td>356</td>
<td>42066</td>
<td>0.008</td>
</tr>
<tr>
<td>Oct-05</td>
<td>323</td>
<td>39551</td>
<td>0.008</td>
</tr>
<tr>
<td>Nov-05</td>
<td>395</td>
<td>39755</td>
<td>0.010</td>
</tr>
<tr>
<td>Dec-05</td>
<td>1543</td>
<td>38129</td>
<td>0.040</td>
</tr>
<tr>
<td>Jan-06</td>
<td>1234</td>
<td>36559</td>
<td>0.034</td>
</tr>
<tr>
<td>Feb-06</td>
<td>800</td>
<td>37015</td>
<td>0.022</td>
</tr>
<tr>
<td>Mar-06</td>
<td>143</td>
<td>42513</td>
<td>0.003</td>
</tr>
</tbody>
</table>

3. Discussion

The results show dramatic fluctuations in the number of telephone calls and unfulfilled test requests from the period prior to the system changeover and extending some months later. These fluctuations can impact on the synchronous and asynchronous channels of communication with consequences for work processes in the department.

3.1. Synchronous communication

The results of the comparison of telephone calls revealed a major increase in the number of incoming and outgoing phone calls associated with the introduction of the new reporting system in November 2005 followed by the new ordering system in January 2006. This implies a rise in the level of activity within the department. The
high standard deviation values for the means of incoming calls suggests that the increased number of calls has not occurred in a sustained way across the department, and are possibly concentrated in those sections which deal with enquiries from the wards. Conversely, the smaller standard deviation values for outgoing calls indicate that the increased number of calls was more consistent across the department. These findings correspond with research suggesting that changes in modes of communication brought about by the introduction of asynchronous CPOE order channels can contribute to levels of disruption and dysfunction [6].

3.2. Asynchronous communication

In the pre-implementation period the recording of a reason for an unfulfilled test request was generally ad hoc and inconsistent. This procedure was standardised after the introduction of the new results reporting system on 22 November 2005. The introduction of structured information allows clinicians to electronically monitor the status of requests. It also indicates a higher level of CSR/ward accountability. However, the rise in the volume of telephone calls beginning with the introduction of the new results reporting system (November 2005) followed by the new order entry system (January 2006) suggests that the phone was used heavily by clinicians as a means of monitoring the status of test requests. This may have been a transitory phenomenon associated with unfamiliarity of the new system [7]. Regular monitoring of the situation using the metrics outlined in this study can answer this question.

While the proportion of unfulfilled requests increased dramatically following the system changeover on 22 November 2005, it fell away after a few months to levels below those found previously. This rise is possibly due to the instability associated with implementation. On the other hand, the significant decrease in the relative proportion of duplicate requests points to the existence of a more fundamental change associated with the new system. This supports existing evidence that CPOE can help to reduce the level of unnecessary and duplicate requests [8].

The fall in the number of cancelled requests as a proportion of all unfulfilled requests is more complicated. There are instances where it is obviously necessary to cancel a test request. Such an occasion occurs when a patient is discharged or a test request has been duplicated by mistake, or even when a doctor may decide to cancel a request. However, not all unfulfilled requests need to be cancelled. For instance, a patient may be temporarily unavailable or may not have fasted, or there may have been a situation where a collection was not possible. A patient may not be available for a blood collection for no other reason than they were undergoing treatment in another part of the hospital at the time. The decrease in the relative proportion of cancelled requests is therefore likely to be a consequence of the replacement of previous ad hoc monitoring systems with improved reporting structures associated with CPOE.

3.3. Laboratory impact

CSR occupies a specific organisational role in the laboratory test process sitting between the clinician’s decision to make a test request and the actual processing of the specimen [3]. Its responsibilities include the maintenance of maximum levels of coordination (of information and specimens), as the preservation of the integrity of the test request. This in turn involves attention to accuracy and requires high levels of accountability and efficiency. The results of this study show that CPOE can impact on
these areas of responsibility. This can occur through the introduction of structured ways of entering data which can lead to improved levels of coordination and accountability. It can also lead to changes in the efficiency of work processes, especially through its ability to reduce duplication. However, these changes are not necessarily consistent. The increased levels of telephone/fax communication in the department associated with the system changeover suggest that it may also severely affect work load levels.

3.4. Limitations:

The choice of research method, in this case the monitoring of telephone/fax communications and unfulfilled orders can be affected by issues of data comprehensiveness and reliability. This study has endeavoured to offset these potential limitations through rigorous attention to the accuracy and completeness of the data.

4. Conclusion

Communication within the hospital setting is all pervasive but is often overlooked or taken for granted. Performance metrics, chosen wisely and used carefully, can be relevant to the task of monitoring changes in communication processes. They can also serve as a valuable tool for identifying trends or potential problems as part of statistical process control methods aimed at the early detection and prevention of problems [9]. This is particularly important with CPOE systems where implementation can have unexpected (possibly dysfunctional) consequences requiring early detection and action.

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References